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RESEARCH PAPER

Iran's Export Potential to Brazil (2001-2018): Based on Conventional Indicators and Gravity-VEC Approach

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Abstract
The present study aimed to investigate the expandability of Iranian export to Brazil using both micro and macro-level approaches. At the micro-level, Iran's export that keeps pace with the Brazilian market were identified based on relevant conventional indicators including normalized revealed comparative advantage index, Cosine index and simple estimation of trade potential. Using HS two-digit data from 2001 to 2018, it is shown that Iran has an export potential to Brazil for some commodities. The impact of major macroeconomic factors on Iran's exports to Brazil is analyzed based on the gravity model and applying the vector error correction method (VECM). In the short-run and the long-run, the results confirm that Iran's GDP, the joint population size of the two countries, air freight cost have a positive effect while Brazil's GDP and Linder variable harm Iran's export to Brazil. The ratio of the official exchange rate of Iran to Brazil has a positive effect in the short-run and a negative effect in the long-run. Brazil's membership in the WTO has a significant positive effect on Iran's exports to Brazil. While the impact of financial and nonfinancial sanctions on Iran's exports to Brazil is not significant. In summary, based on the macro-level indicators, the development of trade relations is logically justified. However, trade capacity between the two countries has not been realized in the given period due to political and international circumstances (not because of the lack of economic justification).
Keywords: Non-Oil Export, Cosine Index, Normalized Revealed Comparative Advantage Index, Trade Potential, Gravity Model, Vector Error Correction Model.
JEL Classification: F14, F42, C13.

Introduction

Export development, especially non-oil exports, is one of the priorities of Iran's development plans in recent years. One of the main barriers to export expansion in developing countries is that they do not recognize their export capacities as well as the target markets where there is a high demand for their exports. Therefore, exporters mainly focus on traditional markets and partners[1], while there is high competition and more difficult to enter. Due to the lack of reliable economic data, it is believed that developing countries produce similar products that are primarily raw materials and therefore, there is not significant bilateral trade between them. Accordingly, insufficient knowledge about the export pattern of the origin country and the import pattern of the destination country makes it less possible to plan efficiently for export

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1. Iran's main export destinations were Asia, China, Iraq, the United Arab Emirates, Afghanistan, the Republic of Korea and Turkey for many years.

development. To this end, it is essential to discover and assess the trade potential between Iran and its potential partners as well as major export sectors, goods and services in which Iran has competitiveness and export expansion capability.

In this sense, Latin America is one of the regions in the world where Iran has not benefited from bilateral trade relations. For years, there was, albeit limited, interaction between Iran and Latin American countries in various political, economic, and cultural fields. Diplomatic relations and political and global issues have affected Iran's trade relations with Latin American countries, so there has never done any important planning to develop trade relations with countries in the region. Latin American countries with an area of 22 million square kilometers and a population of over 600 million are one of the major export destinations of the world; 5.8 percent of total exports of the world went to the region in 2018. However, in these bilateral relations, Iran's trade balance with these countries is negative and faces a deficit of $ 762 million in 2018. Among Latin American countries, Iran's most stable trading partners in recent years are Brazil, Mexico and Venezuela. Figure 1 shows Iran's exports to these countries in the last two decades. As it is evident, in recent years, Brazil is one of Iran's most important export destinations and in 2018 more than 63% of Iran's exports to this region were exported to this country, however, Iran's exports to Brazil account for only 0.02% of Brazil's total imports from the world. In 2018, a decrease of about 11 million US $ (2.3%) in Iranian exports to Brazil despite the 170 million US $ (20%) increase in Brazilian imports from the world raises the question of whether the Brazilian market is considered a stable market for the export of Iranian goods in the long run.

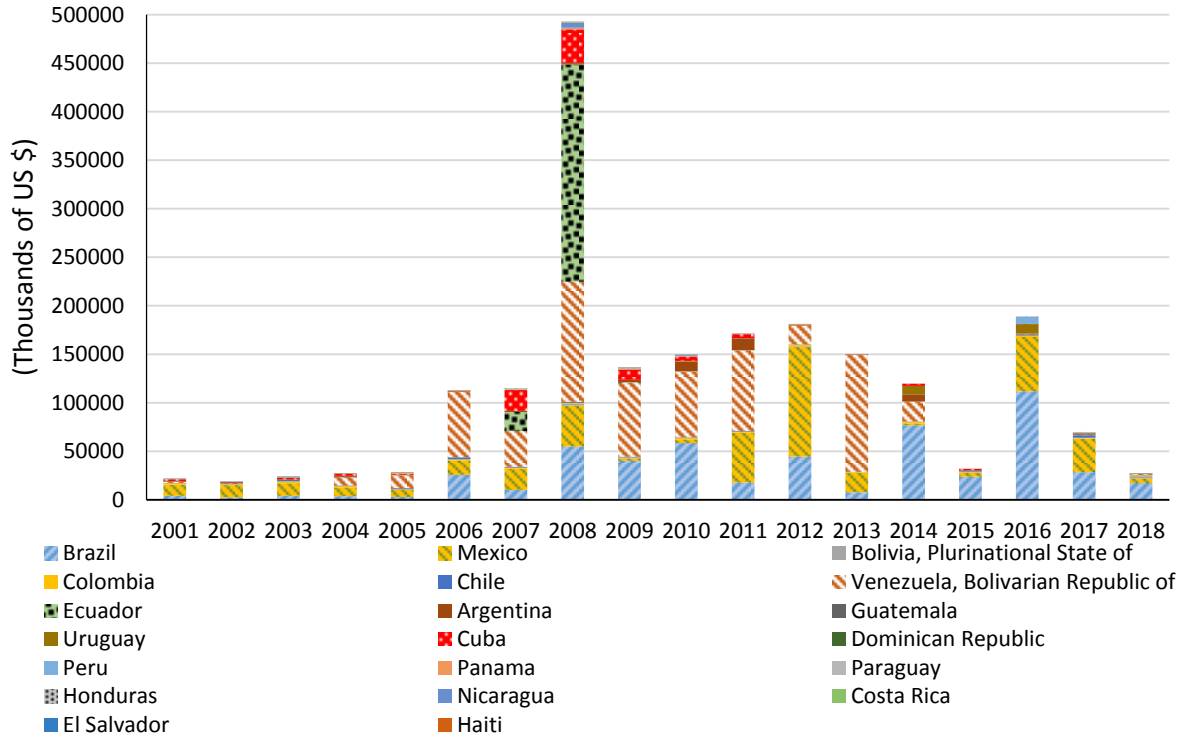

Figure 1. Iran's Exports to Latin American Countries (2001-2018)
Source: Trademap.org.

