Print ISSN: 2008-448X
Online ISSN: 2538-3310
International Journal of Business and Development Studies
University of Sistan and Baluchestan
Homepage: https://ijbds.usb.ac.ir

Financial Sanctions and the Imports of Intermediate and Capital Goods in Iran: DID Method

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ARTICLE INFO

Article type:
Research

Article history
Received: 21.09.2022
Accepted: 25.12.2023

Key words:
financial sanctions, imports, capital and intermediate goods, difference-in-difference method, Iran's economy

JEL Classification:
F51, F14, C12.

Abstract:
During the last three decades, financial sanctions have been imposed on Iran by the United States, the European Union, and the United Nations Security Council. These sanctions have had various effects on Iran's economic sectors. This paper aims at estimating the effect of financial sanctions on the import of capital and intermediate goods in Iran, which was carried out for two independent time periods. The first period (2010-2013) includes multilateral financial sanctions, and the second period (2016-2019) includes multilateral sanctions and the withdrawal of the United States from the JCPOA. We examined the impact using the difference-in-difference (DID) method.

The results of the first period indicate that the decrease in the imports of capital and intermediate goods in Iran depends more on the countries that "provided the sanctions plan" than the countries that did not provide the sanctions plan, because the coefficient of dummy variable for implementation in the random effects model is statistically significant. The negative effect of 0.007 on imports shows that the effect is weak, because this group of countries behaved differently. Since the implementation of multilateral financial sanctions in 2012, some countries such as Australia greatly reduced the export of capital and intermediate goods to Iran, but other countries such as Italy increased the export of capital and intermediate goods to Iran. In the second period, the random effects model is statistically significant. In this model, the negetive effect of

Cite this article: S. Heydarian, M. Pahlavani and S. H. Mirjalili (2023). Financial Sanctions and the Imports of Intermediate and Capital Goods in Iran: DID Method. *International Journal Of Business and Development Studies*, 15 (2), 101-134. DOI: 10.22111/ijbds.2024.47819.2090.

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Publisher: University of Sistan and Baluchestan

0.22 on imports indicates a significant effect. Therefore, the reduction of Iran's imports in this period depends more on the countries that provided the sanctions plan than the countries that did not provide the plan. Since the withdrawal of the United States from the JCPOA in 2018, countries such as Korea, Germany, Russia, UK and Italy reduced the export of capital and intermediate goods to Iran.
The comparison of two independent periods indicates that in the first period, the major share of Iran's imports belongs to the UAE, and in the second period, it belongs to China. Turkey has been Iran's trading partner in both periods and since the imposition of sanctions, it has had an 8% share in the export of capital and intermediate goods to Iran, and with the withdrawal of the United States from the JCPOA, this share has increased to 13%.

1. Introduction

Trade in intermediate and capital goods plays a central role in economic growth, productivity, industrial competition and increasing production capacities (Grossman and Helpman 1991: Ko and Helpman 1995: Ko et al., 1997: Keller, 2004). Imports of intermediate and capital goods provide advantages, because these goods embody foreign knowledge and also imports can enable learning about these goods (for example, reverse engineering), imitation, or facilitate innovation of competing goods. In addition, business relationships, personal interaction and other communication channels lead to cross-border learning of production methods and product design (Veeramani, 2014).

Most of Iran's imported goods are intermediary-capital goods, and due to the competitiveness of import substitute industries with imported goods, the elastic demand for importing the intermediary-capital goods in Iran's industry can be an area for policymaking (Shahin Poor and khosh Raftar, 2018, p. 74). Therefore, in Iran's economy, capital and intermediary goods are very important, because capital goods, including machinery and equipment, are the basis of industrial development that increases production and creates employment. On the other hand, intermediate goods are an integral part of the production of final products. Their availability affects the cost, quality and variety of manufactured goods (Taqvi et al., 2013).

As the sanctions increase and they disrupt imports, a common response by the sanctioned nation is to divert their trade to countries that do not participate in the sanction. This trade diversion leads to a heterogeneous effect: while trade with some countries declines, it simultaneously grows with others. For example, when the United States and the European Union imposed sanctions on Iran, the country increased its oil exports to non-sanctioned countries such as China and India. This adaptive behavior emphasizes the complexity of the impact of sanctions, as target countries find alternative ways to maintain their economies and challenge the intended effects of sanctions (Jildenbäck, 2017). Haider (2017) also

concluded that trade sanctions lead to export deflection and two-thirds of Iran's exports have been deflected to non-sanctioning countries after the imposition of sanctions in 2008. Iran's total exports have also increased. On the other hand, Bown and Crowley (2018) showed that trade diversion could lead to trade decline because it disrupts established trade relationships and creates uncertainty in trade.

Therefore, the effects of economic sanctions, especially financial sanctions, on the structure of foreign trade and especially the composition of imports are important. Financial sanctions, in the form of blocking foreign funds of certain individuals or institutions, avoid lending to the central bank of target countries, limiting international financial relations and access of target countries to various markets, and terminating or restricting foreign financing, will increase trade costs and limit access to foreign exchange resources, and increases the risk of transaction with the financial and banking network of the target country (Laman, 2020). The financial sanctions on Iran's economy have been implemented since 2006 with further restrictions on financial network by the United States of America, and reached its peak in 2011 under the pretext of nuclear and human rights (Heydarian et al., 2022).

Since 2012, they have simultaneously limited Iran's access to the international financial system, and also sanctioned Iran's oil and petrochemical exports, and the import of intermediate goods, which continues (Frank, 2018). In the same year, the European Union imposed financial sanctions against Iran. As a result, Iran had to sell its oil at a significant discount and exchange it for other goods. This unprecedented situation resulted in the depreciation of Iranian rial about two-thirds of its value against the US dollar. An important consequence of these sanctions was the reduction of foreign exchange revenue from oil exports, which is Iran's main source of income. This decrease in foreign exchange revenue limited Iran's ability to import capital and intermediate goods from the world markets (Ghomi, 2022).

According to Kazroni et al. (2016), with the intensification of economic sanctions, it becomes difficult to import intermediate and capital goods in Iran. Due to the problems of supplying raw materials, transferring technology, and providing spare parts, and new production equipment, they have led to the disruption of production and bankruptcy in some industries. It has become difficult for many industries to survive, and production has decreased in the short term (Kazroni et al., 2016, p. 396).

International trade allows developing countries to import capital and intermediary goods that are necessary for domestic production and GDP growth, but the sanctions adversely affect it (Pahlavani et al., 2005). Financial sanctions adversely affected on importing capital and intermediate goods, which in turn play a vital role in the economic development of the country, and they increased

the cost of importing intermediate materials (Rahmati et al., 2014). Also, the largest part of the investment that affected greatly from sanctions was the imports of capital goods.

Therefore, we examined the impact of financial sanctions on the imports of capital and intermediate goods in two periods (2010-2013) and (2016-2019) using the difference-in-difference (DID) method. We will also show that after the implementation of severe multilateral financial sanctions in 2012 and the withdrawal of the United States from the JCPOA in 2018, which countries increased their exports to Iran and which countries decreased.

The organization of the paper is as follows: after the introduction, in the second part, the theoretical background is presented. In the third part, we will discuss the development of foreign trade of Iran under sanction, and in fourth part, empirical literature will be reviewed. In the fifth part, the model and research method are provided. Then we conducted the estimation of the econometric model and provided the interpretation of the results. Finally, the conclusion constitutes the final part of the paper.

2- Literature Review

Financial sanctions are becoming a powerful and widely used tool of foreign policy and an alternative to the projection of military power. They have become progressively more sophisticated and effective in targeting specific objectives due to their increasing interconnectedness with the global financial system. In recent years, the United States has imposed financial sanctions against individuals and companies in Russia, Venezuela, and Iran, among others (Ghasseminejad and Jahan-Parvar, 2021). With these sanctions in place, for trade, financial resources must flow between countries. If the flow of fund is restricted, there will be a reduction in trade. Felbermayr et al.(2020b) find evidence of these spillover effects in their cross-country study, indicating that trade between sanction sender and sanctioned (target) countries is reduced not only by trade sanctions, but also by financial sanctions.

Dollery (1993) also indicated that trade and financial sanctions have a negative effect on the welfare of a small country. According to this study, the main burden of financial sanctions undergoes by capital-intensive imports. Developing countries can gain a lot by importing capital equipment and machinery from industrialized countries, where the latest technologies and research and development activities are embodied in the equipment they use in the production process, and increased their productivity (Fan and Ho, 2008; Almedea and Fernand, 2008).

Hemphill (1974) and Moran (1989) also indicated that in developing countries, due to trade and currency restrictions, imports can no longer be considered a function of income and relative prices. According to them, the largest share of the

imports by developing countries is the import of capital and intermediate goods, for which there is no substitute.

