Challenges and Opportunities of Oil Sanctions for Iranian Economy

Mohammad Mohammadikhabbazan

Hossein Sadeghi[a]

Bahram Sahabi

Tarbiat Modares University (TMU)
Management and Economics School
Department of Theoretical Economics
Tehran, Iran

Abstract

In this paper, the consequences of oil sanctions on Iran's economy were investigated and the pros and cons potentially arising due to such sanctions were highlighted. In this regard, a computable general equilibrium (CGE) model and a social accounting matrix (SAM) were employed to simulate some scenarios. We utilized data and calibrations from a recent paper by the authors Farzanegan, Mohammadikhabbazan, and Sadeghi (2015), which investigates the effects of oil sanctions on Iranian macro indicators and households' welfare by cutting fixed amount of oil export. We introduced a new parameter, "sanction," by which received price of oil export and thus its exportation decrease, incorporating the circumvention of sanctions into our model. While our findings on macro indicators and households' welfare indicated drop in almost all areas, generally similar to those of Farzanegan et al. (2015), surprisingly, a decline was observed in CPI. Net indirect tax also interestingly increased in less stringent oil sanction scenarios, attained a pick, and fell in stricter scenarios thereafter. Moreover, induced by oil sanctions, reallocation of factors and resources resulted in the rise in most of disaggregated activity production levels and decrease in majority of disaggregated activity prices.

Keywords: Oil, Sanctions, Iranian economy, Circumvention of sanctions, CGE model, SAM

1- Introduction

We investigated the pros and cons potentially arising from oil sanctions in Iran.[1]Commenced in 1979 by Jimmy Carter, to change Iranian political conduct, the economic sanctions have been in effect in several forms and on different basis until now.[2]In July 2012, the EU boycotted activities related to Iranian crude oil.[3]Some Iranian politicians blamed (oil) sanctions as the main cause of economic instabilitiesat one time, and some others, by contrast, denied the results arising from sanctions at another time. Iranian Economics and Finance Minister, Ali Tayebnia,in 2013 stated that the recent sanctions had been resulted in the respective 5.8% and 7% reductions in Iranian GDP and per capita income, and mismanagement exacerbates vulnerability to economic sanctions.[4]Due to the sanctions, Iranian oil industry reduced its production about 25%, where this fall can be, partly if not wholly, the cause of reductions in Iranian GDP and per capita income.[5]

[a]Corresponding author (sadeghih@modares.ac.ir).

[1]Economic sanctions are defined as "the deliberate, government inspired withdrawal, or threat of withdrawal, of customary trade or financial relations"(Hufbauer et al. 2007).

[2]For a historical review of economic sanctions see Daoudi and Dajani (1983) and Hufbauer et al. (2007).

[3]Besides, the US congress is working on a new proposal suggesting Iranian-Oil-Free Zone which aims to boycott the entire transfer of Iranian oil. See:http://www.defenddemocracy.org/media-hit/the-case-for-an-iranian-oil-free-zone/
and see: http://www.defenddemocracy.org/media-hit/frustrated-with-diplomacy-some-in-congress-seek-total-ban-on-irans-oil/
Farzanegan and Raeisian Parvari (2014) have examined this proposal and the response of international oil prices to such policy.

[4]The interview with Tayebnia is available at:
http://www.bbc.co.uk/persian/business/2014/03/140306_tayebniya_economy_iran.shtml (in Farsi)

[5]Iranian oil production decreased to about 3 million bbl/d in 2012/2013 from more than 4 million bbl/d in 2005.See:http://www.amar.org.ir/Default.aspx?tabid=581; and http://www.opec.org/opec_web/en/publications/338.htm;

However, mostly during Mr. Ahmadinejad presidential period, Iranian government denied the effectiveness of such oil sanctions on Iran's economy.[6]While some evidences show that Iranian government tries to dodge sanctions,[7] it is often claimed by Iranian government that non-oil productions can compensate for reductions in oil export.

Although economy-wide researches on sanctions are rare, there are many studies that investigate the outcomes of sanctions in the political economy environment. For instance, some studies such as Farzanegan (2011) and Farzanegan (2014) concern the relationships between sanctions and military spending, and some studies investigate the differences between the effectiveness of sanction in the shortrun and long run (Dizaji and van Bergeijk (2013)and Hufbauer et al. (2007)).In this regard, Askari et al. (2001),Clawson (1998), and Torbat (2005) believe that sanctions are ineffective actions, while Eaton andEngers (1992, 1999) argue that sanctions may be of effective measures. Moreover, Farzanegan (2013)shows that underground economy in Iran may increase due to the sanctions. However, such political economy considerations were not of the goals of this paper.

