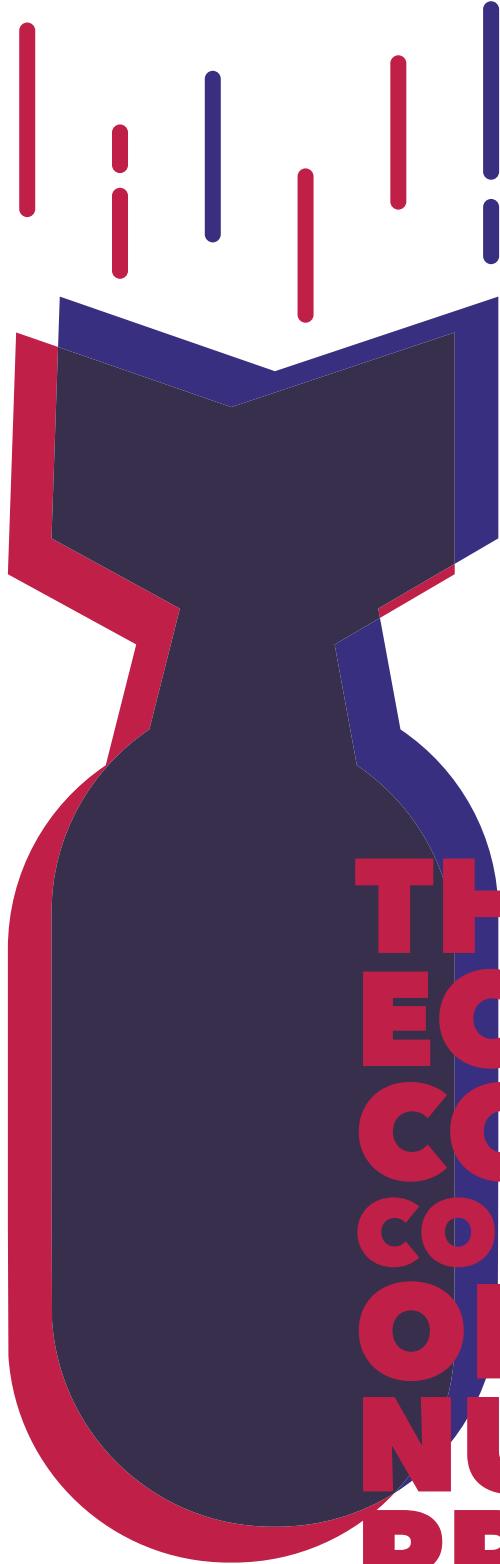




المنتدى الاستراتيجي العربي
ARAB STRATEGY FORUM



THE ECONOMIC COSTS AND CONSEQUENCES OF IRAN'S NUCLEAR PROGRAM

The adverse economic situation in Iran has led to frequent protests in Iranian regions through the previous years, where the protestors referred to inflation, unemployment, poverty, and corruption as their main concerns. This situation is a result of the consecutive international sanctions that aim at preventing Iran from further developing its nuclear program. Thus, the program has burdened the Iranian economy with indirect costs due to the sanctions, in addition to the direct financial costs of building and operating the program's facilities.

The program's direct financial costs could be broken down into the cost of infrastructure, and that of operation. The infrastructure costs amount to nearly 13 billion dollars so far, which is the cost of the uranium mines, processing facilities, enriching facilities, nuclear fuel production infrastructure, isotope separation facilities, in addition to the cost of building Bushehr reactor, which is one of the most expensive reactors in the world, despite its limited technical capabilities.

The annual operational costs of the Iranian nuclear program ranged from 45.7 to 73.3 million dollars from 2011, since Bushehr reactor was operational, to 2017. This is the cost of different stages, from extracting uranium or to manufacturing nuclear fuel. The cost of producing nuclear fuel in Iran is higher than the global average due to international sanctions that limit its ability to acquire raw materials or equipments, which increases the cost of acquiring them in the black market, or domestically producing them.

As the nuclear program developed, the international community imposed consecutive and various sanctions on Iran, from 2006, until the sanctions relief in 2015, following the nuclear deal. However, in 2018, the United States withdrew from the deal and re-imposed sanctions on Iran. Consecutive sanctions led to falling FDI to Iran, and international companies annulled new contracts worth tens of billions of dollars of investments, especially in the Iranian energy sector, which needs 130 to 300 billion dollars of new investments until 2020, just to maintain its level of production. As FDI fell, and the economy shrank, unemployment rose in Iran, especially for the young. Nearly third of the Iranian youth cannot find a job, which contributes to their dissatisfaction with the economic situation.