Frank (2018) stated that there were more than 800 active sanctions in 2005. In recent years, several sanctions have been imposed against countries such as Myanmar, North Korea, Iraq, Venezuela, Russian Federation and Iran. Compared to other sanctions imposed in the past decades, these sanctions have been very comprehensive and severe. They greatly limited the country's access to international financial markets and restricted the import of intermediate goods into the country.

Multilateral sanctions have stronger economic effects than unilateral sanctions. Yang et al. (2009) finds that multilateral sanctions of the US and the EU have a negative effect on EU trade (imports, exports and total trade), but unilateral US sanctions only have a negative and significant impact on EU trade. Yang et al. (2009), Caruso (2003) and Frank (2018) find a significant negative effect of sanctions on trade. Haines (2017) studied the global impact of recent sanctions on Russia, Iran, and Myanmar, and finds that the total cost of these sanctions in 2014 was about $50 billion, equivalent to 0.4 percent of global trade.

Rasoulinejad (2016) and Haider (2017) indicated that the international sanctions imposed on Iran after 2006 have drastically changed Iran's trade direction and deflected trade flows from Europe to Asian countries. Ko and Helpman, 1995; Ko, Helpman and Hoffmeister, 1995; Keller, 2001 and 2002 argued that the impact of exchange rate depreciation on the imports of intermediate goods, in addition to make friction in financial markets, trigger the long-run effect of sanctions. In addition, it adversely affects technology transfer channel of intermediate goods .

Krueger (1983, p. 9) argues that "the decrease in the import of capital goods reduces the growth rate of the GDP and the decrease in the import of intermediate goods and raw materials has a negative effect on production and employment. Kazeroni and Khezri (2017) argued that severe economic sanctions have reduced the imports of intermediate goods, but weak economic sanctions have had a positive effect on capital goods imports from other countries.

Jalal Abadi et al. (2007) showed that the most important factor related to the import of goods is the exchange rates, and changes in exchange rates can easily affect the demand for the imports of related goods.

Sediq Mohammadi et al. (2023) indicated that the sanctions imposed on Iran's oil exports depreciated the exchange rate by reducing foreign exchange earnings. With exchange rate depreciation, the price of raw materials and intermediate and capital goods increases domestically and limits production.

The high dependence of production on the imports of raw materials and intermediate goods exposes a country's economy to potential threats. Even if the sanctions procedures do not lead to the cessation of imports, with the increase in

import costs, the cost of domestic production will increase, which on the one hand will increase domestic price levels and on the other hand, it will reduces the competitiveness of products in the international markets (Turki and Mazaheri, 2022).

Anderson and Van Wynkoop (2003) find that the effect of distance on international trade is based on established theoretical foundations and evaluated the effect of distance in international finance. Their empirical studies show that distance is important for the level of bilateral financial investment.

We used the gravity model to explain normal bilateral trade. In its original form, the gravity model predicts bilateral trade flows based on the economic size of two countries and the distance between them. Based on the assumptions of the gravity model, the volume of trade between two countries is a function of the economic size of the countries and is inversely related to the distance between them.

Therefore, according to the theoretical studies above, it can be said that financial sanctions disrupts the flow of capital and intermediate goods, which can have severe consequences on the stability and economic growth of the affected country. It can also disrupt supply chains, impede technological progress, and hamper economic growth. Countries that are subject to such sanctions often face higher costs, the reduction of productivity and increased difficulties in accessing the tools and resources necessary for their economic development (Nosratabadi,2023).

Financial sanctions on intermediate goods can have significant effects throughout global supply chains. When countries impose these sanctions, they restrict the flow of essential components and raw materials that industries rely on to produce finished goods. As a result, producers may experience production lags, increased costs, and challenges in securing alternative sources. This disruption can lead to increased prices for consumers and potential shortages in the market (Cavalcanti & Jalles, 2019)

Imported intermediate goods as production inputs can significantly affect the economy. When quality and affordable inputs are imported, producers can produce superior products at lower costs, leading to increased production and economic growth. This could increase competition in domestic markets, potentially lowering prices and raising product quality. Any fluctuations in the price or supply of these inputs can negatively affect domestic production. Furthermore, while such imports can negatively affect a country's trade balance, they can facilitate the transfer of technology and knowledge, optimize production processes, and increase productivity. When imports of intermediate goods decrease, domestic producers face difficulties in obtaining raw materials, which can lead to lower production and higher prices. Also, dependence on internal resources may reduce the quality of goods and lead to a decrease in competition (Cavalcanti & Jalles, 2019).

Imports of capital goods play a key role in achieving sustainable development goals. The imports of capital goods facilitate capital formation at a lower price (Mutreja et al., 2018), enables the adoption of new technologies in the production process (Békés and Harasztosi, 2020) and increases the production capacity of developing countries (Carrasco and Tovar, 2021).

The impact of financial sanctions on the imports of capital goods has led to a significant decrease in foreign investment and restricted access to global markets for importing machinery, technology and other capital goods. The lack of these goods, in turn, has hindered the growth of Iran's economy and has led to a decrease in productivity, stagnation of technology and cost increase. In addition, the restriction in importing quality capital goods has forced Iran to rely on domestic or imported lower-quality substitutes that may not meet international standards.

3- Foreign trade development under sanction

As it was illustrated in Figure (1), the imports of capital goods, raw materials and intermediate goods have decreased after the imposition of sanctions in 2007.The import of intermediate and capital goods decreased from 38.2% and 12.64% of total import to 20.52% and 6.95% respectively. The intensification of international restrictions is one of the major external factors affecting the foreign trade in 2007 and 2008. Based on these sanctions, American banks are prohibited from any type of finance, opening the letter of credit, remittances and guarantees for exports to and imports from Iran, investment in Iran and purchasing Iranian goods and services (Alavi, 2013).

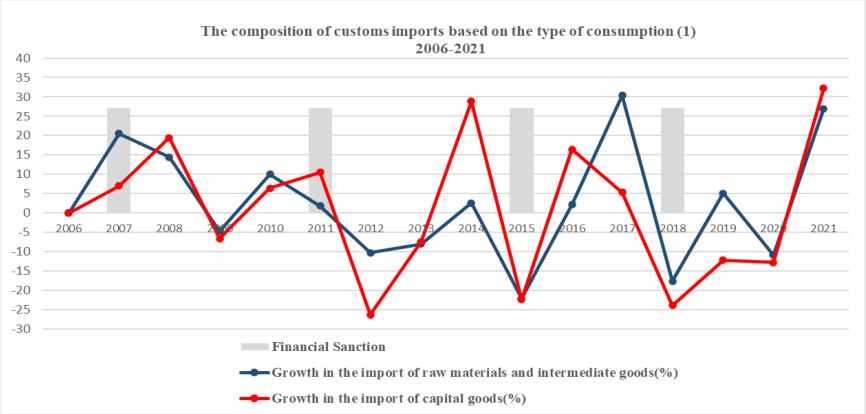


Figure (1): financial sanction and growth in the import of capital goods, raw materials, and intermediate goods in Iran

Source: Central Bank of Iran, "Economic report and balance sheet (2006-2021).

In 2011, the severe financial sanctions imposed, and the value of imports decreased. There was negative growth of imports value after 2011, except for 2014 (Aghaei et al., 2017, p. 59).

The growth rate of the imports of raw materials and intermediate goods in 2010 was 10.3% and that of capital goods was 6.37%, which in 2011 reached 1.83% and 10.53%, respectively.

Following the imposition of financial sanctions in 2011, foreign trade was affected by exchange rate fluctuations due to the sanctions and as a result, it led to the decrease in the value of import. Moreover, with the imposition of financial sanctions in 2015, we were witnessed the biggest decline in the growth rate of imports in a decade. Apart from the severe decrease in the imports in 2011, which was mostly due to the trade sanctions, the imposition of financial sanctions in 2015, led to a 21.1% decrease in imports. Also, the import of $52.2 billion of capital and intermediate goods and raw materials in 2014 decreased to 41.4 billion dollars in 2015.

Another aspect of the impact of the financial sanctions on the imports is on the origins of imports which has experienced a sharp increase in the concentration over a decade. Till the end of 2015, the share of the first 10 exporting countries to Iran has been increasing in volume and in value. It means that the origins of imports have been changed to a great extent. Iran's imports pattern has changed regionally, so that it has changed from the European Union to Asian and neighboring countries (Kazroni et al., 2017).

In 2018, share of the imports of raw materials and intermediate goods was 14.89% and the capital goods was 23.94%. In the same year, the balance of payments affected by the unilateral withdrawal of the United States from the JCPOA[1] and the return of financial sanctions. Therefore, the export and import of goods decreased compared to the previous year. Sanctions has resulted in the composition of trade parties and purchasing from third countries, and in the increase of the costs of imported goods, and made the imported intermediate and capital goods more expensive (Heydari Mutlaq, 2018).