Using a CGE model and SAM to simulate oil sanctions,Farzanegan et al. (2015)exogenously reduce the quantity of oil exportation from Iran and indicate that total imports, exports, private consumption, GDP, and capital income fall whilereal exchange rates, net indirect taxes, and labor income increase. They also show that, compared to lower income households, higher income households undergo more welfare loss. However, Farzanegan et al. (2015) do not include falls in price received for oil exportin their simulation; Hufbauer et al. (2007) argue that "lower price received for embargoed export" is one way to "engender costs to the target country."In addition, how and to what extend oil sanctions can affect Iranian activity sectors are remained unaddressed. Farzanegan et al. (2015) do not show the effect of oil sanctions on disaggregated activity price and level of productionas well as price level. They also neither simulate a very strict scenario nor open a path to incorporate circumvention of sanctions into the model.

To respond to sanctions, a sanctioned country can change its resource allocation. For example, Siddig (2011) shows that although most of Sudanese macro indicators such as GDP, export, import, GDP price index, and welfare level (shown by equivalent variation) decrease due to the EU sanctions, to compensate for the losses, the majority of sectors indicate an output rise. This adjustment process is highly expected for the case of Iran where the country suffers from Dutch disease, and unforeseen rise in the revenues from exportation of natural resources has led to unutilized capacity in non-resource tradable commodity sector.[8]In addition, a sanctioned country such as Iran may partially circumvent sanctions via channels by dealers and companies. However, it can induce some costs to the sanctioned country by decreasing the received price of exportation. For instance, in December 2013, Mr. BabakZanjani, blacklisted both by the US and the EU for helping Iranian government to dodge oil sanctions, was arrested because of withholding 1.9 billion dollar of oil revenues.[9]

In this study we probe into the effects of oil embargo on Iranian macroeconomic indicators including CPI and disaggregated activity price and level of productions. The idea of this paper is that Iran reallocates its endowments and technologies for the partial mitigation of harmful effects of oil sanctions. In fact, the main objective of this workis to answer the question that whether the oil sanctions could introduce some opportunities, besides all challenges, for Iranian economy through adjustment process.[10]This question was addressed as the concern of both senders and receiver of oil sanctions. We employedStandard Computable General Equilibrium (CGE) Model in GAMS, hereafter SCGE, by Lofgren et al. (2002) and utilized a SAM for the year 2001 and calibrations used byFarzanegan et al. (2015).

[6]"From right and from left, they adopt sanctions, but for us they are annoying flies, like a used tissue"(Mr. Ahmadinejad, on an official visit in Tajikistan, The Telegraph, 10 June 2010) See: http://www.telegraph.co.uk/news/worldnews/middleeast/iran/7816395/Iran-dismisses-new-UN-sanctions-as-a-used-hanky.html

[7] See: http://www.bbc.com/news/world-middle-east-18640746

[8]For an understanding of "Dutch disease," see Corden and Neary (1982), Krugman (1987), and Neary and van Wijnbergen (1986).

[9]See: http://www.bbc.com/news/world-middle-east-25551849

[10]Note that in this paper we only simulate the oil sanctions and suppose that Iranian economy is not under pressure of banking or financial sanctions which may offset the advantages, if any, arising from oil sanctions.

A general equilibrium approach is of value sinceit israrely applied in the case of Iranianoil sanctions.[11]To simulate oil sanctions, we introduced the parameter *sanction*so that received price from oil exportation falls and developed some scenarios. Our findings indicated that oil sanctions can lower the CPI and may provide the opportunity for other industries to grow. Nevertheless, GDP, total export and import, capital income, absorption, private consumption, and households' welfare declined at the same time of the soaring exchange rates and labor income.

This section is followed with the neoclassical description of adjustment process to sanction in section 2. In section 3methodology and data is presented. Section 4 expresses the setup of simulations and scenarios. Section 5presents the results and discussion, and finally, section 6 concludes the paper. Also, complementary tables are provided in appendix.