The Iranian currency collapsed due to the sanctions, especially the new US sanctions, which led to depreciation of the Iranian Rial against the US dollar, until it reached 112 thousand Rials per dollar last August in the black market, compared to an official rate of 36 thousand dollars at the beginning of

the year before the sanctions. As a result, inflation skyrocketed to record rates, and reached an annual average of 203% in 2018, according to some estimates. Economic sectors in Iran were influenced by the sanctions, especially the oil sector that witnessed a fall in its production and exports, which are vital to the Iranian economy. The industrial sector production fell as well since it was directly targeted by the sanctions, including the recent US ones. Also, the agricultural sector was affected by the shortage of mechanization and modern techniques due to the sanctions, and the inability of the domestic industrial sector to fill the gap.

International sanctions led also to deterioration of the Iranian infrastructure as the public revenues of oil exports decreased, and the international companies declined from investing in the sector because of the sanctions. This, in addition to the technical setback due to the sanctions that limited the transfer of modern know-how and equipments to Iran, led to a poor condition of the Iranian infrastructure, which decreases its efficiency, and costs it annual productivity loss.

The Iranian economy has lost in aggregate, nearly 500 billion US dollars, from 2006 with the first nuclear-program-related sanctions, until the economic recovery in 2016 after the sanctions relief. As the United States unilaterally re-imposed sanctions on Iran, and the parties doing business with it, the Iranian economy could suffer losses again. However, the effectiveness of the new sanctions will depend on the compliance of third parties, whether governments or companies. It is expected that European companies will comply with the sanctions to avoid losses, while the Asian companies might keep their business ties with Iran, or even strengthen them, unless the US administration pressures the Asian governments using other bilateral issues.

INTRODUCTION

During the last days of the year 2017, and through the first of week of 2018, Iranians took to the streets in several cities to protest adverse economic conditions, and inefficient public policies to address them. Later in June, protests broke out again and lasted for days, until the end of the month, and then broke out again in July and August, and spread to more cities. Remarkably, protests even extended to Tehran's Grand Bazaar¹, a historic trade hub, that is known to be conservative with close ties to the regime². Protestors held slogans that expressed their dissatisfaction with rising inflation, unemployment, corruption, and poverty³.

Since December 2017, and until August this year, the official exchange rate of the Iranian Rial against the US dollar has plummeted by 20%⁴. Consequently, average annual inflation rose to 12.1% according to official estimates⁵. Unemployment rate has also increased to 12.1% in the first quarter of the current year⁶. Poverty rate has as well started to rise since 2014 when it reached 10.5%, after its decline from 13% to 8% between 2009 and 2013⁷.

These economic pressures, that has contributed to the rise of dissatisfaction and protests in Iran, are a result of the economic sanctions that the international community has imposed on Iran as a response to its nuclear program, specifically the 2012 sanctions package, and more recently, the United States' sanctions in 2018, that are being imposed after the American administration has withdrawn from the nuclear deal of 2015. The new sanctions will be effective at two stages, the first one in August, and includes sanctions on Iran's imports of raw and semi-manufactured metals, like gold, steel, aluminium, coal, in addition to isolating certain Iranian industries. The second stage will be effective as of November, it includes sanctions on the Iranian central bank and financial sector, in addition to the shipping and energy sectors, with specific focus on Iran's oil exports⁸.

Thus, the Iranian nuclear program has, in addition to its direct financial cost that include infrastructure and operational costs of the nuclear facilities, indirect economic costs that resulted from the effects of the program's progress on Iran's international relations, and the consecutive sanctions that were imposed on Iran's economy, when the program's secret capacities were discovered, which affected the Iranian economy and people for years, and raised the indirect economic costs of the program, to a level that dwarfed the program's direct financial burden.

For decades, Iran has sought to keep secret the information about the financial costs of its nuclear program, for two main reasons, the first is that information on the costs of the program at different stages could uncover its capabilities and progress, by comparing the declared costs to financial details of similar nuclear programs worldwide, and to raw materials and technical capacities, suspected to have been acquired by Iran. The second reason is to avoid domestic instability, which might be the result of public discontent as the Iranian people learn about the costs of the program amid economic crises, which have been specifically frequent since the global sanctions were imposed in the first half of the past decade.

The Iranian government seeks also to block information on the indirect economic costs of the program as well, in order to cover the magnitude of the economic damage of the sanctions, which might imply how successful the international community has been in pressuring Iran, and how long the latter could endure the imposed sanctions, or additional ones, and consequently, whether it could further maintain its nuclear program in the future.