Figure (2) illustrates the classification of imported goods according to the type of consumption. The analysis of the composition of imported goods in (2006) suggests that the imports of raw materials and intermediate goods still accounts for the largest share of the total imports. The imports share of this product group in 2006 was equal to 76.87%, which did not change significantly compared to the previous year. However, the imports value of this group of goods has grown by 5.7 percent compared to(2005). The share of capital goods is 23.11 percent in 2006, which has decreased compared to the previous year.

[1] Joint Comprehensive Plan of Action (JCPOA)

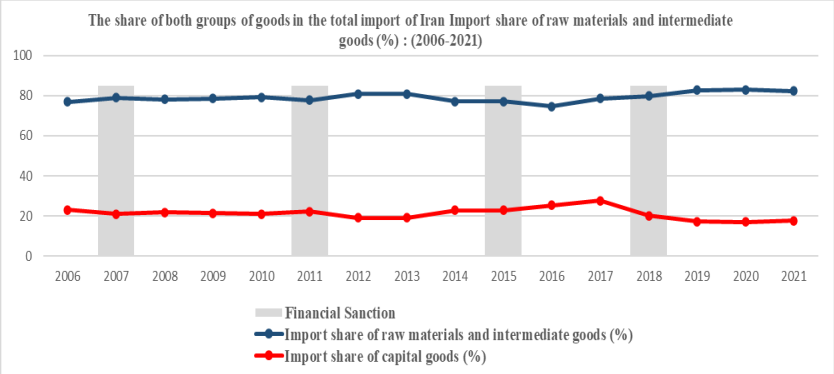


Figure (2): financial sanction and share in the import of capital goods, raw materials, and intermediate goods in Iran

Source: Central Bank of Iran, "Economic report and balance sheet (2006-2021).

In 2007, the decreasing trend of the share of capital goods in the total customs imports continued and reached to 21.8% from 23.13% in the previous year. Moreover, the share of raw materials and intermediate goods has increased from 76.87% of customs imports in the previous year to 78.92% in 2007.

Financial sanctions intensified at the end of (2010). Imports of raw materials and intermediate goods took the largest share of the total imports i.e. 79.12%, which compared to its share in (2006) increased at the rate of 1.3% . However, the imports of capital goods decreased by 1.5% compared to the previous year.

In(2011), raw materials and intermediate goods took the largest share of 77.73% out of the total imports which decreased 2.5% compared to its share in the previous year.

In(2015), the reduction of foreign exchange earnings happened due to sanctions, the prolongation of the process of nuclear negotiations, and the postponement of the implementation of the JCPOA until the end of December 2014, among others decreased the value of customs trade transactions.

In 2015, the "raw materials and intermediate goods" accounted for the largest share of the customs imports value with 77.12% and the share of the "capital goods" reached 22.28%.

By the unilateral withdrawal of the US government from the JCPOA agreement and the implementation of financial and economic sanctions in two stages during (2018), the foreign trade declined in 2017 compared to 2016 in terms of weight and value.

In 2018 the share of "raw materials and intermediate goods" in the total imports increased to 79.84% compared to 67.3% in 2017. Also, the share of capital goods

in total imports was 20.16% in 2018, which decreased by 6.5% compared to the previous year.

4- Empirical literature Review

The studies conducted on the research topic could be divided into two groups. First**,** the impact of economic sanctions on the imports of goods (capital and intermediate goods, food and medicine, luxury, basic, agriculture) in Iran as follows:

Jeong (2019) investigated the impact of US sanctions on the import of luxury goods by North Korea and its 71 trading partner, using the difference-in-differences method over the period 2004-2017. The results indicated that the sanctions have been effective only to the countries that have implemented the sanctions. Jeong concludes that UN Resolution 1718, which was primarily aimed at banning the export of luxury goods to North Korea, was effective in limiting North Korean luxury goods imports for the period 2006–2007. The paper also found that four countries, primarily China, accounted for 91.4 percent of North Korea's luxury goods imports in 2007.

Barseghyan (2019) explored the economic impacts of sanctions on the Russian economy using panel data and the Synthetic Control Method for the period 2000-2017. The estimation results indicated that after the imposition of sanctions, the real GDP per capita and the net FDI inflow in Russia decreased, while the ban on the import of agricultural and food products boosted the Russian agricultural sector and led to an increase in the agricultural productivity and the revenue of farm workers.

Mehrgan and Kordbcheh (2017) investigated the short-term and long-term effects of the sanction of capital goods' imports on GDP using a multivariate distributed lag model. Empirical findings indicated that the effect of declining capital goods' imports on GDP follows a quadratic function, so that these effects reach their maximum in the third year. Also, the findings show that the long-term increase coefficient is equal to 0.68, that is, a one percent decrease in the imports of capital goods will decrease GDP by 0.68 percent.

Kazrooni and Khezri (2017) examined the effect of economic sanctions on the imports of capital, intermediate and consumer goods in Iran, using the fully modified least squares model (FMOLS) during the period 1981-2013. The results indicated that both weak and strong economic sanctions have reduced the import of intermediate goods, but the weak economic sanctions have had a positive effect on the imports of capital goods from other countries.

Ostadi et al. (2013) explored the impact of economic sanctions on the imports of consumer, intermediate and capital goods. They employed the OLS method and time series statistics over the period 1976-2011. The results suggested that the adverse effect of economic sanctions on the imports of capital goods is greater than that of intermediate and consumer goods.

Second, the impact of economic sanctions (financial, trade and international) on foreign trade of Iran as follows:

Besedes et al(2022) investigates the Effect of Financial Sanctions on Trade in Goods and Services. They examined the extent to which financial sanctions imposed by Germany through European Union and United Nations commitments adversely affected Germany's trade in goods and services. Financial sanctions reduced Germany's inflows and outflows of financial assets, as well as imports and exports of goods and services. The relative effects on trade in goods and services are weaker than on financial assets, about half as large in the case of goods and two-thirds as large in the case of services. The effect on trade in goods is entirely due to episodes where financial sanctions are accompanied by export restrictions of specific goods. In the case of services exports, they are affected by financial sanctions once export restrictions are considered.

Ghodsi and Karamelikli (2022) investigates the impact of general and targeted EU sanctions against Iran on quarterly bilateral trade values between the 19 members of EU and Iran between the first quarter of 1999 and the fourth quarter of 2018. They used a non-linear autoregressive distributed lag (NARDL) model. The results indicated that sanctions have strongly hampered trade flows between the two trading partners. The impact of sanctions on the imports of EU19 from Iran is more than four times stronger than on the exports of the EU19 to Iran. Moreover, the EU's sanctions hampered trade in almost all sectors, except for the primary sector. Furthermore, the study finds that the impact of smart sanctions targeting Iranian entities and persons is much smaller than the impact of sanctions on trade and the trade. Smart sanctions affected the exports from the EU19 to Iran, while they are statistically insignificant for the imports from Iran.

Gutmann and et al.(2022) investigates the effect of US sanctions on trade flows of 184 countries during the period 1995–2019 using standard panel difference-in-differences estimations and event study. Russia does not change its trade patterns in response to US sanctions. The negative effect of US sanctions on trade with China is larger. Hence, the results are consistent with the consistent observation in the empirical literature that sanctions have important adverse effects on a country's economy and society. Further results indicate that the effect of US sanctions on exports to the sanctioned countries is more persistent than the effect on imports from these countries.

Pestova and Mamonov (2019) examined the economic impact of financial sanctions on the Russian economy using the BVAR model. The results indicated an average decrease of GDP growth in 2014 and 2015 by 0.43 and 0.74% respectively. Financial sanctions have had a limited effect on consumption and investment, wages, and inflation in Russia. The negative impact of sanctions on the interest rates, imports, and the Ruble exchange rate in 2015 has been severe.

Ezzati and Kazemi Mehrabadi (2017) explored the effect of economic sanctions from banking (monetary) channels on Iran's industrial production during 1988-2013. The estimated model is based on the endogenous growth model that have been analyzed through the econometric method of a system of simultaneous equations. The impact of banking sanctions on industrial production has been through the decrease of industrial production due to money transfer problems, a decrease in the country's trade, and as a result, the limited import of intermediate goods, raw materials, and capital goods.

Ezzati (2016) investigated the direct and indirect effects of sanctions on Iran's economic growth focusing on the foreign sector during the period 1977-2012 using the endogenous growth model and 2SLS econometric method. The findings suggest that the sanctions led to the reduction of the economic growth through limiting total imports, capital goods, intermediate and primary goods' imports, and exports.

Thaver and Ekanayake (2010) investigated the impact of apartheid (1950-1994) and international sanctions (1981-1994) on South African import demand function using a cointegration test and unrestricted error correction model over the period 1950 to 2008 .This study examines the impact of apartheid (1950-1994), particularly the period of international sanctions (1981-1994) against the apartheid government, on the South African imports .The estimation results indicated that international sanctions have a positive impact on the import demand in the short term but have a negative impact on the import demand in the long term.