2- Adjustment Process and Sanctions in the Neoclassical Trade Model

Usual comparative analysis, introduced by Kemp (1964), can best show how an economy adjusts itself to sanctions. The simple neoclassical model of trade is illustrated in Figure 1 for Iran. It is similar to what is used by Dizaji and van Bergeijk (2013) with minor differences to represent adjustment process for the case of oil sanctions on Iran. To simplify the analysis, suppose that Iranian productions consist of two alternatives: *Oil* and *Others*. *Others* can be perceived as a blend of all commodities except for *Oil*. Also, for ease of analysis, suppose that oil sanctions ban the whole exportation of *Oil*. Given the availability of endowments and technology, as constant parameters during the analysis, the curve *I*represents the maximum attainable combination of *Oil* and *Others*. Three convex indifference curvesincludingC_1, C_2, and C_3 represent domestic consumer preferences, where each is a mixture of *Oil* and *Others* yielding a constant level of utility. There are two price ratios $P_A$andP_W. If the economydoes not trade, P_A is the equilibrial price derived from maximizing consumer preferences subject to the existing maximum attainable combination of *Oil* and *Others*. WithP_A, the curve *I*is in tangent with C_2 at the point *A* which shows an autarky condition.$P_W$is the world ratio price. If P_A and $P_W$are different, there is a tendency for the country to enter international trade for increasing the domestic utility. To do so, Iran is specialized in producing *Oil*, produces at point *B*, exports *Oil*, and imports *Others*. Therefore, the country reaches a superior indifference curve; curve C_3 at point *D*. The differences between *D* and *B* determine the amount of exports and imports.

To show the adjustment process as well as welfare changes induced by oil sanctions, one can compare the results arising from two circumstances: free trade and complete sanctions. In short run, complete sanction pushes the country down from point *D* to point *B.* At point B, the country suffers from sanction, losing an amount of welfare equal to the difference between C_3andC_1. However, in long run, Iran can adjust its use of endowments and technology for mitigation of the harmful effects of sanction. We suppose that Iran has enough time and there are neither non-convexities nor imperfections so that the adjustment process is possible without incurring significant costs. Hence, the country goes along the curve *I* from point *B* to point *A*. Since the difference between C_3 and $C_2$is less than the one between C_3andC_1, it is implied that the damaging consequences of sanction are partly relieved. Although the overall result is against the domestic welfare, it is in favor of producing *Others*. Generally speaking, it can be claimed that under circumstances of oil sanctions other activities gain and thrive.

3- Methodology and Data

This section overviews the neoclassical structure of SCGE and describes the data used in the paper.

3-1- Structure of Standard Computable General Equilibrium (SCGE)

In this work, SCGE was applied to investigate the economic consequences of oil sanctions in Iran.[12] SCGE has a neoclassical nature, as it features a static multi-sectorial model with an entirely-specified trade side of a small open economy. The modelis written as a bunch of simultaneous linear and non-linear equations, explaining the behavior of and interactions among the economic players within an economy recorded in the SAM.

[11]Siddig (2011) highlights "simulation of economic sanctions using the CGE approach is particularly rare."Some studies which also concern economic sanctions in other countries by employing CGE models are Hubbard and Philippidis (2001),Mc Donald and Roberts (1998), Philippidis and Hubbard (2005), and Siddig (2009).

[12]For a complete description of SCGE see Lofgren et al. (2002).

Decisions on production and consumption, respectively, are driven by profit and utility maximization represented as first-order conditions. In addition, the entire system as a whole, not necessarily individuals, has to meet a set of constraints to ensure that markets and macroeconomic aggregations are in balance.

Each activity maximizes its profit subject to its production technology. Profit is defined as the difference between revenue and cost of intermediate inputs and factors. Each activity is able to produce at least one commodity (or service), and at the same time, each commodity (or service) is produced by at least one activity. Constant Elasticity of Substitution (CES) functions specify the technology at the top level. Besides, value-added is the output of CES functions using the primary factors as inputs. Disaggregated intermediate inputs are aggregated by using a Leontief function. For all factors, factor market is competitive, factor supply is fixed at the observed level, and factors are fully-employed by activities to the point that their marginal revenues equal to their wage. An economy-wide wage variable freely varies to equalize the quantity supplied to the amount demanded by all activities via paying an activity-specific wage.

Households, enterprises, government, and rest of the world represent institutions in our model. Households' income includes income from factors and transfers from enterprises, government, and rest of the world. Their income is used for consuming home or marketed commodities, savings, paying direct taxes, and transferring to other institutions. Although, like households, enterprises receive their income from factors and transfers from other institutions, unlike households, they do not consume. Enterprises allocate their incomes for transferring to other institutions, paying direct taxes, and savings. The sources of government income are collecting taxes and receiving transfers from other institutions. Government income is used for purchasing commodities and transfers to other institutions. In this model, the rest of the world is considered as the destination and the origin of Iranian foreign trades.Alltransfer payments between rest of the world and domestic factors and institutions are fixed in foreign currency, and the current account deficit denotes foreign saving – the difference between spending to and receiving from rest of the world.