To this end, this study provides an overview of Iran-Brazil relations from 2001 to 2018, the years when detailed statistics on bilateral trade between the two countries are available. Statistics show that despite the efforts of both countries to expand trade relations, little progress has been made in their bilateral relations (Figure 2). In 2003, Petrobras, a Brazilian oil company, obtained a license to explore oil in Iran, so Iran became Brazil's largest trading partner in the Middle East. The period of the presidency of Lula da Silva in Brazil and

Ahmadinejad in Iran was a remarkable period of high-level political and economic delegations exchange; signing of various documents and agreements is unprecedented in this period. As is evident in Figure 2, since 2005 there is an increase in the volume of Iran's export to Brazil. However, despite the efforts made to increase Iran's exports to Brazil, even when the political situation was in Iran's favor, the increase in Iran's exports to Brazil has not been significant. In the period under review, although Brazilian exports to Iran are much higher than their imports from Iran, the Iran's imports from Brazil are not stable and have fluctuated a lot.

Figure 2. Iran-Brazil Bilateral Trade 2001-2018
Source: Trademap.org.

This paper aims to identify Iran's potential export capacities in the micro level and the feasibility of export expansion in the macro level in trading with its largest trading partner in this region, i.e. Brazil. To make a stable and robust trade relationship in the long-run, it is required to know Brazil's imports needs and Iran's exports capacity. For this purpose, we will examine the status and performance of eight commodity groups, according to HS, at the same level of two digits. These are among the major export commodities of Iran and the major import needs of Brazil. These include 1- machinery, mechanical appliances, nuclear reactors, boilers; parts thereof 2- organic chemicals, 3- plastics and articles thereof, 4- iron and steel, 5- ores, slag and ash, 6- fish and crustaceans, molluscs and other aquatic invertebrates, 7- fertilizers, 8- ships, boats and floating structures[1].To this end, the Cosine index evaluates the complementarity degree of Iran's export pattern and Brazil's import pattern. The Normalized Revealed Comparative Advantage Index indicates the performance of selected export commodities in this article and their competitive position compared to other global suppliers and their capability to expand exports to new markets, such as Brazil. The simple estimation of trade potential method in selected commodities reveals Iran's export potential to Brazil. Comparing the estimated potential and the actual trade, we will show that Iran used how many percent of its export potential in trade with Brazil. Finally, using time series regression and gravity-VEC model an attempt will be made to investigate the effect of macroeconomic indicators including economy size (GDP), joint population size, economic differences (Linder), the ratio of the official exchange rate of Iran to Brazil and transportation cost on Iran's export to Brazil in the span of 1989 to 2018.

1. The period of reference (2001-2018) is chosen due to the data availability.

This article consists of five sections. Following a brief overview of the history of trade relations between Iran and Brazil in Section 1, some of the most relevant empirical studies are reviewed in Section 2. Research methodology and the indicators of estimating trade potential and the gravity-VEC approach are introduced in Section 3. Section 4 represents research findings, i.e., the trend of Cosine index, Normalized Revealed Comparative advantage index, Simple estimation of trade potential, and estimation of Gravity Model. The final Section is devoted to conclusions and policy implications according to the findings in section 4.

Literature Review

Many studies have analyzed the possibility of expanding export frontiers using conventional methods. But, few of them are dedicated to examining Iran's trade relations with Latin American countries. The related research works can be divided into the following two categories: 1- studies examining economic and trade relations with Latin American countries 2- studies that use either conventional methods to estimate trade potential or the gravity approach to find macroeconomic indicators influencing bilateral trade.

In the first category, Afshari (2005), Caro and Rodriguez (2009), Eskandari (2013), Pindo (2015), Aurelio and Gomes (2018) and Aranda (2018) research works are related to Iran's presence in Latin America and its economic relations with the countries in the region.

Aurelio and Gomes (2018) in their most recent study argue the presence of Brazil in the Middle East based on a south-south approach and indicate that these relations are limited by the United States mainly because of a conflict of interest.

In their research, Pourrostami and Sobhanian (2013) have examined the economic relations of the Latin American region. They investigated per capita income convergence in Latin America and the Caribbean using the Beta and Sigma convergence approaches over 1980 to 2009. The research results showed that based on the beta convergence approach, the convergence hypothesis among the 29 countries in the region does not hold. The convergence hypothesis is only validated for countries with an average per capita income above $ 3,000 per year, using the Beta and Sigma convergence approaches. Lotfalipour and Shakeri (2011) examined the economic convergence between Iran and Latin American countries. They have evaluated the effects of a trade block establishment on bilateral trade using the gravity model approach. The results show that the trade block can increase trade among member countries by 89%.

The above mentioned studies have cited the achievements and challenges of different periods of international issues and regional tensions. These studies focus on the economic and political dimensions of Iran-Latin America relations and discuss the challenges in this regard. However, none of them investigated the trade capacities and the appropriate strategies for developing Iran's exports to the region and more particularly to Brazil.

In the second category, Vali Beigi et al. (2004); Rahmani (2005); Hassanpour and Haji Mirzaei (2008); Rahmani and Abedin Moghanaki (2008); Pakravan and Gilanpour (2013); Bayat and Sadeghian (2014); Astaneh et al. (2014); Laursen (2015); French (2017); Pourrostami et al. (2018); Stellian and Buitrago (2019); and Saki et al. (2019) have used post-trade data to estimate the trade potential between trading partners based on the Drysdale index, the revealed comparative advantage, cosine index and simple trade potential index.

Many studies have examined the effect of macroeconomic, spatial and environmental variables on the volume of bilateral trade between countries using the model of gravity. Prominent research works include the study of Ravenstein (1885) and Tinbergen (1962). In these studies, the effect of unfair conditions such as heavy taxes, oppressive laws, etc. in the countries of origin and favorable conditions in the destination countries on migration and trade have been investigated.

Anderson (1979) and Bergstrand (1985) are the first to offer a theoretical economic

foundation for the gravity equation under the assumptions of product differentiation by place of origin and Constant Elasticity of Substitution (CES) expenditures. The academic interest in the gravity model was recently stimulated by the influential works of many researchers such as Martinez and Nowak (2003); Batra (2006); Boughanmi (2008); Asgari (2011); Soori and Tashkini (2012); Pourrostami (2015); Harati et al. (2015); Azarbayejani et al. (2015); Žiković et al. (2015); Shirazi et al. (2016); Rasoulinezhad and Kang (2016); Popova and Rasoulinezhad (2016); Ghanbari and Ahmadi (2017); Rasoulinezhad and Popova (2017); Michael and Emeka (2017); Irshad et al. (2017); Alam & Ahmed (2018); Rahman et al. (2019); Karami et al. (2019) Rasoulinezhad (2019); and Yazdani et al. (2019); are among the researches that explored bilateral trade model of Iran with its trade partners. These studies show that the gravity model provides a good fit of the variables affecting the amount of trade between different countries.