Thus, official data on the program's direct financial costs, or economic costs of the international sanctions on Iran, are unavailable, especially the data on direct costs, which is not even accessible to Iranian officials, and is only available to very few top figures in the Iranian state⁹. As a result, the costs of the program, direct or indirect, could instead be estimated based on the bits of available data, supported by international comparisons and approximations, in order to bridge the gaps in required information, while allowing for a margin of error for the final estimates.

DIRECT FINANCIAL COSTS OF THE IRANIAN NUCLEAR PROGRAM



COSTS OF INFRA-STRUCTURE

The direct financial cost of the Iranian nuclear program could be broken down to two categories, the first is the cost of building infrastructure and facilities for the program, and the second is the operational costs, which includes for example the cost of acquiring uranium ore, either by extraction from Iran's limited reserves, or through imports, then converting, enriching, and manufacturing it into nuclear fuel through the fuel cycle.

Since the nuclear fuel cycle begins by acquiring uranium ore, Iran has sought to utilize its limited reserves of uranium to supply its nuclear program, by developing mining infrastructure. It constructed two primary mines, with an associated milling plant for each, Saghand mine, with an annual capacity of 50 metric tonnes, and Gchine with an annual capacity of 21 metric tonnes. To utilize these mines, Iran invested 39 million dollars in Saghand, and 19 million dollars in Gchine, with a total cost of 58 million dollars¹⁰.

After acquiring uranium ore, it is converted into uranium hexafluoride, and then into low-enriched uranium hexafluoride. This process is undertaken in the Iranian nuclear program in Isfahan conversion facility, which cost nearly 30 million dollars of investments, with an annual capacity of 200 tonnes of uranium hexafluoride, and 30 tonnes of low-enriched uranium hexafluoride. Afterwards, uranium is enriched in Natanz enrichment facility, which cost from 180 to 260 million dollars of investments. And then, nuclear fuel is manufactured, for which Iran built a fuel manufacturing plant in Isfahan, with a cost from 30 to 80 million dollars¹¹.

Iran also established Arak nuclear complex, which includes a heavy water reactor, a heavy water processing plant, and isotope separation facilities. Comparing the complex's infrastructure with nuclear structures of various capacities worldwide,

it is possible that the cost of the reactor was between 70 to 150 million dollars, and the plant from 10 to 25 million dollars, and the separation facilities from 25 to 40 million dollars. Thus, the total cost of Arak complex could reach 200 million dollars.¹²

In total then, the cost of the Iranian investment in infrastructure of the nuclear fuel cycle has reached 600 million dollars and could mount to one billion dollars with error adjustments. However, It should be noted that these estimates are in 2004 dollars, thus, accounting for inflation, the cost in 2018 dollars could reach between 802.5 million and 1.3 billion dollars.¹³

In addition to the nuclear fuel cycle infrastructure, the majority of nuclear infrastructure costs in the Iranian program, was incurred for the construction of Bushehr reactor, which lasted for decades due to destruction and frequent delays. Consequently, the total cost, in 2018 dollars, of constructing the reactor when it was finally completed could reach as much as 12 billion dollars, which makes it one of the most expensive nuclear reactors in the world, despite its likely limited technical capabilities, which are surpassed by reactors that cost less than half of Bushehr's total price tag.¹⁵

OPERATIONAL COSTS

Besides the nuclear infrastructure costs of the Iranian program, which could exceed according to the estimates above, 13 billion dollars, the program costs additions annual operational costs for the program's facilities, whether in the stage of uranium ore extraction, or importing, or enrichment and manufacturing into nuclear fuel.

Iran faces higher costs for domestic production of nuclear fuel due to several reasons related to its limited reserves of uranium ore, limited technical capabilities, and international sanctions that increase the cost of acquiring raw materials and equipment at the black market. Iran's determination to produce nuclear fuel domestically is the basis of its crisis with the

international community, and it has turned down in the past offers to provide its program with years-worth supply of low-enriched uranium, in attempts to solve the crisis¹⁶.