Except for home-consumed commodities, all domestic output and import enter the markets. For marketed output, there are two stages in the chain. For a given commodity in the first stage, disaggregated outputs of different activities, considered as imperfect substitutes, are aggregated using a CES function. In the next stage, a constant elasticity of transformation (CET) function allocates aggregated domestic output between domestic sales and export. Domestic demand (intermediate and transaction input, household and government consumption, and investment) is also derived from a CES aggregation function of domestic output and import.[13] Both demands for exported and imported commodities in the international markets are assumed to be infinitely elastic at given world prices.

It is known that there are three macroeconomic balances including government, external, and Savings-Investment balances. Among the broad available options, we use a set of macroeconomic closures known as "Johansen closure" (Johansen, 1960)as a helpful instrument for avoiding the misleading welfare effects in a static model.[14]Taking into account the government balance, real government consumption and all tax rates are fixed, while the government savings, defining as the residual of difference between current government revenues and spending, being freely varying. Concerning the external balance expressed in foreign currency, the current account deficit (foreign savings) is fixed, whereas the exchange rate is flexible. Since all transfers between domestic institutions and rest of the world are fixed, the trade balance must be fixed as well.The last balance, Savings-Investment balance, is investment-driven. Compared to the real investment quantities which are fixed, the values of savings are adjusting. In fact, Savings-Investment balance implies that for selected non-government institutions the base year savings rates change to equalize savings to investments.[15]

3-2- Data

To calibrate the parameters and exogenous variables, SCGE utilizesSAMas the main dataset providing an economy-wide micro-consistent benchmark.[16]

[13]This function is often called Armington function, named after Paul Armington who first introduced using of CES function for this purpose (Armington, 1969).
[14]Farzanegan et al. (2015)also used such a closure rule.
[15]We also use DPI as numeraire.
[16] For general discussions of SAMs, see Pyatt and Round (1985) and Reinert and Roland-Holst (1997).For perspectives on SAM-based modeling, see Pyatt (1988) and Robinson and Roland-Holst (1988).

In the present work,we applied the SAM by Mehrara and Barkhordari (2007) for the year 2001 which is used also by Farzanegan et al. (2015).[17] To ease reporting of results on disaggregated activity price and level of production, and also to avoid infeasibility in solving the modelunder the strictest scenario, we aggregated the SAMaccording to the standard of Central Product Classification (CPC) Ver.2 (UNSD, 2014) in its first level where there are ten classes of commodities. However, there are three exceptions in our SAM. First, oil must have a distinct account in the SAM, so it was disaggregated from its mother class (ores and minerals, electricity, gas, and water). Second, we aggregated the two last classes (business and production services; community, social, and personal services) in one for activity (services).Third, we disaggregated the produced services into two groups including tradable and non-tradable services. The aggregated SAM has 52accounts: 11 accounts representing commodities, 10 accounts for activities, 20 accounts showing Iranian urban and rural households separated by income level, 2 accounts for labor and capital, 3 accounts for tariff and direct and indirect tax, 2 accounts showing domestic and export transaction costs, and finally4 accounts, each for enterprises, government, saving-investment, and rest of the world. This SAM entered balancing program using the iterative adjustment method provided in SCGE.[18]

Although employing the SAM and calibration procedure in SCGE provides us with the most of coefficients and exogenous variables in our analysis, SCGE requires introduction of Armington and CET elasticities, elasticity of substitution between factors (bottom of technology nest), elasticity of substitution between aggregate factors and intermediate inputs (top of technology nest), output aggregation elasticity for commodities, Frisch parameter,[19] and expenditure elasticity of goods from the outside of the model. We utilized the same calibrations as whichare used byFarzanegan et al. (2015)who review other studies especially those concerns Iran. Hence, we set3 for the Armington elasticity, 2.5 for CET elasticity, 0.8 for elasticity of substitution between factors, 0.6 for elasticity of substitution between aggregate factors and intermediate inputs, 6 for output aggregation elasticity, -1 for Frisch parameter, and 1 for expenditure elasticity of goods.[20]

4- The Setup of the Simulations and Scenarios

The technique applied in the present work for modelling theoil sanctions is a modification of what is used by Siddig (2011)for simulation of economic sanctions placed by the EU on Sudanese economy. Siddig (2011) allows tax rates (which were fixed before sanctions) on export and import be variable, and instead, fixed the amount of import and export (which were variable before sanctions). The main implication of sanction-induced shock to Sudanese economy on the model structure isthat the rates of tariffs increase to the amount that forces imports and exports to decline. On the other hand, this effect implies that the sanctioned country (Sudan) receive huge revenues from tariffs as their rates should be very high.To solve this problem, Siddig (2011) prohibits the sanctioned country from reaping the profits arising from high tax revenues.