According to the above research works, the study of the factors affecting Iran's exports to Brazil has not been considered by any research so far. Therefore, the present study primarily uses post-trade data to identify goods that have enough capacity to export from Iran to Brazil, using the revealed comparative advantage index, the cosine index and the simple estimation of trade potential. The main determinants affecting trade flows from Iran to Brazil will be identified using the Gravity-VEC model, which is described in detail in the following section.

Research Methodology

Many empirical studies have used post-trade data to examine how trade between countries develops. In the present study, based on some researches (Balassa, 1965; Linnemann, 1966; Finger and Kreinin, 1979; Drysdale, 1988; Unctad, 2002), the value of potential trade and the improvement of trade relations has been investigated using simple mathematical and statistical methods.

Trade potential estimation methods at two levels, micro and macro, can be broadly categorized into three groups: 1- estimation of trade potential using similarity test including cosine index, normalized revealed comparative advantages, 2- simple estimation of trade potential method, and 3- trade potential estimation method using gravity model. Indicators of the first two groups, which are at the micro-level, show in which goods or commodity groups there is trade capacity between the two countries. The model of gravity at the macro-level determines the factors affecting trade between the two countries. In the following, first, the conventional indices of the three above-mentioned methods are introduced and then in the next section, these indices will be calculated using Iran's exports to Brazil.

Cosine Index

Trade complementarity index is an empirical technique that can be used to assess the extent to which the export specialization and the import specialization of trade partners complement one another concerning world trade (Pourrostami et al., 2018: 295). Cosine Measure (COS) was first introduced by Roy Allen in 1956, to be developed and enhanced by Linnemann, 1966 and Pourrostami et al., 2018: 296. In this criterion, the COS is used to measure the degree of export-import compliance of the two countries. This criterion is defined in Equation 1:

$$COS_{ij} = \frac{\sum_{n=1}^{n=n}\left(X_{ik} * M_{jk}\right)}{\sqrt[2]{\left(\sum_{n=1}^{n=n} X_{ik}^2\right) * \left(\sum_{n=1}^{n=n} M_{jk}^2\right)}} \quad (1)$$

$K = 1,2,3,\ldots,n\text{-}1,n$

where, X_{ik} is the exports of country i in commodity k to the world. M_{jk} is the imports of country j in commodity k from the world. The smaller angle indicates that country i's exports to all destination countries in the world are similar to countries j's imports from all over the world, and vice versa. When the export goods of country i are the same as the imported goods of country j, there is a complete degree of complementarity between the two countries. When the values of X_{ik} and / or M_{jk} are zero for commodity k, trade-in commodity k between countries i and j cannot exist, and the vectors Ei and Mj become perpendicular to each other. Therefore, Cosij = 0 and the degree of complementarity of trades will be zero. In summary, the Cosine measure lies between two extreme values of zero and one. The closer the COS is to one, the greater the trade complementarity, and vice versa.

Normalized Revealed Comparative Advantages

The principle of comparative advantage is one of the most fundamental economic theories of international trade. Liesnar (1958) pioneered the definition of the "strong" sector of a country. In his analysis, the strong sector refers to sectors that contain more commodities with a comparative advantage and specialize in their production. For this reason, exports are expected to increase in the "strong" sector.

This method was later used by Blasa (1933-1983) and is now called the Blasa index. Besides, because this index uses the real flow of exports to introduce the "powerful sectors of the country" as the sectors with an advantage, this index is called the" revealed comparative advantage" index. The formula of the index is as follows:

$$RCA_{ki} = \left[\frac{X_{ki}}{X_i} \Big/ \frac{X_{kw}}{X_w}\right] \quad (2)$$

where, X_{ki} is the export of country i in commodity k, and X_i is the total export of country i. W represents the world. The RCA index calculation is based on real trade data and lies between the extreme of zero and infinity. When the value of the index for commodity k is between zero and one, it shows the lack of comparative advantage of exports in commodity k. But if the value of the index goes from 1 to infinity, it indicates a comparative advantage in commodity k's export. Besides, the trend of the index over time shows where the country is going in terms of export specialization. A downward value of the index means moving towards the loss of specialization and its upward value means increasing the specialization in the export of commodity k. For a better evaluation of RCA, this index is normalized to a maximum of +1 and a minimum of -1 in equation 3:

$$NRCA_{ki} = \frac{RCA_{ki} - 1}{RCA_{ki} + 1} \quad (3)$$

In this case, positive values indicate a comparative advantage and negative values indicate a lack of comparative advantage . The closer the NRCA value for a commodity is to +1, the higher the country's comparative advantage in exporting that commodity, and the closer the value of this index is to -1, the lower the country's comparative advantage in exporting that commodity.

Simple Estimation of Trade Potential

The first major attempt to measure countries' export potential was made by UNCTAD (2002). In the present study, this method is used to estimate Iran's export potential to Brazil based on the formula in equation 4 as follows:

$$XP_{ij}^{k} = 30\% * MIN\left(X_{iw}^{k}, M_{jw}^{k}\right) \quad (4)$$

K=1, 2, …,n

The value of exports and imports of Iran and Brazil to the world as well as bilateral trade between the two countries based on HS - two digits are extracted from the Trademap website. The unrealized export potential between the two countries is calculated using Equation 5 as follows:

$$UX_{ij}^{k} = XP_{ij}^{k} - M_{ji}^{k} \quad (5)$$

Where,

UX_{ij}^{k} is the unrealized export potential of country i (Iran) in commodity k, M_{ji}^{k} is the import value of country j (Brazil) from country i (Iran) in commodity k.