One of the reasons for higher cost of domestic production of nuclear fuel in Iran is the scarcity of uranium ore in the country, and that its majority falls in the high extraction cost category where the cost per kilogram is between 130 and 260 dollars, compared to cheaper categories that cost 40 to 80 dollars to extract one kilogram of, which are more abundant in Brazil, China, and Kazakhstan, among other countries. Also, Iran's uranium ore is mostly low concentration uranium, which makes it more expensive to process, compared to higher concentrations types.¹⁷ Consequently, as the program developed, the annual cost of exploration and extraction of uranium ore in Iran increased gradually from 4.8 million dollars in 2006,¹⁸ to 79.6 million dollars in 2015.¹⁹

In total, the global average cost of the entire nuclear fuel cycle, reached 1390 dollars per kilogram of nuclear fuel in 2017,²⁰ down from 2770 dollars per kilogram in 2011, when Bushehr's reactor was first operational. And since a 1000-megawatt reactor, like Bushehr, needs approximately 20 thousand kilograms of nuclear fuel annually,²¹ then, the total annual cost of producing nuclear fuel for such reactor was nearly 55.4 million dollars in 2011, and 27.8 million dollars in 2017. However, since domestic production of nuclear fuel in Iran is costlier, because of higher costs of uranium ore mining, sanctions influence, and technical setbacks, the cost of supplying Bushehr's reactor with nuclear fuel will exceed that of similar reactors. It is estimated that the cost of supplying one Iranian reactor exceeds the global average by additional 17.9 million dollars annually.²² Thus, the total annual cost of supplying Bushehr's reactor with nuclear fuel could have ranged from 73.3 to 45.7 million dollars, between 2011 and 2017.

THE ECONOMIC CONSEQUENCES OF SANCTIONS ON IRAN



GLOBAL SANCTIONS

In addition to the direct financial costs, the Iranian nuclear program has had, for nearly a decade, additional, indirect economic costs that resulted from a series of gradual sanctions, imposed by the international community to deter Iran from developing its program. These sanctions have impacted the Iranian economy and cost it losses that dwarfed the direct financial burden of the program.

The first international sanctions on Iran were imposed long before its secret nuclear facilities were discovered in 2002, when the National Council of Resistance uncovered the existence of undeclared nuclear facilities in Iran, which sparked the crisis of the Iranian nuclear program.²³ The pre-nuclear sanctions were related to the consequences of the Iranian revolution in 1979. In November of the same year, the United States banned

imports from Iran, and froze 12 billion dollars of its assets. In 1995, American companies were banned from investing in Iranian oil and natural gas, and from trading with Iran in general. Later in 1996, the American congress passed a law requiring the American government to impose sanctions on foreign companies that invest more than 20 million dollars in the Iranian energy sector, annually. And in 2006, following the discovery of Iranian secret nuclear capacities, the UN security council imposed sanctions on Iran's trade in nuclear materials and technology, and froze assets of Iranian individuals and companies. In 2007, the United States imposed additional sanctions on Iran, while the security council tightened trade and economic sanctions on the country. And in 2010, the security council tightened again financial sanctions on Iran, and expanded arms sanctions. Following, in 2011, the assets of 243 Iranian entities and 40 individuals were frozen. And finally, in 2012, a new batch of sanctions was imposed, which was the harshest on the Iranian economy. The United States, imposed sanctions on the Iranian central bank and its oil exports revenues, and banned international banks from completing oil contracts with Iran, while exempting major customers, including India, South Korea, and Turkey, in return for their cutting imports from Iran. In the same year the European Union's boycott of Iranian oil exports came into effect, and in addition, the EU countries announced further sanctions on Iranian banks, trade, and natural gas imports, and froze assets of individuals and companies that provide Iran with technology.²⁴

Following the 2012 sanctions, Iran threatened to block transport of oil from strait of Hormuz, before accepting in 2013 to curb uranium enrichment above 5% and to give UN inspectors more access to its facilities, during the talks with the P5+1 group in Geneva, which consisted of the United States, Russia, China, France, The United Kingdom, and Germany. The talks led eventually in 2015 to the nuclear deal that limited Iran's nuclear activities, in return for lifting the sanctions, a deal that was unanimously approved by the UN security council.²⁵

The deal led to an improvement in the Iranian economic performance in 2016 and 2017. However, in May 2018, The US president, Donald Trump, withdrew from the deal, which he frequently scorned during the presidential elections, and the first years of his term.²⁶ The US administration declared that it will re-impose sanctions on the Iranian economy in two packages. The first is effective since August, and sanctions Iran's trade in metals and raw material, and some industries as well. The second package is effective as of November, and includes sanctions on the Iranian central bank, financial sector, and shipping and energy sectors. This package aims mainly at bringing down Iran's oil exports to zero.²⁷ However, unlike the United States, the rest of the nuclear deal parties still uphold it, and the UN security council has not announced any new sanctions on Iran.