In this paper, we modified the approach used by Siddig (2011). In this regard, while we let the amount of oil export to remain variable in the model, we introduced theparameter *sanction*:

$$PE_{oil} = pwe_{oil} \cdot (1 - te_{oil} - sanction) \cdot EXR + \sum PQ_c \cdot ice_{c,oil} \quad Eq.\ 1$$

Where:
PE_{oil} = export price of oil in local currency;
pwe_{oil} = f.o.b. (free on board) export price of oil in foreign currency;
te_{oil} = export tax rate;
EXR = exchange rates;
PQ_c = price of commodity c used as trade input; and
$ice_{c,oil}$ = quantity of commodity c used as trade input per exported unit of oil.

[17] Source of the SAM which Mehrara and Barkhordari (2007) modified is the SAM for 2001 issued by the formerIranian Organization of Management and Planning.
[18] The SAM is available upon the request from authors.
[19]Frisch parameter measures the elasticity of the marginal utility of income with respect to income.
[20]Our simulation showed that the results are not sensitive to varying key elasticities around their initial level in a fairly reasonable neighborhood, but sensitive to the choice of closures. To preserve the brevity of the paper, we did not report these sensitivity analyses since ours were similar to those of Farzanegan et al. (2015).

The parameter sanction ($0 < sanction < 1$) decreases received price of oil export by Iranian oil activity in Eq. 1, forcing the oil producer to reconsider his optimal decision, reducing the amount of export.[21]Since this parameter only appears in one equation, there will not be any profit, and automatically, there is no need to do anything for preventing the sanctioned country (Iran) from reaping profits. Besides, by introducing *sanction*, it is also possible to model oil sanctions by supposing that Iran, a small-open economy, can potentially circumvent sanctions at the expense of receiving less per barrel of oil export than before. While the world price of oil is fixed considering the assumption that Iran is a fairly small-open economy, circumvention of sanctions compels Iranian oil activity to pay dealers a certain proportion of oil world price.*sanction* can also be served as a transaction cost which is imposed due to oil sanctions. We did not differentiate between these functions of *sanction* here since the consequent results will be the same.

To develop oil sanction scenarios, first we should have an understanding of Iranian oil export destinations and the amount of oil export to those destinations. By the order of their prominence, the most important regions importing Iranian oil can be grouped into 5 major areas: Europe, Asia (except of Japan), Japan, Africa, and remaining areas. During the period 1979 to 2009, Europe has been the biggest purchaser of Iran's oil by nearly importing 39% of the Iranian oil on average. After Europe, the major importing areas are Asia and Japan with a respective average of 26% and 18% of Iranian oil (CBI, 2012).Thus, scenarios should include cutting in oil export by regions. Besides, it would be useful to consider some tougher scenarios like the Iranian-Oil-Free Zone suggestion.

To simulate the effects of oil sanctions, we developed 6 scenarios other than the base simulation. In the base simulation we supposed that there are no oil sanctions, so *sanction* must be zero (Table 1). In other scenarios, we set *sanction* at 0.05, 0.1, 0.2, 0.3, 0.4, and 0.5. By increasing the parameter *sanction* the amount of oil export must decrease in response to oil sanctions. Corresponding decreases in oil export for the mentioned increases in *sanction* are 16.10%, 31.95%, 59.02%, 76.36%, 86.28%, and 92.17%.[22]The reason we developed these broad scenarios is that we are not sure which scenario exactly expresses the actual oil sanctions. Therefore, by means of various scenarios, we tried to get a good grasp of how sanctions affect Iranian economy, from slightly lenient oil sanctionsin scenario 1 to a severely strict one in scenario 6.

5- Results and Discussion

This section reports the findings of paper in two subsections: results on Iranian macro indicators and results on disaggregated activity production level and price.

5-1- Results on Iranian Macro Indicators

Not surprisingly, similar to the findings by Farzanegan et al. (2015), oil sanctions have huge impacts on almost all macro indicators (Table 2); exchange rates and factor income increase while absorption, private consumption, total export and import (see also Table A.1 and Table A.2 in appendix), households' welfare (see also Table A.3 in appendix),[23]capital income, and GDPdecrease.[24]Besides, reactions of net indirect tax revenues and CPIare interesting.

[21]The optimal mix between domestic sales and exports for the commodity c in SCGE is determined by the first-order condition expressed in the following equation:

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1-\delta_c}{\delta_c}\right)^{\frac{1}{\rho_c - 1}}$$

Where:

QE_c = quantity of export for commodity c;
QD_c = quantity of domestic sale for commodity c;
PE_c = export price for commodity c in local currency;
PDS_c = supply price for commodity c produced and sold domestically;
δ_c = a CET function share parameter for commodity c; and
ρ_c = a CET function exponent for commodity c.