Gravity Model

Model Specification

To examine the possibility of expanding the export of one country to another, it is necessary to examine the impact of macroeconomic variables on relations between the two countries. The gravity model is one of the common models for this purpose. Two important factors in the gravity model to explain the flows of bilateral trade are the geographical distance between the two countries and their economic size. The simple equation of the gravity model for two countries (i and j) is as follows:

$$T_{ij} = G\frac{GDP_i * GDP_j}{D_{ij}} \quad (6)$$

where, G is the constant, T stands for bilateral trade flows, D indicates geographical distance and GDP represents economic dimensions of the two countries. We take the logarithmic transformation of equation 6 to get a linear form for estimation. The result is as follows:

$$LogT_{ij} = \alpha + \beta \log(GDP_i) + \delta \log\left(GDP_j\right) - \varphi \log\left(D_{ij}\right) + \varepsilon_{ij} \quad (7)$$

Following the manipulation performed by Deardorff (1998), Rasoulinezhad & Popova (2017), Equation 7 was transformed into Equation (9) according to the principle of logarithm in Equation (8).

$$Log\ (XY) = Log(X) + Log(Y) \quad (8)$$

Thus, the new form of the gravity model is formulated as:

$$LogT_{ij} = \alpha + \mu \log\left(GDP_i * GDP_j\right) - \varphi \log\left(D_{ij}\right) + \varepsilon_{ij} \quad (9)$$

Deardorff (1998) developed the above equation adding population size, so the ultimate structure of the gravity model will be as follows:

$$LogT_{ij} = \alpha + \mu \log\left(GDP_i * GDP_j\right) + \omega \log(POP_i * POP_j) - \varphi \log\left(D_{ij}\right) + \varepsilon_{ij} \quad (10)$$

In the present study, the gravity model is specified as follows:

$$LnExport_t = \alpha_0 + \alpha_1 LnGDP_{it} + \alpha_2 LnGDP_{jt} + \alpha_3 LnPOP_{ijt} + \alpha_4 LnLinder_{ijt} + \alpha_5 LnExch_{ijt} + \alpha_6 LnAirfr_{it} + \alpha_7 SANCF_t + \alpha_8 SANCNF_t + \alpha_9 WTO_t \quad (11)$$

where, $export_t$ denotes Iran's exports to Brazil, GDP_{it} and GDP_{jt} represent the economy size in Iran and Brazil. POP_{ijt} indicates the joint population size in Iran and Brazil (population $_{Iran}$ + population $_{Brazil}$). Linder variable is an economic difference between countries, which is the difference in GDP per capita (Purchasing Power Parity at current US $) between Iran and the partner country, Brazil:

$$Linder = |PPP_{Iran} - PPP_{Brazil}| \quad (12)$$

As it is shown in Equation 13 Exch is the ratio of the official exchange rate of Iran to Brazil. This explanatory variable is included in the gravity model according to the study of Bergstrand (1985) and Dell ‟Arricia (1999).

$$Exch_{ijt} = \frac{Official\ exchange\ rate\ (LCU\ per\ US\$,\ period\ average)_{Iran}}{Official\ exchange\ rate\ (LCU\ per\ US\$,\ period\ average)_{Brazil}} \quad (13)$$

One of the important variables introduced in the gravity model is the geographical distance between the two countries. Since the geographical distance between the two countries is fixed, the air freight cost[1] (million ton-km) of the exporting country, Iran, has been included in the model as a proxy to measure the effect of the distance between the two countries on exports. Non-financial sanctions (SANCF), financial sanctions against Iran (SANCF) and the membership of Brazil to WTO (WTO) are our main three dummy variables. If the co-integration test confirms a long-run relationship between the variables, an error correction model (VECM) would be considered as follows:

$$\begin{aligned}\Delta LnExport_t = {} & \alpha_1 + \alpha_1 ECT_{t-1} \\ & + \sum_{i=0}^{n} \beta_i \Delta LnExport_{t-i} \\ & + \sum_{i=0}^{n} \gamma_i \Delta LnGDP_{it-i} \sum_{i=0}^{n} \delta_i \Delta LnGDP_{jt-i} \\ & + \sum_{i=0}^{n} \varepsilon_i \Delta LnPOP_{ijt-i} \\ & + \sum_{i=0}^{n} \theta_i \Delta LnLinder_{ijt-i} + \sum_{i=0}^{n} \lambda_i LnExch_{t-i} \\ & + \sum_{i=0}^{n} \mu_i \Delta LnAirfr_{t-i} + \varphi Dummy + \varepsilon_{1t}\end{aligned} \quad (14)$$

where, β, γ, δ, ε, θ, λ and μ are the coefficients to be estimated, ECT_{t-1} is the vector error correction term which is obtained by the long-run co-integration relationship, φ is the coefficient of a dummy variable, Δ is the difference operator, n is the number of lags and ε_{1t}

1. Air freight is the volume of freight, express, and diplomatic bags carried on each flight stage (operation of an aircraft from takeoff to its next landing), measured in metric tons' times kilometers traveled. https://www.indexmundi.com/facts/indicators/IS.AIR.GOOD.MT.K1

indicates the serially uncorrelated error terms.

Gravity Model Dataset Description

To measure the effect of macroeconomic variables on Iran's exports to Brazil, based on the gravity model, time series regression is conducted in the period 1989 to 2019. The model variables are all in the natural logarithmic structure, except for the dummy variables, which take the values zero and one. The definitions and units of all variables are presented in Table1. It should be noted that data on export volume comes from the WITS (World integrated solution, 2020) and ITC (International Trade Center, Trademap, 2020). GDP, population, exchange rate in Iran and Brazil are collected from the World Development Indicators online database. As mentioned earlier, the selected proxy that shows the effect of geographic distance on the gravity model is the air freight cost data extracted from the World Bank online database.

Table 1. Variables of Model

Variables	Definition	Unit
Export	Export volume from Iran to Brazil	Thousand US $
GDP	GDP of Iran and Brazil	current US $
POP	Joint Population size of Brazil and Iran	
Linder	GDP per capita, PPP	(current international $)
Exch	The ratio of the official exchange rate of Iran to Brazil	LCU per US$, period average
Airfr	Air Freight Cost	(million ton-km)
SANCF	Dummy variable takes one when there are none financial sanctions against Iran (1996, 2005-2014)	Dummy (0/1)
SANC	Dummy variable takes one when there are financial sanctions against Iran (2011-2014)	Dummy (0/1)
WTO	Dummy variable takes one in the years of Brazil's membership to the WTO (since 1995); otherwise, it takes 0	Dummy (0/1)

Source: Research compilation.

Research Findings

This section presents the result and interpretation of the estimation of Iran's export potential to Brazil using the mentioned indicators and also the impact of macroeconomic variables on Iran's exports to Brazil through the Gravity-VEC model.

Cosine Index

As mentioned in the previous section, the Cosine index, Equation 1, uses data from Iran's exports to the world and Brazil's imports from the world and estimates the extent to which the exporting country (Iran) can meet the import needs of the importing country (Brazil). The value of this index is presented in Figure 3.