Yavari and Mohseni (2010) explored the effect of US trade and financial sanctions in 2000 on the import of capital goods and foreign exchange lending using the consumer surplus method. They find that sanctions reduced the imports of capital goods and financial sanctions and raised the lenders' expected interest rates.

Aziznejad and Seyednoorani (2009) investigated the effect of US sanctions on Iran's foreign trade during the period 1979-2008. They find that since 2007 and by tightening of sanctions, the price of capital goods imported from EU increased between 7 and 10 percent.

In sum, all the above-mentioned studies, that examined the impact of economic sanctions on imports (capital and intermediary, food and medicine, luxury, basic, agriculture), and explored the effects of economic sanctions (financial, commercial and International) on trade, the results indicated that economic sanctions have had a negative effect on imports. Therefore, the contributions (innovations) of this paper are as follows:

A-In Iran, there is no article on the impact of sanctions using the difference in difference or DID method or restriction of trade from the lens of financial sanctions.

B-One of the advantages of DID is that it considers both target group and control group and measures the effect of intervention or policy change on both groups. We employed this method in the article and in the case of Iran. The effect of the intervention (the financial sanctions) was divided into the target group, that is, the group that implemented the sanctions against Iran, and the control group i.e. the group that did not implement the sanctions against Iran .
C-In order to separate the target group and the control group, we reviewed the available data and analyzed the trend of Iran's imports from these countries over the period of the study. Iran's imports from those countries that had an upward trend in spite of sanctions, we considered them as the control group and other countries that implemented sanctions considered them as the target group. Imports' data are taken from the TRADE MAP website.

5- Model specification, data, and variables

We employed the "difference in difference" (D-in-D) method to evaluate the impact of financial sanctions on the import of capital and intermediate goods in Iran. The DID method is used to measure the treatment effect caused by the imposition of financial sanctions. It is a quasi-laboratory economic approach that was first developed by "Ashenfelter" (1978) and is used when an exogenous change has occurred (or a policy has been implemented) and the objective is to examine the effects of that change or provide an estimate from the unrealized reality of the outcome variable for the implemented policy . In this method, one group is considered as "control group" and another group is considered as "target group". The target group is the group that is affected by the applied policy or change (Here are the multilateral financial sanctions (first period) and the withdrawal of the United States from the JCPOA (second period)).
We denoted the time before and after the policy by the symbols ta and tb. The equations can be calculated following "Hackman" et al. (1999) for the years before and after the sanctions to measure and identify the effect of target (the occurrence of financial sanctions) on the import of goods in Iran as follows.
The DID method compares the changes in the trend of trade in the target group, before and after the occurrence of the event (the first difference) with the changes in the trend of trade in the second group, before and after the occurrence of the event (the second difference). Using the DID method in estimating the gravity model can remove the effect of other factors from the model and measure only the net effect.
Therefore, the basic form of the DID method is as follows:

$$Y_{ist} = \beta_0 + \beta_1 Ttreatment_s + \beta_2 t_t + \beta_3 (treatment_s \times t_t) + \varepsilon_{ist} \quad (1)$$

In addition, control variables can be added to the above equation as X vector and this equation can be written as the following:

$$Y_{ist} = \beta_0 + \beta_1 treatment_s + \beta_2 t_t + \beta_3 (treatment_s \times t_t) + X_i \theta_i + \varepsilon_{ijt} \quad (2)$$

where t is a dummy variable of time in which the observations of the target group have a value of one, and the observations of the control group have a value of zero, $treatment_s$ is a dummy variable in which the observations before the event occurs , take the value of zero, and the observations after the occurrence of the event take the value of one, and X is the vector of control . The variable Treatment*t depicts the extent of effectiveness from a specific change on the dependence variable. Then the definitions of the coefficient of variable for equation (1) are as follows:

β_0: dependent variable for the control group before the event occurs.

$\beta_2 + \beta_0$: dependent variable for the control group after the event occurs.

$\beta_1 + \beta_0$: dependent variable for the treatment group before the event occurs.

$\beta_0 + \beta_1 + \beta_2 + \beta_3$: dependent variable for the treatment group after the event occurs.

Therefore, the estimators of DID method could be as equation (3):

$$\hat{\beta}_3^{DID} = \Delta Y_T - \Delta Y_C = [(\beta_0 + \beta_1 + \beta_2 + \beta_3) - (\beta_0 + \beta_1)] - [(\beta_2 + \beta_0) - (\beta_0)] \quad (3)$$

An argument for using the difference-in-difference (DID) method is that, basically, this method is suitable for conducting such research that a group of countries have implemented sanctions against Iran and a group of countries have not implemented sanctions against Iran. The DID method considers the target group and the control group. The target group is the group that has been affected by the policy (here financial sanctions) and implemented that policy against Iran. The control group is a group that has not been affected by the policy (here financial sanctions) and has not implemented that policy against Iran. Therefore, it is appropriate to use this method.

Second, an article published in 2019 used the difference-in-difference (DID) method for the impact of sanctions on luxury goods, which we used it in this article.

Third, the DID method has been used for such purpose to see how much the imports from target countries to Iran increased (decrease) with the imposition of sanctions. In other words, how much the target group (the group that implemented the financial sanctions plan) affected on the imports of capital and intermediate goods, as well as the net effect of the financial sanctions of the target group on the imports of capital and intermediate goods by Iran. The variable of D in-D represents this net effect.

Fourth, a number of published articles in Iran have used the DID method, and our work is in the same line with those articles that used the DID method.

Data and variables: We examined the effect of financial sanctions on the imports of capital and intermediate goods. The empirical analysis consists of two periods:

The first period, 2010-2013, includes the period of multilateral financial sanctions. The second period, includes the period 2016-2019, in which, in

addition to the multilateral financial sanctions, U.S. withdrawal from the JCPOA also occurred. Since 2006, the United States used unilateral sanctions and no other country, or the United Nations Security Council implemented sanctions or trade bans against Iran (Nademi and Hasanvand: 2010, p. 154).

The timing of financial sanctions is such that unilateral financial sanctions were imposed on Iran in 2005and were seriously implemented in 2006 (Nefiu, 2018). The multilateral financial sanctions (US and Europe) became severe in the end of (2010) and the beginning of(2011) (Heydarian et al., 2021), that is why we considered it as the first period (2010-2013).

We considered 2012 as the turning point of the policy change, because in 2011, the disconnection of SWIFT services happened, and multilateral financial sanctions imposed. For the second period of 2016-2019, The turning point of policy change was 2018, which multilateral financial sanctions imposed, concurrence with the withdrawal of the United States from the JCPOA, which intensified these sanctions.

We considered independent hypothesis for each period as follows:

In this study, For the purpose of further analysis, for each period considered the independent hypothesis that we mention below:

First period(2010-2013):

1- the multilateral financial sanctions and the most severe financial sanctions against Iran over the period 2010-2013 had a negative and significant effect on the import of capital and intermediate goods.

2- Iran's imports under multilateral financial sanctions may be more affected by those countries that implemented sanctions.

Second period(2016-2019):

1- the application of multilateral financial sanctions along with the withdrawal of the United States -from the JCPOA over the period 2016-2019 has a negative and significant impact on Iran's imports.

2- Iran's imports under multilateral financial sanctions along with the withdrawal of the United States from the JCPOA have been more effects for the countries that have implementation sanctions.

We classified Iran's trading partners into two types: first, countries that submitted their proposal to the UN Security Council to sanction and sanctions. second, countries that were not implemented sanctions. Therefore, the control group includes countries that have not implemented financial sanctions. While the target group includes countries that implemented sanctions.

In other words, we can categorize member states into those who implemented sanctions and those countries that did not implement them, which is a realistic method to examine available data. Therefore, the import data are extracted from the TRADE MAP website. It includes a panel dataset of 68 countries that Iran imported from them. (Annex(1)).

We also define a time dummy variable to examine the impact of severe and multilateral financial sanctions imposed on Iran. In addition, the dependent variable in this model is import (in thousands of dollars at the current price). The data related to this variable were extracted from the international site: www.trademap.org. Also, the independent variables of the model that is GDP was extracted from the World Bank website and the data on the distance extracted from the CEPII website. Also, Real exchange rate obtained from the following equation:

$$\text{Real exchange rate} = \text{Nominal exchange rate} * \frac{P^d}{P^f}$$

P^d=CPI is IRAN

P^f= Average inflation of 15 major trading partners with Iran is considered.[1] The inflation rate of 15 countries was extracted from the International Monetary Fund website.

the variable of implementation dummy, is obtained from the United Nations Security Council, and the time dummy variable that shows the effect of UN sanctions on Iran.