Note that this equation assures that a decrease in the export-domestic price ratio generates a decrease in the export-domestic supply ratio.

[22]Alternatively, we could alter the parameter *sanction* so that the percentage changes in oil export are precise without fractions or exactly equal to hypothetical decreases by regions. However, it does not have a significant effects on the underlying reasons presented in sections 5.

[23]Changes in E.V. (equivalent variation) represent the welfare changes under various scenarios.

In alternative scenarios, reaction of net indirect tax resembles an inverse U shape. With small losses in oil revenues, net indirect tax revenues rise, attain a pick in the scenario 2, and drop in larger losses in oil revenues. This behavior can be explained by the fact that during the lenient oil sanctions, the increases in tax revenues from producers (taxes on gross output value and value added) and from consumers surpass the losses from decreases in tax revenues from export and import. However, after attaining a pick, the losses in indirect tax revenues outweigh the gains, decreasing net indirect tax revenues.

Opposed to the evidences from Iranian economy during the last years, our findings show that oil sanctions could help price level dropping. This finding seems reasonable considering the fact that Iranian economy has been suffering from Dutch disease in the past decades, and oil sanctions stimulate other activities to prosper. Furthermore, based on our non-monetary modeling of oil sanctions, the lasting inflation in Iran could be attributed to other factors such as wrong government monetary policies, where the money supply has been continuously increasing during the last years. Supposing that other activates become stronger under oil sanctions, and they mostly supply their products and services to domestic markets, we expect that CPI decreases. We will return to strengthen reasoning for the response of CPI below.

5-2- Results on Disaggregated Activity Production Level and Price

While oil sanctions impose a huge reduction in oil production (Table 3.1), almost all other activity production levels increase, except for financial services (with small declines) and for construction activity (with approximately unchanged production level).Among activities with increasing production levels, by order of their importance, activities including mining, transportation, and industrial activities indicate the largest changes. The underlying causes of these rises lie on the fact that Iranian economy reacts to oil sanctions by reallocating its technology and endowments, and other activities for being stronger. In fact, the higher exchange rates accompanied with lower-priced capital provide other activities with the opportunity to produce and export more. Moreover, the fall in the supply of commodities and services induced by the drop in imports should be mitigated by the rises in domestic productions.

Based on supply and demand rules, with larger production levels, we expect falls in most activity prices. Activity price for agricultural, oil, food, distribution, and financial activities reduces, while the transportation, industrial, construction, and services indicate a rise in their activity prices (Table 3.2). The reason for such rise in some activity prices is that increases in production levels of activities can also increase the demand for goods and services by other activities (such as transportation) as inputs. However, in general, the drops outweigh rises in disaggregated activity prices, so that price level (CPI) declines. Note that the results may differ in the case of including other sanctions in our simulation.[25]

6- Conclusion

In this research we studied the economic effects of oil sanctions on Iran. This paper focuses on the effects on Iranian macro indicators and level and price of disaggregated production. Standard Computable General Equilibrium (SCGE) by Lofgren et al. (2002) is the basis of our analysis.Also,as an economy-wide database, social accounting matrix (SAM) in 2001 provides the equilibrial starting point of the analysis, as well as the most of coefficients and parameters.Macro closures of the model are closed according to "Johansen closure."Byaddition of the parameter *sanction* to the equation for export price of oil, and increasing its amount gradually to reduce the received price of oil export, we simulate the oil sanctions where the amount of oil export decreases in six scenarios. The scenarios range from a slack oil sanction scenario to a very stringent one.

Our findings show that although oil sanctions hugely affect Iranian economy, they provide the opportunity for almost all activities to flourish.By order of their importance, macro indicators including the total export, total import, private consumption, total households' welfare, capital income, absorption, GDP, and CPI are ***negatively*** affected. The decline in CPI is the most interesting finding of this work, where it shows that, using a non-monetary model, oil sanctions are not the culprit of high inflation rate in Iran. On the other hand, macro indicators that are **positively** affected, in order of their importance, are exchange rates and labor income.

[24]For a discussion about underlining reasons of findings on macro indicators and household welfare, see Farzanegan et al. (2015).

[25]For example, results may show inflationary effects when simulation includes sanctions on total export.

The reaction of net indirect tax also presents intriguing results: net indirect tax increases in less stringent sanction scenarios, attains a pick, and then falls in stricter sanction scenarios.