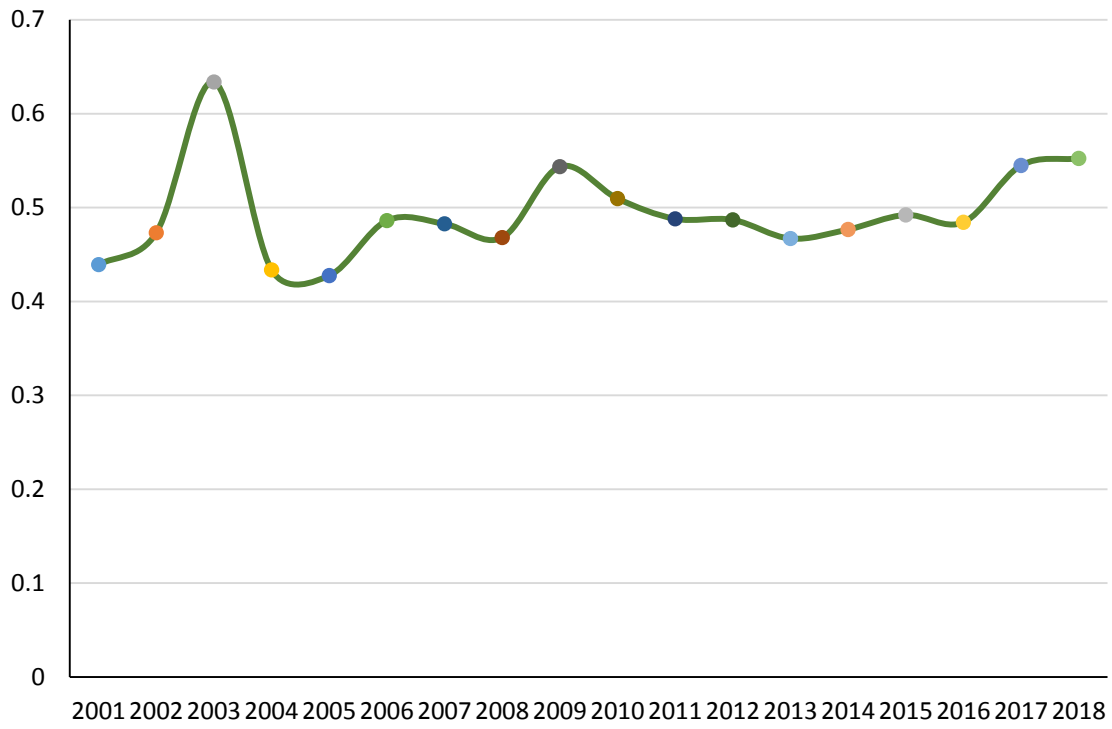

Figure 3. The Cosine Measures of Iran 2001-2018
Source: Calculation by authors, based on (ITC, 2018) data.

The index peaked in 2003 and declined in the subsequent years. However, it has increased from 0.44 in 2001 to 0.55 in 2019. Therefore, the value of the index has an increasing trend with an average of about 0.5 in the period under study. Knowing that the closer the index is to one, the greater is the trade similarity, the degree of similarity between Iran's export pattern and Brazil's import pattern is quite good.

Considering the value of the Cosine index, which is based on real export, it can be concluded that Iranian exporters can compete in the Brazilian market. Therefore, it can be expected that the increase in production scale to expand exports to the large Brazilian market is economically justifiable.

Normalized Revealed Comparative Advantage Index

The calculated value of the NRCA index for the studied goods is shown in Figure 3. Knowing that NRCA index is between +1 and -1, Figure 4 clearly shows that Iran has no comparative advantage in exporting most commodities from 2001 to 2009. However, since 2009, Iran has had a positive comparative advantage in the export of some goods, such as fertilizers, organic chemicals, plastic products, iron and steel, ore. That is, since 2009 Iranian exporters have been able to compete with other producers in the Brazilian market. It can also be noticed that fertilizers have had the highest comparative advantage, followed by organic chemicals, plastic products, ores, iron and steel.

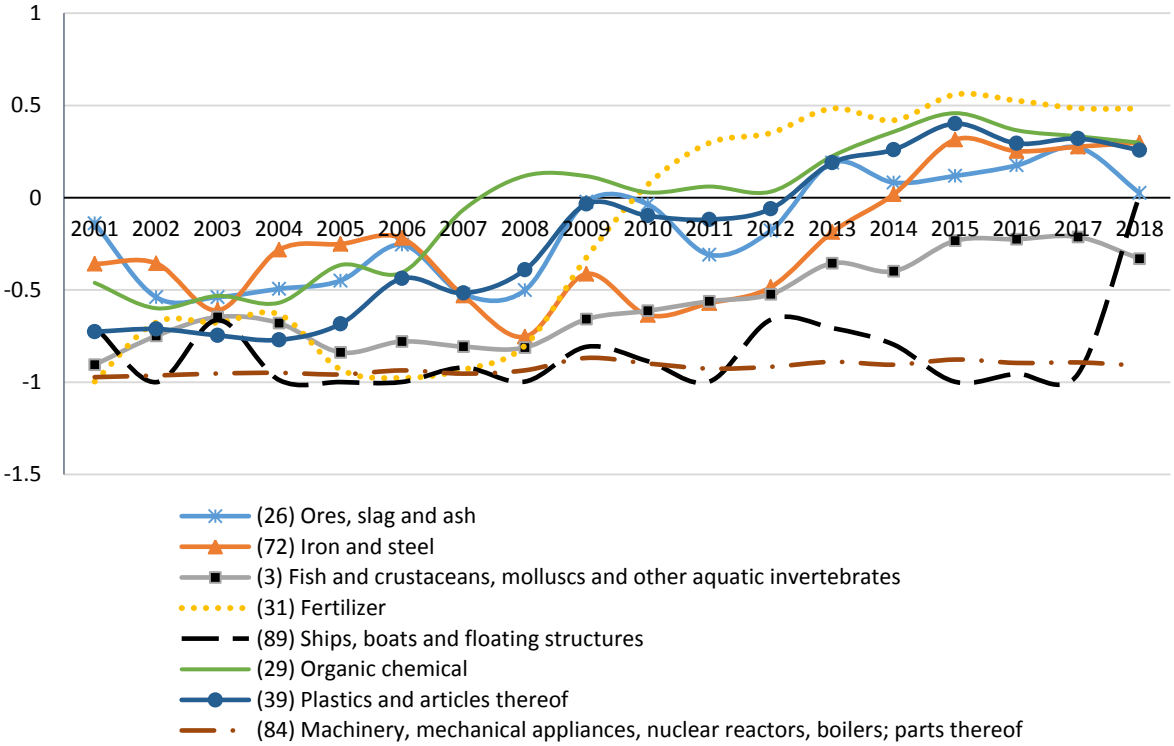

Figure 4. Normalized Revealed Comparative Advantage Index - Iran
Source: Research finding, based on (ITC, 2018).