07 FALLING FOREIGN DIRECT INVESTMENTS

International sanctions on Iran, from 2006 to the 2012 package, included countries banning their companies from investing in Iran's economy, in addition to imposing sanctions on the foreign companies that do invest there. And since more than half of FDI inflow to Iran is concentrated in its energy sector,²⁸ the sanctions on the sector have exacerbated the impact on FDI to Iran. However, even prior to the first nuclear program sanctions in 2006, FDI inflow to Iran was starting to fall. Since 2003, one year after the secret nuclear capacities were discovered, FDI inflow to Iran started decreasing, until it reached 2 billion dollars in 2008, from 3.1 billion dollars in 2002. And from 2009, FDI inflow increased again, peaking at 4.7 billion dollars in 2012, before falling again after the sanctions to 2 billion dollars in 2014 and 2015, and then rising to 3.4 billion dollars in 2016 after the sanctions relief.²⁹

However, what Iran has lost in FDI since its nuclear crisis, far exceeds the setbacks in FDI inflow compared to the pre-crisis years, as this excludes the annulled investment plans of international companies, especially in the oil sector during the previous decade, which witnessed a quick rise in oil prices that incentivized energy companies to increase their investments in oil-rich countries, especially in Western Asia³⁰, an opportunity that Iran has missed because of its nuclear crisis. The annulled investment contracts in Iran's energy sector up to 2010 are estimated at 60 billion dollars.³¹

Following 2010, sanctions on Iran were even tighter, and international companies were not considering investing in Iran until the nuclear deal was reached in 2015. Foreign direct investments to Iran

increased to 3.4 billion US dollars in 2016, and then reached 5 billion US dollars in 2017, the highest level of FDI to Iran ever.³² However, after the United States withdrew from the deal in 2018, and announced imposing new sanctions on Iran, and any company to do business with its economy, some major international companies, specifically European ones, have started to withdraw from the Iranian market. The most notable example is the French company "Total", which withdrew from a project to develop Pars gas field, a 4.8 billion US dollars project, after the announcement of the new sanctions. Nevertheless, it is expected that the Asian companies, especially the Chinese state-owned ones, will not adopt the American sanctions, since these companies do not do business with the United States, and thus would not be vulnerable to secondary sanctions. State-owned Asian companies already have major investment contracts in Iran, including the Pars gas field development project, as the Chinese state-owned CNPC contributes to 30% of the project in addition to Total's share.³³ Thus, the aggregate effect of the new American sanctions would depend on how responsive the western and Asian companies are to the secondary sanctions.

In general, the loss of potential investment opportunities, due to frequent sanctions along the years of the Iranian nuclear crisis, coincides with the Iranian government estimates that its energy sector needs 130 to 145 billion dollars of new investments by 2020, only to preserve its production capacity and prevent it from falling.³⁴ Other estimates of Iranian officials, raise the needs to 300 billion dollars.³⁵

UN- EMPLOYMENT

As investments and growth decline, the rate of job creation slows down, pushing unemployment to increase. In Iran, 800 to 900 thousand persons enter the labor market every year, and even before the tightening of the sanctions in 2012, The Iranian economy was able to create only 200 thousand new jobs a year, which must have declined after the sanctions. And while the official Iranian data otherwise show that unemployment fell after 2012, as demonstrated in table (1), unofficial estimates point to a rise in unemployment, and that it reached 14% in 2014, instead of the official 10.6%. In addition, the World Bank estimated that Iran needs to create a million new jobs every year from 2015 to 2020, only to keep unemployment at 10%³⁶, but evidently, the Iranian economy has failed so far, even after the sanctions relief, since unemployment has risen to 12.4% in 2016, and then fell to 11.8% in 2017,³⁵ and then increased again in the first quarter of 2018 to 12.1% according to the official Iranian data,³⁸ which could mean real unemployment rates that exceed this with a couple of percentage points.

Unemployment is a worse problem for the Iranian youth in specific, which might explain why they constitute the majority of the protestors in the recent waves across Iranian cities in 2017 and 2018, which were motivated mostly by adverse economic conditions. Youth unemployment in Iran is more than double the national unemployment rate. In 2013, unemployment for the age category 15-24 was 23.6%, it kept rising through the sanctions years until it reached 30.3% in 2017,³⁹ which means that nearly third of the Iranian job-seeking youth could not find a job opportunity.