Our findings also show that due to oil sanctions, activity production level of most activities increase simultaneous with production pricedrop. While production of oil industry definitely declines in response to oil sanctions, activities that ***increase*** their production level are mining, transportation, industrial, distribution, food, agricultural, and services, in order of their importance. The activity production level which ***decreases***is financial. Constructions activity production is almost unchanged. Moreover, activity production prices for oil, agricultural, financial, food, distribution, and mining ***decrease*** in order, while transportation, construction, services, and industrial activities show an ***increase*** in their activities production prices.

This study broadly investigates the effects of oil sanctions. Detailed findings that suggest oil sanctions can elevate other activities and reduces CPI are quite unique about Iran. Other useful applications ofour approach to model sanctions can be investigating the effects of lifting oil sanctions. In addition, it is possible to study the effects of placing bans on all tradable commodities; similar to what happens in banking sanctions. Because all income levels of both urban and rural households are presented in the SAM, so this study would be useful for whom concerning on policy implications against or for sanctions. Lastly, to analyze the effects of sanctions onother countries, for example the case of Russian sanction over Ukraine conflict, our approach can also be used by providing appropriate datasets from those countries. We leave these paths open to further researches.

Tables and Figures:

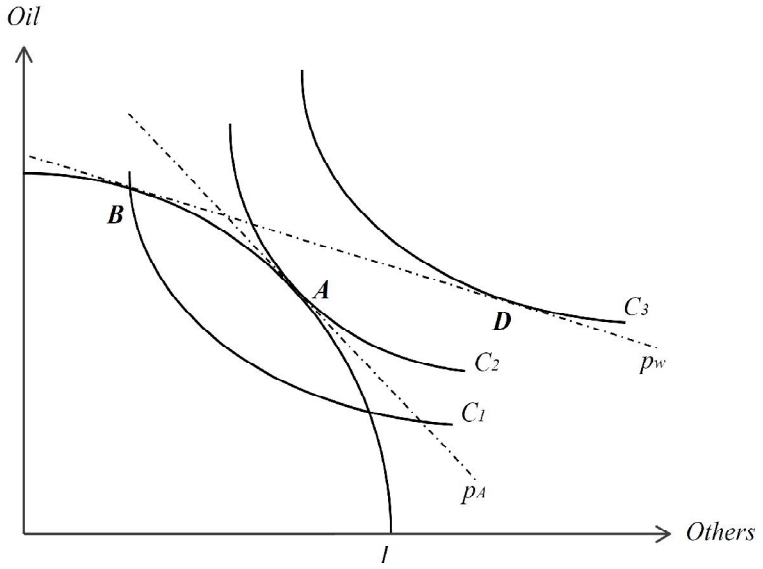

Figure 1.Adjustment Process in the Neoclassical Model of Trade

Table 1. Scenarios and Corresponding Percentage Changes in Oil Export Due to the Increasing Sanction

	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Sanction	0.05	0.1	0.2	0.3	0.4	0.5
Oil Export	-16.10	-31.95	-59.02	-76.36	-86.28	-92.17

Source: Author's calculation

Table 2.Percentage Changes in Iranian Macro Indicators Induced Byoil Sanctions

Indicator	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Absorption	-0.1	-0.2	-0.9	-1.6	-2.3	-2.7
Private Consumption	-0.1	-0.4	-1.5	-2.8	-3.8	-4.6
Total Export	-5.4	-10.3	-17.8	-22.1	-24.5	-26.0
Total Import	-6.5	-12.5	-21.5	-26.8	-29.7	-31.4
GDP	-0.1	-0.2	-0.9	-1.6	-2.2	-2.6
Net Indirect Tax	0.9	1.4	1.0	0.0	-0.8	-1.3
Exchange Rate	3.5	7.0	12.8	16.5	18.6	19.9
CPI		-0.1	-0.5	-0.8	-1.0	-1.1
Labor Income	2.3	4.6	8.1	10.0	10.9	11.3
Capital Income	-0.8	-1.5	-2.7	-3.5	-4.0	-4.3
Total households' welfare	-0.1	-0.4	-1.5	-2.7	-3.8	-4.5

Source: Author's calculation

Table 3.1.Percentage Changes in Disaggregated Activity Production Level Due to Oil Sanctions

Activity	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Agricultural	2.7	5.4	9.9	12.7	14.2	15
Mining	6.9	14.3	28.6	39.2	45.9	50.2
OIL	-13.9	-27.5	-49.8	-63.2	-70	-73.5
Food	3.3	6.4	11.4	14.4	15.9	16.7
Transport	6	11.9	21.5	26.7	29	30.2
Industrial	4.8	9.5	17.5	22.6	25.5	27.2
Construction				-0.1	-0.1	-0.2
Distribution	4	7.9	14.3	18.1	20.1	21.2
Financial		-0.2	-0.8	-1.6	-2.4	-3
Services	0.6	1	1.6	1.8	1.9	1.8