Simple Estimation of Trade Potential

The results of calculating the potential of Iranian exports to Brazil are shown in Figure 5. As can be seen, most of this potential has not been used. The majority of these commodity groups gained more potential over time and particularly in recent years. The highest estimated potential belongs to the commodity group of plastics and articles thereof, followed by organic chemicals and iron and steel, which have relatively higher potential.

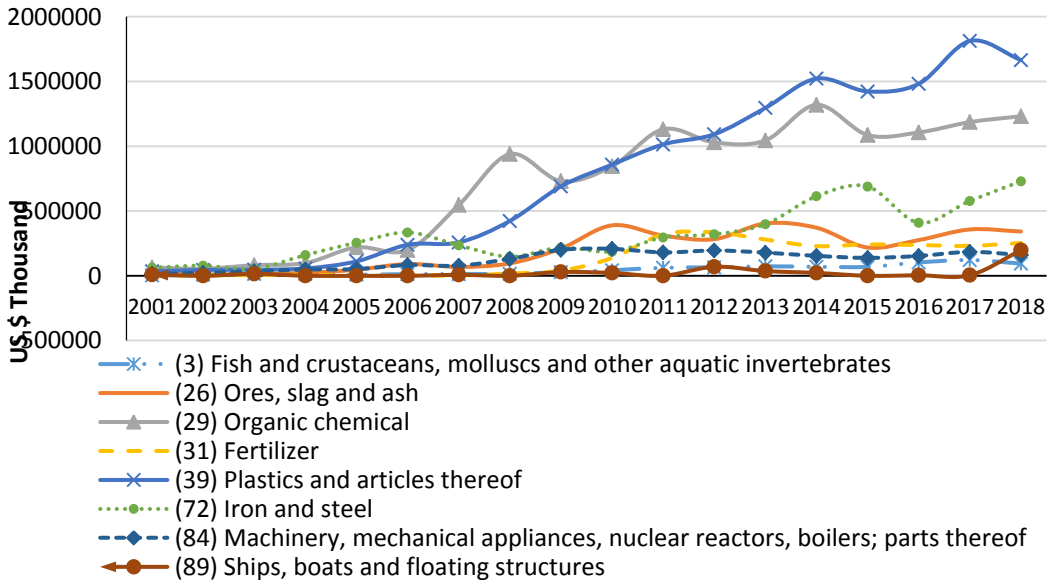

Figure 5. Iran's Export Potential to Brazil
Source: Research finding, based on (ITC, 2018).

Comparison of estimated trade potential with real trade between Iran and Brazil (Appendix 1) shows that in the period under review only some goods, and in some years a small part of trade potential was used. As can be seen in Appendix 1, Iran's export capacity to Brazil in most of commodity groups, in different years has remained completely unused. The results reveal that Iran has been well placed in the export of the goods understudy in the global competition in recent years. However, the export of these commodities from Iran to Brazil is very small and in many cases nothing, though these goods are the main imports of Brazil.

Gravity Model

Before estimating time series regression, model variables must first be examined for the presence or absence of a unit root. In the present study, the Augmented Dickey-Fuller (Dickey and Fuller, 1981; 1979) and the Phillips-Perron (1988) evaluate the stationary test. If a time series variable is non-stationary and possesses a unit root, it is necessary to check the consistency of their linear composition through the co-integration test. Accordingly, the Johansen-Juselius co-integration test would be processed to determine the existence and the number of co-integrating vectors.

Unit Root Tests

In the first stage, the Augmented Dickey-Fuller (ADF) and Phillips-Perron tests are applied to all variables at levels and first differences to estimate the stationarity of all series. The results are presented in Tables 2 and 3 and proved that all the variables become stationary through doing the first difference except for the exchange rate, which is stationary at a level according to the ADF test. At the same time, all variables are I (1), except for the joint population size, which is stationary at a level according to the pp test.

Table 2. ADF Unit Root Test Results

Variable	ADF	1% level	5% level	10% level	H0	Stationary
Lnexport	-1.83	-3.67	-2.96	-2.62	Accept	No
D(Lnexport)	-5.66	-3.67	-2.96	-2.62	Reject	yes
$lnGDP_i$	-0.74	-3.68	-2.97	-2.62	Accept	No
D($lnGDP_i$)	-3.17	-3.68	-2.97	-2.62	Reject	yes
$lnGDP_j$	-1.07	-3.67	-2.96	-2.62	Accept	No
D(lnGDPj)	-4.35	-3.68	-2.97	-2.62	Reject	yes
Lnpop	-0.91	-3.71	-2.98	-2.62	Accept	No
D(Lnpop)	-3.3	-3.76	-3.00	-2.64	Reject	yes
lnLinder	1.83	-2.64	-1.95	-1.61	Accept	No
D(lnLinder)	-2.55	-2.65	-1.95	-1.60	Reject	yes
LnAirfr	-0.15	-3.68	-2.9	-2.62	Accept	No
D(LnAirfr)	-8.30	-3.68	-2.97	-2.62	Reject	yes
LnExch	-7.7	-3.67	-2.96	-2.62	Reject	yes

Source: Research finding, using Eviews 10.
Note: ADF refers to Augmented Dicky Fuller, D refers to first differences.

Table 3. PP Unit Root Test Results

Variable	pp	1% level	5% level	10% level	H0	Stationary
Lnexport	-1.77	-3.67	-2.96	-2.62	Accept	No
D(Lnexport)	-5.73	-3.67	-2.96	-2.62	Reject	yes
$lnGDP_i$	1.50	-2.6	-1.95	-1.61	Accept	No
D($lnGDP_i$)	-3.06	-2.6	-1.95	-1.60	Reject	yes
$lnGDP_j$	-1.15	-3.67	-2.96	-2.62	Accept	No
D($lnGDP_j$)	-4.36	-3.68	-2.97	-2.62	Reject	yes
Lnpop	-13.83	-3.67	-2.96	-2.62	Reject	yes
lnLinder	-1.03	-3.67	-2.96	-2.62	Accept	No
D(lnLinder)	-4.15	-3.67	-2.96	-2.62	Reject	yes
LnAirfr	-1.87	-3.67	-2.96	-2.62	Accept	No
D(lnAirfr)	-8.30	-3.68	-2.97	-2.62	Reject	yes
LnExch	-2.65	-3.67	-2.96	-2.62	Accept	No
D(LnExch)	-3.38	-3.67	-2.96	-2.62	Reject	yes

Source: Research finding, using Eviews 10.
Note: PP refers to Phillips-Perron, D refers to first differences.