Therefore, the basic form of the DID method is the following equation:

$$Ln(Import)_{ijt} = \beta_0 + \beta_1 Ln(GDP_{ijt}) + \beta_2 Ln(Dist_{ijt}) + \beta_3 Ln(Rexch_{ijt-1}) + \gamma_1 Sanc_{ijt} + \gamma_2 Impelemntion_{ijt} + \gamma_3 (Impelemntion_{ijt} \times Sanc_t) + \varepsilon_{ijt} \quad (4)$$

where indices i and j are countries and t a symbol denotes time.

$Ln(Import)_{ijt}$ denotes Imports of country i from country j (in thousands of dollars at the current price).

$Ln(GDP_{it})$ denotes natural logarithm of real GDP at the current price $Ln(Dist_{ijt})$ denotes the natural logarithm of the weighted distance of the important cities of the countries,

$Ln(Exch_{it}$ denotes the natural logarithm of Real exchange rates of countries

$Impelemntion_{ijt}$ denotes dummy variable indicating the implementation of the sanctions by the target countries

$Sanc_{ijt}$ denotes a dummy variable indicating the time of the event and $(Impelemntion_{ijt} \times Sanc_t)$ denotes dummy variable indicating the DID approach

ε_{ijt} denotes the error term.

Imports of capital and intermediate goods is a function of gross domestic product, exchange rate, financial sanctions, and distance between two countries. In this paper, the logarithm of the real gross domestic product used to show the size of the economy. It is expected that the coefficient of GDP in the model will be positive, meaning that the larger the size of two economies, the greater their bilateral trade.

[1] The investigated countries are: China, UAE, Russia, Turkey, Switzerland, India, Germany, Iraq, South Korea, Pakistan, Indonesia, Afghanistan, Belarus, Georgia, Azerbaijan.

The logarithm of the distance is another variable of the gravity model. Considering that sanctions have different impact on neighboring and non-neighboring countries, we considered the distance variable in the model, since the imports are mostly reoriented towards neighboring countries.

The effect of exchange rate on imports is that when the exchange rate depreciate, people have to pay more units of domestic currency in exchange for receiving one unit of foreign currency. Therefore, the cost of buying foreign goods increases and of course the demand for the imports of foreign goods decreases.

Sanction or $Sanc_{ijt}$ which is a dummy variable includes the value of one for the years under the sanction and zero for the other years. The effect of sanction on the imports is that when the sanction is intensified, imported goods become more expensive, and with the increase in the price of imports, products dependent on imported raw materials also become more expensive, hence the imports price index increases.

Another dummy variable represents $Impelemntion_{ijt}$ or the implementation of the sanctions by the target countries, take the value of one and the countries that have not implemented sanctions take the value of zero. By joining the target group (the group that implemented the financial sanctions), the imports of capital and intermediate goods decreases.

Another dummy variable is $(Impelemntion_{ijt} \times Sanc_t)$ or DID approach, which indicates the interaction between the time dummy variable and the dummy variable for sanction implementation. It is expected to have a negative sign which shows the net effect of financial sanctions of the target group on the imports of capital and intermediate goods which is a key coefficient in this paper.

Therefore, to estimate equation (4), first, we examined the stationary of the variables and then the type of model. (Annex (2):

The results of Chow and Hausman test also indicate that the panel model is random effects.

As cross-sectional regressions using ordinary least squares (OLS) do not take into account unobserved factors, and lead to potentially biased and inconsistent estimates, therefore, the random effect panel data model is estimated using generalized least squares (GLS) to account for country-specific unobserved effects and unobserved differences between countries.

In other words, we assume that the country-specific constant terms are randomly distributed. Therefore, considering that the random effects model is a more powerful estimation method than pooled OLS, panel data are utilized to observe country-specific factors, but there is a limit to the complete observations. To solve such issues, we can rely on the dynamic panel model proposed by Arrelano and Bond (1991). This paper implements the dynamic panel model with the random effects.

In the following, the random dynamic panel model is used using the two-stage generalized moments method and Arellano-Band estimator. In the panel models, its dynamic form is obtained by entering dependent variable lags as independent variables on the right hand side of the model. The method of generalized moments is used when the number of sections is greater than the number of time series. In this method due to the existence of a dependent variable with lag on the right side, one of the basic assumptions of classical models, which is the lack of autocorrelation between independent variables and the disturbance term, is violated. As a result, least squares methods cannot be used to estimate the coefficients of the model.

For the consistency of the estimator and the validity of the tools, it is necessary that there is no serial correlation between the error terms and the tools. To this end, Sargan tests and AR(1) and AR(2) statistic are used. In these tests, the non-rejection of the null hypothesis means the absence of second-order serial correlation in the error terms of the first-order differential equation of the GMM estimator and the validity of the tools. The dynamic panel data GMM method has the advantages in terms of incorporating individual heterogeneity and more information, removing distortions in cross-sectional regressions, which will result in more accurate estimates, with higher efficiency and less linearity in GMM. Dynamic data panel GMM method is used when the number of cross-sectional variables (N) is more than the number of time and years (T), which is also the case in the discussion of this paper, that is, the number of countries is more than the number of time (Bond, 2002; Baltagi, 2008).

6- Model Estimation and interpretation of the results

In this section, we provide the empirical results for the model over the two periods:

A: The first period, 2010-2013, when severe and multilateral financial sanctions were imposed on Iran.

The estimated results of financial sanctions on the imports of capital and intermediate goods are presented in Tables 1 ,2 and 3. As Table (1) shows, Iran's imports pattern is similar to normal countries. The result of Pooled OLS and random effects estimation in Table(1) shows that the estimated results are statistically significant. In other words, the volume of Iran's imports, as the gravity model shows, is a function of the gross domestic product, while it has the reverse relationship with the distance between countries. This means that there are many imports from geographically close countries. A large part of Iran's imports of capital and intermediate goods from the UAE highlights these features of the gravity model[1].

[1] Table(2) illustrates The share of the top 10 exporters of capital and intermediate goods to Iran. Annex(3):

On the first hypothesis, which states that multilateral financial sanctions against Iran have a negative and significant effect on the imports of capital and intermediary goods, in table (1), the dummy variable of multilateral financial sanctions (A) is integrated in OLS and the random effect has a negative sign and is not statistically significant, but the same variable (A) in table (3) is statistically significant only at the 10 percent confidence level, which has a negative effect of 0.49 on the imports of capital and intermediate goods.

Table (1): Impact of financial sanctions on Iran's imports of capital and intermediate goods in the first period (2010-2013): Pooled OLS and Random Effects method

Variables	Pooled OLS				Random Effect			
	1	2	3	4	1	2	3	4
GDP(log)	0.28*** (0.018)	0.35*** (0.017)	0.39*** (0.012)	0.44*** (0.015)	0.48*** (0.019)	0.51*** (0.036)	0.53*** (0.024)	0.56*** (0.062)
Distance(log)	-0.05*** (0.021)	-0.08*** (0.032)	-0.11*** (0.029)	-0.09*** (0.034)	-0.15*** (0.038)	-0.19*** (0.055)	-0.21*** (0.058)	-0.25*** (0.062)
Real Exchange Rate(log)	-0.25*** (0.015)	-0.27*** (0.022)-	-0.28*** (0.025)	-0.30*** (0.029)	-0.31*** (0.011)	-0.35*** (0.030)	-0.40*** (0.034)	-0.38*** (0.029)
UN Sanctions Dummy(A)	-0.18 (0.023)			-0.21 (0.035)	-0.24 (0.033)			-0.26 (0.054)
Implementation Dummy(B)		0.003 (0.041)		0.005 (0.019)		-0.007* (0.011)		-0.06 (0.012)
A*B(interaction)			-0.01 (0.054)	-0.05 (0.032)			-0.08* (0.003)	-0.11*** (0.022)
constant	1.22*** (0.095)	1.28*** (0.084)	1.34*** (0.078)	1.39*** (0.069)	1.25 (0.122)	0.27 (0.054)	1.30 (0.124)	1.42*** (0.232)
observation	544	544	544	544	544	544	544	544
R-Squared	0.513	0.532	0.552	0.580	0.622	0.685	0.738	0.792

Source: Authors' calculations
*,**,***: statistically significant at 1%,5% and 10% respectively.
Note: 1) The numbers in parentheses are Robust standard errors.

The second hypothesis, which states that the reduction of Iran's capital and intermediate goods imports depends more on the implementation of sanctions by countries, is supported by the results of the empirical analysis at the 10% confidence level. The estimation of the coefficient for the Implementation Dummy variable, indicates that it is statistically significant only in Table (1) in the random effects model at the confidence level of 10%, which shows a negative effect of 0.007 on imports. As illustrated in table (2), due to the multilateral sanctions in (2012), countries such as Japan and France, that used to be exporters of capital and intermediate goods to Iran, are no longer among the top 10 exporters to Iran.