Table 3.2.Percentage Changes in Disaggregated Activity Price Due to Oil Sanctions

Activity	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Agricultural	-0.5	-1	-1.9	-2.4	-2.8	-3
Mining	-0.1	-0.2	-0.4	-0.6	-0.7	-0.8
OIL	-0.7	-1.4	-2.5	-3.2	-3.7	-3.9
Food	-0.2	-0.5	-1	-1.4	-1.7	-1.9
Transport	0.8	1.7	3.8	5.7	7	7.8
Industrial	0.6	1.1	1.9	2.2	2.4	2.4
Construction	0.7	1.3	2.3	2.8	3.1	3.3
Distribution	-0.3	-0.6	-1	-1.3	-1.5	-1.6
Financial	-0.4	-0.7	-1.3	-1.7	-2	-2.1
Services	0.7	1.5	2.5	3.1	3.3	3.4

Source: Author's calculation

Appendix: Complementary Tables

Table A.1. Percentage Changes in Iranian Disaggregated Exportinduced by oil Sanctions

Exported commodity	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Agricultural	15.58	32.49	65.28	89.22	103.99	112.93
Mining	24.93	54.22	117.63	169.87	205.26	228.48
Food	16.32	34.12	68.87	94.48	110.41	120.14
Transport	14.51	29.42	54.53	68.38	74.78	78.17
Industrial	14.92	31.02	61.98	84.57	98.70	107.48
Distribution	13.86	28.64	56.50	76.11	87.89	94.94
Financial	10.16	20.54	38.98	51.11	58.02	61.94
Tradable Services	14.42	29.91	58.88	78.20	88.65	94.04

Source: Author's calculation

Table A.2. Percentage Changes in Iranian Disaggregated Importinduced by oil Sanctions

Imported commodity	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Agricultural	-9.91	-18.60	-31.50	-38.83	-42.83	-45.17
Mining	-7.01	-13.48	-23.91	-30.51	-34.37	-36.67
Food	-9.17	-17.52	-30.45	-38.14	-42.46	-45.02
Transport	-5.64	-10.58	-17.49	-20.84	-22.43	-23.36
Industrial	-4.74	-9.22	-16.51	-21.07	-23.70	-25.28
Distribution	-7.77	-14.66	-25.04	-31.09	-34.45	-36.43
Financial	-10.79	-20.01	-33.27	-40.63	-44.62	-46.94
Tradable Services	-13.65	-24.96	-40.22	-47.69	-51.14	-52.80

Source: Author's calculation

Table A.3. Percentage Changes in Iranian Disaggregated Household's Welfareinduced by Oil Sanctions

Household's welfare	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Urban Household 1	0.1	-0.1	-0.8	-1.8	-2.6	-3.2
Urban Household 2		-0.2	-1	-2	-2.9	-3.6
Urban Household 3		-0.2	-1.1	-2.2	-3.2	-3.9
Urban Household 4		-0.2	-1.1	-2.2	-3.1	-3.8
Urban Household 5		-0.2	-1	-2.1	-3	-3.7
Urban Household 6		-0.2	-1.1	-2.2	-3.1	-3.9
Urban Household 7		-0.2	-1	-2	-2.9	-3.6
Urban Household 8		-0.2	-1.2	-2.3	-3.2	-4
Urban Household 9	-0.1	-0.3	-1.3	-2.5	-3.4	-4.2
Urban Household 10	-0.2	-0.7	-2.2	-3.8	-5.2	-6.2
Rural Household 1		-0.2	-1	-1.8	-2.6	-3.1
Rural Household 2	-0.1	-0.3	-1.2	-2.1	-2.9	-3.5
Rural Household 3	-0.1	-0.3	-1.1	-2	-2.7	-3.3
Rural Household 4	-0.1	-0.3	-1.1	-2	-2.8	-3.4
Rural Household 5	-0.1	-0.3	-1.2	-2.1	-2.8	-3.4
Rural Household 6	-0.1	-0.4	-1.3	-2.3	-3.1	-3.7
Rural Household 7	-0.1	-0.4	-1.2	-2.1	-2.9	-3.5
Rural Household 8	-0.1	-0.4	-1.2	-2.2	-3	-3.6
Rural Household 9	-0.1	-0.4	-1.4	-2.5	-3.4	-4.1
Rural Household 10	-0.2	-0.7	-2.3	-3.9	-5.2	-6.2

Source: Author's calculation

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