CURRENCY VALUE

Consecutive sanctions on Iran have led to the decline of foreign currency inflow to the country, whether from oil exports or foreign direct investments. Thus, the Iranian Rial depreciated as the supply of foreign currency to the Iranian economy slumped after the sanctions, especially the 2012 package. The Rial's exchange rate against the US dollar was 11.2 thousand Rials per dollar at the end of 2011, few months before the sanctions were tightened. By the end of 2012, the rate was 12.3 thousand Rials per dollar. And in 2013, the Rial depreciated even more sharply, reaching a rate of 24.8 thousand Rials per dollar by the end of the year, a 121.4% increase in the dollar exchange rate in two years after the 2012 sanctions. The Iranian currency kept depreciating through the following years, even after the sanctions relief, and by January 2018, the exchange rate was 36 thousand Rials per dollar, a 221.4% increase since 2012.⁴⁰

After the United States withdrew from the nuclear deal, and announced new sanctions this year, the Iranian Rial plummeted even more. The official exchange rate reached 44 thousand Rials per dollar in August.⁴¹ In addition, foreign currencies are even more expensive in the black-market due to shortage of official supply. The black-market rate per dollar has reached 112 thousand Rials by August.⁴²

As the imports prices hiked with the Rial's depreciation, and also because of the sanctions on Iran's foreign trade, which affected the supply of goods in the Iranian domestic market, consumer prices hiked, eroding the Rial's purchasing power, and the real income of the Iranians during the sanctions years. Table (1) shows to the average annual inflation rates in Iran from 2004, before the first package of sanctions, up to 2015, when the nuclear deal was signed, leading to the sanctions relief. As the table shows, the Iranian inflation

rates were relatively high after 2006; they declined with the global economy's crisis and fall of demand in 2009 and 2010, before resurging to 20.6% in 2011, then to 27.4% in 2012, and then peaking at 39.3% in 2013. Inflation slowed down in the following years, due to the economic shrinkage the followed the sanctions, and the fiscal and monetary policies that the Iranian authorities implemented to control inflation.

More recently this year, following the quick depreciation of the Rial against foreign currencies, the average annual inflation rate has reached record levels in Iran, that are estimated at 203% by unofficial sources.⁴³ Such deterioration of the purchasing power of Iranian consumers, has contributed to the frequent protests in Iran along the past months.

Iran Macroeconomic Indicators (2015-2004)

| YEAR | GDP GROWTH (%) | INFLATION (%) | UNEMPLOYMENT (%) |
|------|----------------|---------------|------------------|
| 2015 | -1.3 | 13.7 | 11.1 |
| 2014 | 4.6 | 17.2 | 11.1 |
| 2013 | -0.2 | 39.3 | 10.4 |
| 2012 | -7.4 | 27.4 | 12.2 |
| 2011 | 2.6 | 20.6 | 12.3 |
| 2010 | 5.8 | 10.1 | 13.5 |
| 2009 | 1 | 13.5 | 12 |
| 2008 | 0.3 | 25.6 | 10.5 |
| 2007 | 8.2 | 17.2 | 10.6 |
| 2006 | 5 | 11.9 | 11.3 |
| 2005 | 3.2 | 13.4 | 12.1 |
| 2004 | 4.3 | 14.8 | 10.3 |

Source: World Bank Database <<https://data.worldbank.org/>>

IMPACTS ON IRANIAN ECONOMIC SECTORS



THE OIL SECTOR

The Iranian economic sectors were affected by the global sanctions since 2006, according to how connected they are to global markets, and whether the sanctions have targeted their activities directly. The Iranian oil sector was both the most globally connected and dependent sector, and was directly targeted by the sanctions, thus it was at the forefront of the most affected sectors in Iran by the sanctions.

The oil sector is a cornerstone of the Iranian economy. The country has the 4th largest proved oil reserves in the world, following Venezuela, Saudi Arabia, and Canada, respectively. Its reserves were 185.4 billion barrels of crude oil by the end of 2016.⁴⁴ Before the first nuclear program sanctions were imposed in 2006, Iran exported, from 2000 to 2005, on average, 2.4 million barrels of crude oil per day.⁴⁵ And along the years from 2007 to 2011, that witnessed arms sanctions and freezing of Iranian assets, the Iranian oil exports did not fall, but otherwise increased to 2.5 million barrels per day on average, due to limited sanctions on the oil sector back then.⁴⁶

The sanctions impact was felt after the 2012 package, which were economic in nature, and aimed at harming the Iranian economy. Immediately in 2012, the Iranian oil exports fell to 2.1 million barrels per day, and then to 1.2 million barrels in 2013, and 1.1 million barrels in 2014 and 2015, before increasing again to 1.9 million barrels per day in 2016, after the sanctions relief, following the 2015 nuclear deal between Iran and the P5+1 group, which curbed Iran's nuclear activities.⁴⁷