But other countries such as China and the UAE increased the export of capital and intermediate goods to Iran. Switzerland and Turkey export of capital goods to Iran remained almost constant, and tightening of financial sanctions since (2012), restricted the imports of intermediate and capital goods to Iran. The

problems of supplying raw materials, transferring technology and the procurement of spare parts and new production equipment, have led some industries to low capacity production and even bankruptcy.

In 2013, Germany and India reduced their exports to Iran, thus India is not among the top 10 exporting countries. As can be seen in Table (2), almost all the top 10 capital and intermediate goods exporters submitted sanction implementation plan to the UN Security Council but failed to seriously implement their plans. All these facts are reflected in the coefficient estimates for the implementation dummy variable which is significant and trivial in Table (1).

Prior to imposing sanctions in 2011, Australia and Romania were not among the top 10 exporters of capital and intermediate goods to Iran. However, in 2012, they were among top 10 exporters of capital and intermediate goods to Iran. The export volume of these commodities to Iran has been decreasing since 2013, so that Romania is not among the top 10 exporting countries to Iran.

Therefore, the hypothesis of reduction of Iran's imports depends more on the countries that presented the sanction plan than on the countries that did not present the sanction plan, has a weak result, because the result is very small (negative 0.0007). UN sanctions in 2011, led countries such as Australia (Y) to reduce the export of capital and intermediate goods to Iran, but countries such as Italy (Y) increased the export of capital and intermediate goods. Korea (Y) export of capital and intermediate goods to Iran remained almost constant. We expected that the import from the countries presented sanction implementation plan to decrease more than the countries that did not present this plan, but this is statistically insignificant.

Table (2): Top 10 countries exporting capital and intermediate goods to Iran

country	year(2010)	Sanction Implemention	country	year(2011)	Sanction Implemention	country	year(2012)	Sanction Implemention	country	year(2013)	Sanction Implemention
United Arab Emirate	15,669,233	N	United Arab Emirate	16,488,017	N	United Arab Emirate	17,217,297	N	United Arab Emirate	18,129,499	N
Chaina	5,788,316	N	Chaina	7,436,737	Y	Chaina	8,175,001	N	Chaina	9,772,011	N
Germany	4,566,346	Y	Korea	4,749,959	Y	Germany	4,825,896	Y	Italy	4,309,364	Y
Korea	3,642,849	Y	Germany	3,435,399	Y	Turky	3,782,235	N	Turky	3,942,300	N
Turky	2,464,204	N	Turky	3,079,908	N	Switzerland	3,388,228	N	Switzerland	3,605,082	N
Switzerland	2,359,523	N	Switzerland	2,523,983	N	Korea	2,833,378	Y	Germany	2,293,680	Y
France	1,970,370	Y	France	1,800,974	Y	India	2,047,148	N	Korea	2,062,477	Y
Italy	1,745,340	Y	Italy	1,687,190	Y	Australia	2,030,419	Y	Sweden	906,771	N
Japan	1,567,937	N	Japan	1,299,558	N	Romania	1,639,203	Y	Australia	838,712	Y
India	1,270,591	N	India	1,180,330	N	Italy	1,083,758	Y	Japan	786,568	N

Values are based on thousands of dollars

Y: denotes those countries have submitted their request for sanction's implementation to the UN Security Council.

N: denotes those countries have not submitted their request for sanction's implementation to the UN Security Council.

Source: Research calculations based on data from the UN COMTRAD database

In the following, we used random dynamic panel-data model, one-step GMM and Arellano-Bover/ Blundel- Bond Estimator. In the conventional econometric model, the generalized moments model has a lag variable as a dependent variable, and for this reason, it is also called a dynamic panel data model.

Table (3): Effect of financial sanctions on the import of capital and intermediate goods in Iran, the first period (2010-2013) Random dynamic panel model: GMM and Arellano-Bond estimator

Variables	Random Effect			
	4	3	2	1
Lim $_{t-1}$(log)	0.27*** (0.241)	0.31*** (0.250)	0.38*** (0.262)	0.42*** (0.301)
GDP (log)	0.36*** (0.036)	0.42*** (0.047)	0.48*** (0.076)	0.57*** (0.082)
Distance (log)	-0.16*** (0.158)	-0.19*** (0.159)	-0.23*** (0.155)	-0.31*** (0.174)
Real Exchange Rate (log)	-0.28*** (0.016)	-0.32*** (0.019)	-0.41*** (0.033)	-0.44*** (0.025)
UN Sanctions Dummy(A)	-0.49* (0.359)			-0.39 (0.425)
Implementation Dummy(B)		-0.09 (0.015)		-0.14 (0.158)
A*B(interaction)			-0.14* (0.039)	-0.27** (0.068)
constant	2.11 (0.112)	2.87 (0.152)	2.53 (0.168)	2.99 (0.180)
Wald Test[1]	0.000	0.05	0.000	0.000
Saregan test	0.39	0.45	0.27	0.35
Autocorrelation test[2]	0.15	0.34	0.45	0.56

Source: Research calculation
***,** and * show statistical significance at 1%, 5% and 10% levels, respectively.
Note: 1) The numbers in parentheses are Robust standard errors

As illustrated in table (3), the results of estimating the coefficients of equation (4) indicate that the imports variable with one year lag has a significant impact on imports. By examining the structure of Iran's economy and the need for imports and the resulting dependencies, as well as culture and consumption habits, using the imports of the past period in the model seems necessary. Import lags from previous periods can significantly affect current import activities due to their impact on supply chain dynamics and trade operations. lags in past imports can lead to imbalances in inventory(stock) level, which potentially resulting in inventory(stock) shortages or excess inventory(stock). This imbalance requires

[1] The obtained numbers are P values.
[2] The consistency of GMM estimation has been confirmed through the non-significance of the Sargan test (x^2) and the lack of second-order autocorrelation through the non-significance of the test (Z), and they confirm the validity of the results of the tested models based on the GMM method.

adjustments in import planning, often requiring businesses to expedite shipments or negotiate more favorable terms with suppliers.

Also, the GDP coefficient is statistically significant and has a positive sign, which means that with the increase in the size of the economy, the volume of trade also increases. Kruger (1983, p. 9) also indicated that "the decrease in the imports of capital goods reduces the growth rate of GDP, and the decrease in the imports of intermediate goods and raw materials has a negative effect on production and employment." The coefficient of other variables of gravity model, i.e. the distance between two countries, is also in accordance with the expectation and it's significant. The coefficient of this variable is negative and statistically significant at 1% level. Due to the sanctions that have a different impact on neighboring and non-neighboring countries, and to avoid the sanctions, Iran's imports are mostly from neighboring countries. Jeong (2019) also indicated that distance has an inverse effect on trade volume.

As illustrated in table (3), the coefficient of sanctions in the model is negative and statistically significant at 1%. To see the net effect of the financial sanctions of the target group on the imports of capital and intermediate goods in Iran, the AB variable coefficient is important, which is a key coefficient. Estimation of the coefficient for the mutual effect of the variables A and B, represents the variable of difference in difference (D-in-D).

Among the other variables of the model, we can mention the real exchange rate variable. The results indicates that the coefficient of this variable is negative and statistically significant at the 10 percent level. Therefore, the real exchange rate has a negative effect on the import level. If the exchange rate depreciates, people have to pay more units of domestic currency in exchange for one unit of foreign currency. Therefore, the cost of buying foreign goods increases and of course the demand for the imports of foreign goods decreases. Keller (2001) indicated that exchange rate depreciation impacts on the imports of intermediate goods. It also makes friction in the financial markets and provoke the long-term effect of sanctions.

The results suggest that the estimated coefficient has a negative sign in the pooled OLS and random effects models, but at the 10% confidence level it is statistically significant and trivial in the random effects model in table (3), the estimated coefficient of interaction between dummy variables A and B is statistically significant at the 5% level and negative 0.27. It is reasonable to choose a significance level of 0.05 to minimize the possibility of a type I error. Therefore, the results provide evidence that multilateral financial sanctions have been effective only for the countries that implemented the sanctions. Therefore, based on the results, it can be claimed that the net effect of the financial sanctions of the target group on the imports of capital and intermediate goods was negative 0.27.

B: The second period, 2016-2019, in which, in addition to multilateral financial sanctions, withdrawal from the JCPOA also took place.

To this end, the estimated results of financial sanctions on the imports of capital and intermediate goods are shown in Tables 4, 5 and 6. As Table 4 illustrates, Iran's import pattern is similar to normal countries. Pooled OLS and random effects estimation in Table (4) show that the estimated results are statistically significant. In other words, the volume of Iran's imports, as the gravity model shows, has a direct relationship with the gross domestic product, while it has the inverse relationship with the distance between countries. This means that there are many imports from geographically close countries. A large part of Iran's imports of capital and intermediate goods from China highlights these features of the gravity model.[1]

On the first hypothesis of the second period, which states that the withdrawal of the United States from the JCPOA has a negative and significant effect on the import of capital and intermediate goods, in table (4), the dummy variable of multilateral financial sanctions (A) in OLS and the random effect has a negative sign and is not statistically significant, but the same variable (A) in table (6) is statistically significant only at the 10% level of confidence, which has a negative effect of 0.53 on the imports of capital and intermediate goods.