Johansen Co-Integration Test

The obtained results of the ADF and PP tests indicate that the variables are integrated of order one, I(1), so the Johansen co-integration test is used to test the long-run relationship of the variables. Due to a limited number of observations, the maximum lag length for the test was set at one. The Johansen co-integration test procedure uses two test statistics to determine the number of co-integrating vectors. These are trace and maximum eigenvalue test statistics. The results presented in Table 4 indicate that there are five co-integrating equations, which mean there is a long-run relationship among them.

Table 4. Johansen and Juselius Co-integration Test Results

Trace Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.959577	257.9227	111.7805	0.0000
At most 1 *	0.879685	168.0891	83.93712	0.0000
At most 2 *	0.814191	108.7951	60.06141	0.0000
At most 3 *	0.721583	61.67014	40.17493	0.0001
At most 4 *	0.579545	25.86834	24.27596	0.0313
At most 5	0.054104	1.608614	12.32090	0.9755
At most 6	0.001826	0.051166	4.129906	0.8530

Maximum Eigenvalue Test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.959577	89.83364	42.77219	0.0000
At most 1 *	0.879685	59.29397	36.63019	0.0000
At most 2 *	0.814191	47.12495	30.43961	0.0002
At most 3 *	0.721583	35.80181	24.15921	0.0009
At most 4 *	0.579545	24.25972	17.79730	0.0046
At most 5	0.054104	1.557449	11.22480	0.9637
At most 6	0.001826	0.051166	4.129906	0.8530

Source: Research finding, using Eviews 10.
Note: * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

VECM Estimation

The VECM can be run to figure out the long and short-run relationship among the time series variables because all the variables are of the same order one I (1), and there is a long-run causality relationship between the dependent variable and independent variables according to the co-integration test. The normalized co-integrating coefficients and corresponding standard errors are presented in Table 5 which confirms the validity of the estimated coefficients in the long-run. The estimated VEC model in the long-run is as follows:

$$LExport = -3.55 \times LGDP_{Bra} + 0.97 \times LGDP_{Irn} + 5.57 \times LPOP - 3.41 \times Linder - 0.39 \times LEXCH + 1.35 \times LAirfr \quad (15)$$

Table 5. Long-Run Estimation of VECM

	$\mathbf{LGDP_{Bra}}$	$\mathbf{LGDP_{Irn}}$	**LPOP**	**Llinder**	**LEXCH**	**LAirfr**
coefficients	-3.557197	0.974805	5.570579	-3.416941	-0.393149	1.350127
standard error	0.21719	0.31326	0.34633	0.29845	0.13041	0.39178
t-statistics	-16.37	3.11	16.08	-11.44	-3.01	3.44

Source: Research finding, using Eviews 10.

According to equation 15, there is a positive relationship between the economy size of Iran, the joint population size of Brazil and Iran and air freight cost, while there is a negative relationship between Brazil's GDP, Linder variable and exchange rate with Iran's Export to Brazil in the long-run. The results reveal that a one percent increase in Brazil's GDP decreases Iran's export to Brazil in the long-run by nearly 3.55%. Since the value of Iran's exports to Brazil accounts for a small share of Brazil's total imports and Iran's total exports, it is clear that Iran will no longer be one of Brazil's top priorities for imports if Brazil's GDP increases. On the other hand, a one percent increase in Iran's GDP, in the long run, increases Iran's exports to Brazil by almost 0.97%. An increase of one percent in the joint population size of the two countries will increase Iran's exports to Brazil in the long run by approximately 5.57%. This relationship can be analyzed given the fact that a larger market leads to more demand and consumption and thus more imports. The economic difference between countries is statistically significant, with a negative sign. An increase of one percent in the Linder variable reduces Iran's exports to Brazil by approximately 3.41%. This means that any increase in the difference in GDP per capita between the two countries will lead to a decrease in Iran's exports to Brazil, which is in line with Linder's theory. A one percent increase in Iran's exchange rate to that of Brazil will reduce Iran's export value by approximately 0.39 percent in the long run. Finally, Equation 15 shows that a one percent increase in Iran's air freight cost increases Iran's exports by approximately 1.35 percent, while an increase in transportation costs should reduce exports. This finding, which is inconsistent with the theory, maybe since most of Iran's exports to Brazil are done by ship, and if the cost of air transportation increases, exports will decrease but increase by ship.

Short-run coefficients are also estimated. The effect of these variables in the short run is shown in Table 6. The three dummy variables are introduced to the model as exogenous variables and only appear in the short-run VEC model. It should be mentioned that the validity of the VEC model is evaluated by applying the Jarque-Bera test of normality, the autocorrelation LM test and the heteroskedasticity test.

Table 6. Short-Run Estimation of VECM

	Coefficient	t-Statistic	Prob.
GDP_{Bra}	-7.749905	-3.687903	0.0024
GDP_{Irn}	3.373176	1.697641	0.1117
POP	2155.505	3.345610	0.0048
Linder	-4.183260	-3.828786	0.0018
Exch	1.110618	2.553782	0.0229
Airfr	1.965534	1.596447	0.1327
Sancf	-0.058069	-0.099711	0.9220
Sancnf	-0.256490	-0.408945	0.6888
WTO	8.148505	3.639906	0.0027
R-squared:	0.689902		
Durbin-Watson stat:	2.276473		
Jarque-Bra:	0.03		
Prob	0.98		
Breusch-Godfrey Serial Correlation LM Test:			
Prob. Chi-Square(2)	0.41		
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Prob. Chi-Square(16)	0.99		

Source: Research finding, using Eviews 10.

The results confirmed that our VEC model successfully passes all the tests which prove its validity. Moreover, the results show that the evaluated coefficients in the short-run model are mainly significant at the level of 5%, except for Iran's GDP, air freight cost, financial and none financial sanction. Compared to long-run coefficients, the effects of these variables on Iran's exports to Brazil are greater in the short run. Generally, short-run and long-run coefficients have the same direction, except for the exchange rate coefficient, which has a negative effect in the long run and a positive effect in the short run.