As Iranian oil exports fell after the 2012 sanctions, exports revenues followed suit, despite oil prices hike from 2011 to 2014, which witnessed historically unprecedented price levels that peaked at 111.7 dollars per barrel of Brent crude in 2013.⁴⁸ Earlier, by the turn of the millennium, Iranian oil exports revenues

rose from 21.3 billion dollars in 2001 to 48.3 billion dollars in 2005,⁴⁹ due to oil prices hike. The revenues were not impacted by the pre-2012 sanctions, and kept increasing to 89.8 billion dollars in 2008, before falling in 2009 and 2010 as the oil prices fell during the global financial crisis. And in 2011 and 2012, the revenues increased again with the oil price boom, to 114.8 and 101.5 billion dollars, consecutively.⁵⁰ Following the 2012 economic sanctions, the Iranian oil exports revenues immediately collapsed to 61.9 billion dollars in 2013, then to 53.7 billion dollars in 2014, and 27.3 billion dollars in 2015, before improving to 41.1 billion dollars in 2016, after the sanctions relief.⁵¹

The new American sanctions on Iran this year aim at bringing down its oil exports to zero. It is thus expected that the Iranian oil exports might indeed start falling again, as the United States pressures importing countries and oil transport companies to boycott Iran. However, as the sanctions become effective, it would be more obvious whether the United States could alone bring the Iranian exports to halt as planned. It is expected for example that China, which imports half of all the Iranian oil exports, would not comply with the new sanctions, especially since Iran offers its main importers, like China and India, lower prices and better deals, and also since transporting oil from Iran to these countries is maintained by state-owned enterprises that do not do business with the United States.⁵²

In general, the Iranian economy is heavily dependent on oil revenues. From 2001 to 2005, before the first nuclear program sanctions, the value of the Iranian oil exports was on average 71.8% of the total Iranian exports. And even with the pre-2012 sanctions, the average value of oil exports was 70% of the total Iranian exports from 2008 to 2012. In addition, from 2001 to 2005, the value of oil exports was on average 70% of the total public revenues,⁵³ and continued to be at least more than half of the revenues until the 2012 sanctions.⁵⁴ Thus, as the sanctions targeted the oil sector, they affected the entire Iranian economic growth, as table (1) shows, and as explained later in detail.

MANUFACTURING AND AGRICULTURE

In addition to falling oil production, global sanctions have also affected Iranian manufacturing sector, especially because of the rising imports prices, including parts and capital goods, after the collapse of the Iranian currency, and also because of the sanctions on exports of machines and equipment to Iran, and sanctions on Iranian goods as well. Thus, the value added of the manufacturing sector shrank by 4.1% and 5.3% in 2012 and 2013, respectively, then grew by 8% in 2014, before shrinking again in 2015 by 4.6%.⁵⁵ The Iranian manufacturing sector employs nearly 24.3% of all the working females, and 35% of working males. And among the industries most affected, the automotive industry's output, which accounts for 10% of the Iranian GDP, shrank from 1.6 million cars, annually, before the 2012 sanctions, to 700 thousand cars afterwards. The sanctions have also affected non-oil exports, including manufactured exports, as Iran lost more than 17 billion dollars in non-oil exports from 2012 to 2014.⁵⁶

The recent American sanctions in 2018 are expected as well to hit the Iranian manufacturing sector, after its brief recovery since the sanctions relief. The first stage of the new sanctions, which became effective in August, specifically targeted Iran's manufacturing sector. It included sanctions on selling or transporting raw or semi-manufactured metals to Iran, like steel, aluminum, graphite, coal, and gold. The first stage also included sanctions on selling or transporting software for integrating industrial processes to Iran in addition to sanctions on the Iranian automotive industry in specific.⁵⁷ Also, Iran's manufacturing sector would likely be affected as the flow of FDI falls and international companies withdraw from the Iranian market due to the new sanctions, which would slow down the already insufficient transfer of technology and know-how to Iran's industries.

Unlike the manufacturing sector, Iranian agriculture has not shrunk during the sanctions years, its value added kept growing by more than 4% annually for all the years that followed 2012. The sector employs 21.8% and 17.2% of all working Iranian females and males, respectively.⁵⁸ However, Iranian agriculture was affected by the global sanctions as they deprived the sector from much needed technologies and limited its capabilities and productivity. Iranian agriculture uses antiquated farming techniques and lacks necessary machines, which decreases the efficiency of resources, whether water, land, or labor, and leads to production levels below their potentials. The level of mechanization in Iranian agriculture is 1.1 horse-power per hectare, to put it in context, mechanization reaches 5 horse-powers in the European Union, for example. And due to the global sanctions, the Iranian sector depends on domestically produced machinery, especially from companies owned, at least partially, by the state. These companies face high prices for imports of components, and difficulty in acquiring raw materials and know-how because of the sanctions, which brings down the quality and quantity of domestic production of machines, and in turn, of the Iranian agriculture.⁵⁹

The outdated level of mechanization in the Iranian agriculture, would probably be sustained as the recent American sanctions on equipment and software become effective, which would also affect Iran's manufacturing sector, the main alternative to imported machines for fulfilling the agricultural sector demand of equipment.