Table(4): Effect of US withdrawal from JCPOA on the imports of capital and intermediate goods in the second period(2016-2019): Pooled OLS and Random Effect

Variables	Pooled OLS				Random Effect			
	1	2	3	4	1	2	3	4
GDP(log)	0.15*** (0.029)	0.25*** (0.034)	0.11*** (0.016)	0.29*** (0.022)	0.33*** (0.091)	0.35*** (0.053)	0.37*** (0.088)	0.42*** (0.051)
Distance(log)	-0.35*** (0.055)	-0.39*** (0.051)	-0.40*** (0.049)	-0.43*** (0.019)	-0.38*** (0.095)	0.43*** (0.055)	-0.49* (0.071)	-0.52*** (0.076)
Real Exchange Rate(log)	-0.29*** (0.451)	-0.26*** (0.455)	-0.32*** (0.359)	-0.34*** (0.566)	-0.27*** (0.121)	-0.35*** (0.147)	-0.38*** (0.252)	-0.40*** (0.452)
UN Sanctions Dummy(A)	0.38 (0.322)			-0.55 (0.252)	-0.24 (0.585)			-0.41 (0.951)
Implementation Dummy(B)		0.2 (0.057)		0.9 (0.018)		-0.22** (0.083)		0.19 (0.087)
A*B(interaction)			-0.2 (0.044)	-0.15*** (0.016)			-0.17*** (0.021)	-0.28*** (0.014)
constant	2.11*** (0.095)	2.18** (0.507)	2.05* (0.078)	0.17*** (0.006)	2.23* (0.955)	2.41 (0.955)	3.65*** (0961)	3.245 (0.666)
observation	544	544	544	544	544	544	544	544
R-Squared	0.301	0.328	0.355	0.347	0.336	0.374	0.386	0.429

Source: Research calculations

***,** and * show statistical significance at 1%, 5% and 10% levels, respectively.

Note: 1) The numbers in parentheses are Robust standard errors

[1] Table(3) illustrates The share of the top 10 exporters of capital and intermediate goods to Iran. Annex(3):

The second hypothesis in the second period, which states that the decrease in the imports of capital and intermediate goods with the withdrawal of the United States from the JCPOA, depends more on the presentation of the sanction implementation plan by countries, is supported by the results of the empirical analysis at the 5% confidence level. These facts reflected in the estimation of the coefficient for the Implementation Dummy variable, which is only statistically significant at the confidence level of 5%, in table (4) in the random effects model, and in this model, it shows a negetive effect of 0.22 on imports. As can be seen in table (5), with the withdrawal of the United States from the JCPOA together with the existence of multilateral sanctions in 2018, countries such as the Netherlands and France, which used to be exporters of capital and intermediate goods to Iran, they are not among the top 10 exporters to Iran, and Korea has also reduced its exports to Iran compared to the previous year. But other countries such as China and UAE increased the export of goods. The share of China, UAE, and Germany is also stable after the withdrawal of the United States from the JCPOA, and the volume of their exports to Iran is high.

In (2019), Korea reduced its export to Iran, thus it's not among the top 10 exporters to Iran. As illustrated in Table (5), almost all the top 10 exporters of capital and intermediary goods to Iran proposed sanction implementation plan to the UN Security Council and with the withdrawal of the United States from the JCPOA and the tightening of multilateral financial sanctions, they were able to implement their plans seriously. All these facts are reflected in the estimation of the coefficients for the Implementation Dummy variable, which is statistically significant and notable in Tables (4) and (6) in the random effects model and the random dynamic model, but it is logical to choose 0.05 significance level to minimize the probability of type I error.

UK and Russia were not among the top 10 countries exporting capital and intermediate goods to Iran before US withdrawal from the JCPOA in 2017. However, in 2018 (along with multilateral financial sanctions and withdrawal from the JCPOA), they become among the top 10 countries exporting capital and intermediate goods to Iran.

As can be seen in Table (5), almost all the top 10 countries exporting capital and intermediate goods to Iran submitted sanction implementation plan to the UN Security Council and have been able to seriously implement their plans. All these facts are reflected in the estimation of the coefficients for the dummy variable of implementation and are statistically significant.

Therefore, the hypothesis that the reduction of Iran's import depends more on the countries that proposed the sanction implementation plan than on the countries that did not propose this plan, has a strong result and significant. Countries such as Korea (Y) have greatly reduced their export of capital and intermediate goods to Iran since the withdrawal of the United States from the JCPOA in 2017, and they are not among the top ten exporters of capital and intermediate goods to

Iran. Other countries such as Germany (Y), Russia (Y), UK (Y) and Italy (Y) also reduced the export of capital and intermediate goods to Iran. Therefore, our expectation is true that the imports from the countries proposed the sanction implementation plan will decrease more than the countries did not propose. It's also statistically significant.

Table (5): Top 10 countries exporting capital and intermediate goods to Iran

Country	Yaer (2016)	Sanction Implemention	Country	Yaer (2017)	Sanction Implemention	Country	Yaer (2018)	Sanction Implemention	Country	Yaer (2019)	Sanction Implemention
Chaina	10,696,326	N	Chaina	13,115,140	N	Chaina	10,248,562	N	Chaina	11,239,833	N
United Arab Emirates	5,689,198	N	United Arab Emirates	8,179,952	N	United Arab Emirate	5,706,468	N	United Arab Emirates	8,970,873	N
Korea	3,460,089	Y	Korea	3,681,600	Y	India	2,650,200	N	Turky	5,022,918	N
Turky	2,724,542	N	Turky	3,182,886	N	Turky	2,580,424	N	India	3,692,093	N
Germany	2,533,502	Y	Germany	3,072,069	Y	Germany	2,451,766	Y	Germany	2,113,566	Y
India	1,955,062	N	India	2,254,605	N	Switzerland	2,103,897	N	Russia	1,164,575	Y
Russia	1,544,082	Y	Switzerland	2,181,850	N	Korea	2,049,474	Y	Switzerland	2,110,439	N
Italy	1,226,841	Y	France	1,764,314	Y	Russia	1,342,654	Y	England	1,022,197	Y
Brazil	1,208,325	Y	Italy	1,426,098	Y	Italy	1,144,982	Y	Italy	1,015,057	Y
Switzerland	1,150,994	N	Netherlands	1,172,460	Y	England	1,090,106	Y	Netherlands	1,005,135	Y

Values are based on thousands of dollars
Y: denotes those countries have submitted their request for sanction's implementation to the UN Security Council.
N: denotes those countries have not submitted their request for sanction's implementation to the UN Security Council.
Source: Research calculations based on data from the UN COMTRAD database

In the following, we use the random dynamic panel model with the one-step generalized moments method and Arellano-bond estimator. As can be seen in table (6), the results of estimating the coefficients of equation (4) indicates that the imports variable with one year lag has a significant impact on imports. The GDP coefficient is statistically significant and positive, which means that with the increase in the size of the economy, the volume of trade also increases. Also, the coefficient of another variable of gravity model, i.e. the distance between two countries, is as expected and significant.
The coefficient of this variable is negative and statistically significant at 1% level. In other words, in the current model and during the period under review, neighboring countries had more bilateral trade
Among the other variables of the model, we can mention the real exchange rate variable. The results show that the coefficient of this variable is negative and statistically significant at the 10 percent level. Therefore, it can be argued that the official exchange rate has a negative effect on the imports level.
As can be seen in table (6), the coefficient of sanctions in the model is negative and statistically significant at 1%. This coefficient is the same as $\gamma 1$ in the DID method. The negative sign of this coefficient shows that with the withdrawal of

the United States from the JCPOA, the import of target group countries to Iran decreased significantly.

Table (6): Effect of financial sanctions on the imports of capital and intermediate goods in Iran, the second period (2016-2019)
Random dynamic panel model: GMM and Arellano-Bond estimator

Variables	Random Effect			
	1	2	3	4
Lim $_{t-1}$(log)	0.29*** (0.232)	0.38*** (0.288)	0.44*** (0.295)	0.54*** (0.314)
Lgdp	0.35*** (0.101)	0.58*** (0.250)	0.26*** (0.004)	1.16*** (0.963)
Distance(log)	-0.55*** (0.125)	-0.28*** (0.171)	-0.33*** (0.215)	-0.41*** (0.179)
Real Exchange Rate(log)	0.26*** (0.412)	-0.36*** (0.425)	-0.28*** (0.385)	-0.42*** (0.363)
UN Sanctions Dummy(A)	-0.53* (0.497)			-0.62 (0.704)
Implementation Dummy(B)		-0.15 (0.091)		0.18** (0.085)
A*B(interaction)			-0.20* (0.153)	-0.33** (0.169)
constant	-3.65 (2.83)	5.22 (3.45)	4.41 (2.96)	-3.85 (3.15)
Wald Test	0.050	0.050	0.000	0.050
Saregan test	0.35	0.39	0.42	0.47
Autocorrelation test	0.28	0.25	0.33	0.52

Source: Research calculations
***,** and * show statistically significance at 1%, 5% and 10% levels, respectively.
Note: 1) The numbers in parentheses are Robust standard errors

According to the results, estimation of the coefficient for the mutual effect of dummy variables of A and B , shows that the estimated coefficient has a negative sign in table (4) and table (6), but statistically significant in the random dynamic panel model. Therefore, according to table (6), in this case, the estimated coefficient of interaction effect of dummy variables A and B is statistically significant at the level of 5%, and its value is negative 0.33. The results provide evidence that multilateral financial sanctions have been effective only for countries that have implemented the sanctions. Therefore, based on the results, the net effect of the target group's financial sanctions on the imports of capital and intermediate goods was negative.