Based on the following analysis, these two results are completely consistent with the theory. We know that with the increase of the exchange rate, that is, with the devaluation/depreciation of the national currency, imports for the domestic consumers become more expensive and exports for the domestic producers become cheaper. Therefore, according to the estimation shown in Table 6, the devaluation/depreciation of the national currency in the short run will increase Iran's exports to Brazil. However, due to the domestic production dependency on foreign currency in the long run, according to Equation 15, the devaluation/depreciation of the national currency increases production costs and reduces exports. According to this estimation, Brazil's membership in the WTO has a significant positive effect on Iran's exports to Brazil. While the impact of financial and nonfinancial sanctions on Iran's exports to Brazil is not significant.

Conclusion

The purpose of this study was to examine the possibility of Iranian exports to Brazil from a micro perspective, i.e. based on goods and export capacity, and also from a macro-level, i.e. the study of the impact of macroeconomic variables on export flows. From a micro point of view, the value of the Cosine index showed that Iran has no comparative advantage in exporting most commodities from 2001 to 2009. However, since 2009, Iran has had a positive comparative advantage in the export of some goods, such as fertilizers, organic chemicals, plastic products, iron, ore and steel. The trend of the export potential index in the period under

review showed that although the export capacity of Iran to Brazil in the studied sectors has gradually increased since 2005, a large part of this capacity remains unused. The highest export capacity of Iran to Brazil was related to plastics and articles thereof and the lowest export capacity was related to ships, boats and floating structures. Comparison of the estimated trade potential with real trade between Iran and Brazil (Appendix 1) shows that only some goods and in some years a small part of this capacity has been used. In the present study, using the time series regression and gravity-VEC model, an attempt has been made to investigate the effect of macroeconomic indicators on Iran's export to Brazil. The results show that Iran's GDP in the long run and the short run, the joint population size of both countries as well as air freight cost have a positive effect on Iran's exports to Brazil. While Brazil's GDP and Linder variables harm Iran's exports to Brazil in the long run and the short run. Besides, the ratio of the official exchange rate of Iran to Brazil has a positive effect in the short run and a negative effect in the long run. The dummy variables appear only in the short-run model, showing that financial and non-financial sanctions are not statistically significant. Besides, Brazil's membership in the WTO has a positive effect on Iran's exports to Brazil.
In summary, the study of trade relations between Iran and Brazil at both micro and macro-levels shows that according to micro criteria, there is a good trade capacity to develop Iran's exports to Brazil, especially in some goods such as plastics and articles thereof, organic chemicals, etc. Based on the macro-level indicators, the development of trade relations is logically justified. However, trade capacity between the two countries has not been realized in the period under review due to political and international circumstances (not because of the lack of economic justification).

As future work to complete the present study, it is suggested that the export potential of other sectors of the economy be worked out. It is also recommended to examine other influential variables affecting bilateral trade relations using Intercountries Trade Force (ITF) theory proposed by Rasoulinezhad and Jabalameli (2018). It is worth noting that the Covid-19 pandemic will have a significant impact on global trade structures and patterns. Future works should consider the impact of this pandemic on bilateral trade relations. The expansion of Internet-based businesses reduces the importance of some influential indicators in the gravity model, such as the geographical distance of countries and the need to define new variables assessing e-commerce infrastructure of the countries.

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Appendix

Table I. Results of a Simple Estimation of Iran's Export Potential to Brazil

	(3) fish and crustaceans, molluscs and other aquatic invertebrates		**(26) Ores, slag and ash**		**(29) organic chemical**		**(31) fertilizer**	
year	**Export potential**	**Realized exports**	**Export potential**	**Realized exports**	**Export potential**	**Realized exports**	**Export potential**	**Realized exports**
2001	2457.6	0	21877.2	0	64061.4	13	32.1	0
2002	8140.5	0	9995.7	0	54178.5	0	3920.7	0
2003	13872.6	0	12217.5	1075	81409.5	12	4912.5	0
2004	14851.8	0	22921.2	0	98185.8	0	7752.3	0
2005	8819.4	0	47301.9	0	219139.2	30	1752.9	0
2006	12410.1	0	90573.9	0	198176.7	0	537.9	0
2007	13042.2	0	68239.5	0	546134.4	0	2603.4	0
2008	15165	0	95778.3	944	939120	152	16523.4	0
2009	27406.5	0	210459.3	0	730825.2	51	39365.4	0
2010	42361.8	0	389364.3	0	845287.5	212	137229.3	0
2011	61912.5	0	310377.3	0	1131038	123	319425.9	0
2012	64939.5	0	282525.6	0	1029608	143	335055.3	15260
2013	72995.7	0	403841.4	0	1044979	78	279670.5	0
2014	69193.2	0	370688.7	0	1319534	0	228883.5	0
2015	68760.9	0	218055.6	0	1086463	40	242196.6	0
2016	102773.4	0	275784.6	0	1106354	0	237147	24175
2017	121216.2	0	357598.5	0	1186618	90	230855.1	21660
2018	94136.4	0	341544.9	0	1231769	31	253114.2	1

Source: Research finding, based on (ITC, 2018).

Table II. Results of a Simple Estimation of Iran's Export Potential to Brazil

	(39) Plastics and articles thereof		(72) Iron and steel		(84) Machinery, mechanical appliances, nuclear reactors, boilers; parts thereof		(89) Ships, boats and floating structures	
year	**Export potential**	**Realized exports**	**Export potential**	**Realized exports**	**Export potential**	**Realized exports**	**Export potential**	**Realized exports**
2001	34957.5	9	62077.2	80	14657.4	0	9409.5	0
2002	44874.6	0	78057.3	0	22339.5	70	10.5	0
2003	46953.6	0	53379.6	0	34511.4	100	15229.5	0
2004	56472	192	160079.1	0	48155.7	0	594.3	0
2005	111053.7	0	255079.5	0	51657.9	4	60	0
2006	239283.9	0	334548.6	3269	82881.3	0	105	0
2007	257627.1	0	235305	0	77565.9	71	7962.9	0
2008	423293.7	347	147079.5	0	130725	38	534.6	0
2009	690186.3	1583	217983.9	45	200736.9	37	29460.3	0
2010	858132	35562	185929.2	0	207650.4	0	22511.1	0
2011	1014098	31580	295771.8	38	180270	8	772.5	0
2012	1092857	3936	319965	0	195208.5	90	70046.7	0
2013	1296143	4053	397778.7	0	178709.7	0	36979.2	0
2014	1522414	1458	614383.5	0	153494.4	4	22850.7	0
2015	1423174	0	688980.6	0	138084.9	2	184.2	0
2016	1482003	188	409307.4	50317	152967.6	13	4317	0
2017	1812803	1	577497.3	11947	184301.4	0	4926	0
2018	1665441	879	729208.5	33866	161070.9	0	197865.3	0

Source: Research finding, based on (ITC, 2018).