7. Conclusion

According to the claim that the decrease in the import of capital and intermediate goods in Iran depends on the countries that presented the sanctions plan rather than the countries that did not present the sanctions plan, the results showed that in the first period of ۲۰۱۰-۲۰۱۳, the coefficient of the implementation variable in the random effects model in terms of Statistically significant.

It shows a negative effect of 0.007 on imports, which is a weak effect because this group of countries behaved differently. Since the implementation of multilateral financial sanctions in 201۲, some countries such as Australia have greatly reduced the export of capital and intermediate goods to Iran, but other countries such as Italy have increased the export of capital and intermediate goods to Iran. But ,in the second period, the random effects model is statistically significant. In this model, the negative effect of 0.22 on imports indicates a significant effect. Therefore, the reduction of Iran's imports during this period depends more on the countries that presented the sanctions plan than on the countries that did not present this plan. Since the withdrawal of the United States from the JCPOA in 201۸, countries such as Korea, Germany, Russia, England and Italy have reduced the export of capital and intermediate goods to Iran.

Also, multilateral financial sanctions against Iran in the first period have a negative effect of 0.49 on the import of capital and intermediate goods. In the second period, the withdrawal of the United States from the JCPOA has a negative effect of 0.53 on the import of capital and intermediate goods.

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Annex(1):

The countries' data used in this study are as follows: Thailand, Brazil, Philippines, Azerbaijan, Qatar, China, Sri Lanka, Australia, Portugal, UAE, Romania, Turkey, Ireland, France, Turkmenistan, Oman, Ukraine,
Singapore, Canada, Russia, India, Kazakhstan, Germany, UK, Korea, Japan, Italy, Cyprus, Slovenia, Switzerland, Sweden, Ghana, United States, Malaysia, Indonesia, Uzbekistan, Finland, Tanzania, Iraq, Luxembourg, Hungary, Vietnam, Argentina, Saudi Arabia, Korea, Turkey, Pakistan, Georgia, South Africa, Spain, Belgium, Belarus, Tajikistan, Slovakia, Bulgaria, Armenia, Denmark, the Czech Republic, Kuwait, Poland, Bangladesh, Afghanistan, the Netherlands, Greece, Lebanon, New Zealand, Hong Kong.

Annex(٢):

Table (1): results of unit root, Chow, Hausman tests

Levin, Lin & Chui		Im, Pesaran & Shin		
P-Value	Test statistics	P-Value	Test statistics	**Variable**
0.000	-5.45	٠,٠٠٠	-3.46	***lnimport***
0.020	-2.64	٠/٠٠٠	-4.41	***lngdp***
0.050	-1.87	٠,٠٠٧	-2.14	***Lnreal exchange rate****
Result	Probability at the level	Test statistics	The type of test	
Panel Model	٠/٠٠٠	١٥٤,٣٣	Chow	
Random Effect Model	٠/٠٦٢	١٢,٦٤	Hausmann	

Source: Research calculations

*Real exchange rate Mana has been stationary with Differentiate once

Annex(3):

Table(2):The share of the top ten countries exporting capital and intermediate goods from the total exports to Iran (first period)

country	year(2010)	year(2011)	year(2012)	year(2013)
United Arab Emirate	0.38	0.38	0.37	0.39
Chaina	0.14	0.17	0.17	0.21
Germany	0.11	0.08	0.10	0.05
Korea	0.09	0.11	0.06	0.04
Turky	0.06	0.07	0.08	0.08
Switzerland	0.06	0.06	0.07	0.08
Italy	0.04	0.04	0.02	0.09
Japan	0.04	0.03	-	0.02
India	0.03	0.03	0.04	-
Australia	-	-	0.04	0.02
Romania	-	-	0.03	
Sweden	-	-	-	0.02

(Unit: %)

Source: Research calculations based on data from the UN COMTRAD database

Table(3):The share of the top ten countries exporting capital and intermediate goods from the total exports to Iran (second period)

country	Yaer (2016)	Yaer (2017)	Yaer (2018)	Yaer (2019)
Chaina	0.33	0.33	0.33	0.30
United Arab Emirates	0.18	0.20	0.18	0.24
Korea	0.11	0.09	0.07	
Turky	0.08	0.08	0.08	0.13
Germany	0.08	0.08	0.04	0.06
India	0.06	0.06	0.08	0.10
Russia	0.05	-	0.04	0.03
Italy	0.04	0.04	0.04	0.03
Brazil	0.04	-	-	-
Switzerland	0.04	0.05	0.07	0.06
France	-	0.04	-	-
Netherlands	-	0.03	-	0.03
England	-	-	0.03	0.03

(Unit: %)

Source: Research calculations based on data from the UN COMTRAD database

تحریم‌های مالی و واردات کالاهای واسطه‌ای و سرمایه‌ای در ایران: روش DID

چکیده:

در طول سه دهه گذشته تحریم‌های مالی از سوی آمریکا، اتحادیه اروپا و شورای امنیت سازمان ملل متحد علیه ایران اعمال شده است. این تحریم‌ها اثرات مختلفی بر بخش‌های اقتصادی ایران داشته است. هدف این مقاله تخمین اثر تحریم‌های مالی بر واردات کالاهای سرمایه‌ای و واسطه‌ای در ایران است که در دو دوره زمانی مستقل انجام شده است. دوره اول (۱۳۹۲-۱۳۸۹) شامل تحریم‌های مالی چندجانبه و دوره دوم (۱۳۹۸-۱۳۹۵) شامل تحریم‌های چند جانبه و خروج ایالات متحده از برجام است. ما تاثیر را با استفاده از روش تفاضل در تفاضل (DID) بررسی کردیم. نتایج دوره اول حاکی از آن است که کاهش واردات کالاهای سرمایه‌ای و واسطه‌ای در ایران بیشتر به کشورهای ارائه کننده طرح تحریم بستگی دارد تا کشورهایی که طرح تحریم را ارائه نکرده‌اند، زیرا ضریب متغیر ساختگی برای پیاده‌سازی در مدل اثرات تصادفی از نظر آماری معنادار است. اثر منفی ۰,۰۰۷ بر واردات نشان می‌دهد که اثر ضعیف است، زیرا این گروه از کشورها رفتار متفاوتی داشتند. از زمان اجرای تحریم‌های مالی چندجانبه در سال۱۳۹۱، برخی از کشورها مانند استرالیا صادرات کالاهای سرمایه‌ای و واسطه‌ای به ایران را به شدت کاهش دادند، اما کشورهای دیگر مانند ایتالیا صادرات کالاهای سرمایه ای و واسطه ای به ایران را افزایش دادند. در دوره دوم، مدل اثرات تصادفی از نظر آماری معنادار است. در این مدل، اثر منفی ۰,۲۲ بر واردات نشان دهنده تأثیر معنادار است. بنابراین کاهش واردات ایران در این مدت بیشتر به کشورهای ارائه دهنده طرح تحریم بستگی دارد تا کشورهایی که این طرح را ارائه نکرده‌اند. از زمان خروج آمریکا از برجام در سال ۱۳۹۷، کشورهایی مانند کره، آلمان، روسیه، انگلیس و ایتالیا صادرات کالاهای سرمایه‌ای و واسطه‌ای به ایران را کاهش دادند. مقایسه دو دوره مستقل نشان می‌دهد که در دوره اول سهم عمده واردات ایران به امارات و در دوره دوم متعلق به چین است. ترکیه در هر دو دوره شریک تجاری ایران بوده و از زمان اعمال تحریم‌ها سهم ۸ درصدی در صادرات کالاهای سرمایه‌ای و واسطه‌ای به ایران داشته و با خروج آمریکا از برجام این سهم به ۱۳ درصد افزایش یافته است.

کلمات کلیدی: تحریم های مالی، واردات، کالاهای سرمایه‌ای و واسطه‌ای، روش تفاضل در تفاضل، اقتصاد ایران.