INFRASTRUCTURE AND TECHNOLOGICAL DEPRIVATION

Iranian infrastructure was affected by the global sanctions, whether the ones starting from 2006, or the 2012 harsher packages, through various channels; As the public revenues declined, especially from the oil sector, less resources were available for public investment in infrastructure. In addition, the sanctions banned international companies from investing and collaborating with Iranian counterparts, which limited the companies' ability to execute infrastructure projects in the country, or to sell equipment and technologies to it. Thus, Iran has partially lost due to the sanctions, both the resources, and the know-how to improve its ailing infrastructure.

The sanctions' effects were exacerbated by the dominance of «Khatam Al Anbiya» company over the Iranian construction sector, which is the largest construction company in Iran, and is owned and managed by the Iranian Revolutionary Guard Corps (IRGC).⁶⁰ The company executes joint projects with 5000 companies in Iran, with contracts worth tens of billions of dollars, employing nearly 250,000 persons. In 2007 and 2010, the United States imposed sanctions on the company among the ones on IRGC and its affiliated companies. The sanctions limited the international companies' ability to invest in the Iranian infrastructure through collaboration with the dominant «Khatam Al Anbiya», which operates in energy, manufacturing, and agricultural sectors as well.⁶¹

This situation resulted in deterioration of the Iranian infrastructure, at least from the second half of the previous decade. In 2007, the quality of Iranian infrastructure was ranked the 66th globally, according to the World Bank's logistics performance index. It gradually deteriorated due to lack of maintenance and development, until it was ranked the 100th and 97th globally in 2012 and 2014 respectively, before improving to the 72nd in 2016, and then to the 63rd in 2018's latest index, following the sanctions relief after the 2015 nuclear deal.⁶²

Consecutive sanctions, from 2006 to 2012, have gradually affected Iranian technological progress as well. For example, Iran's technological readiness rank, one of the Global Competitiveness index's pillars fell to the 116th globally in 2014. Its availability of latest technologies rank fell to the 122nd in 2015, and its capacity for innovation was the 104th in 2015 despite having an advanced rank at the availability of scientists and engineers, as it was the 46th globally, and holding the 45th rank internationally for the quality of its scientific research institutions. Companies spending on R&D in Iran was the 110th globally in 2015, and Iran was ranked the 124th at the FDI and transfer of technologies in the same year. Most of these pillars witnessed positive progress after 2015,⁶³ after the sanctions relief and the improved flow of technology to the Iranian economy.

Iran's technological lag has exacerbated the deterioration of its infrastructure. Telecommunication infrastructure deteriorated the most during the sanctions years, compared to transport related infrastructure (ports, roads, etc.), mostly due to its dependence on more complicated and modern technologies, which demonstrates the effects of technology blockage.⁶⁴ The energy sector Infrastructure as well, has specifically suffered the lack of foreign investments and technology. The sector's infrastructure, at its current condition, threatens to cause shortages in the domestic supply of energy, despite the Iranian vast reserves of oil and natural gas. Iran's oil production capacity depletes by 13% annually in the offshore wells, and by 8% from the onshore ones, because of the limited domestic extractive capacity. Also, in the natural gas sector, and despite having the second largest global reserves, more than two thirds of the Iranian gas reserves exist in wells that have not yet been developed. The energy grid infrastructure as well, has been affected by the sanctions; Iran loses annually 15% of its generated energy by power plants, 13% by refineries, and 8% by transportation.⁶⁶

AGGREGATE OUTPUT EFFECTS OF THE SANCTIONS

The nuclear program, has cost the Iranian economy great losses through the impact of the global sanctions on the various Iranian economic sectors, especially following the 2012 sanctions, which could have yielded in losses that mounted to hundreds of billions of dollars in the few years that followed.

Consequently, and because of other effects of the sanctions, the Iranian economy shrank in three out of the four years from the 2012 sanctions, to the 2015 nuclear deal, as table (1) shows. This means that the Iranian

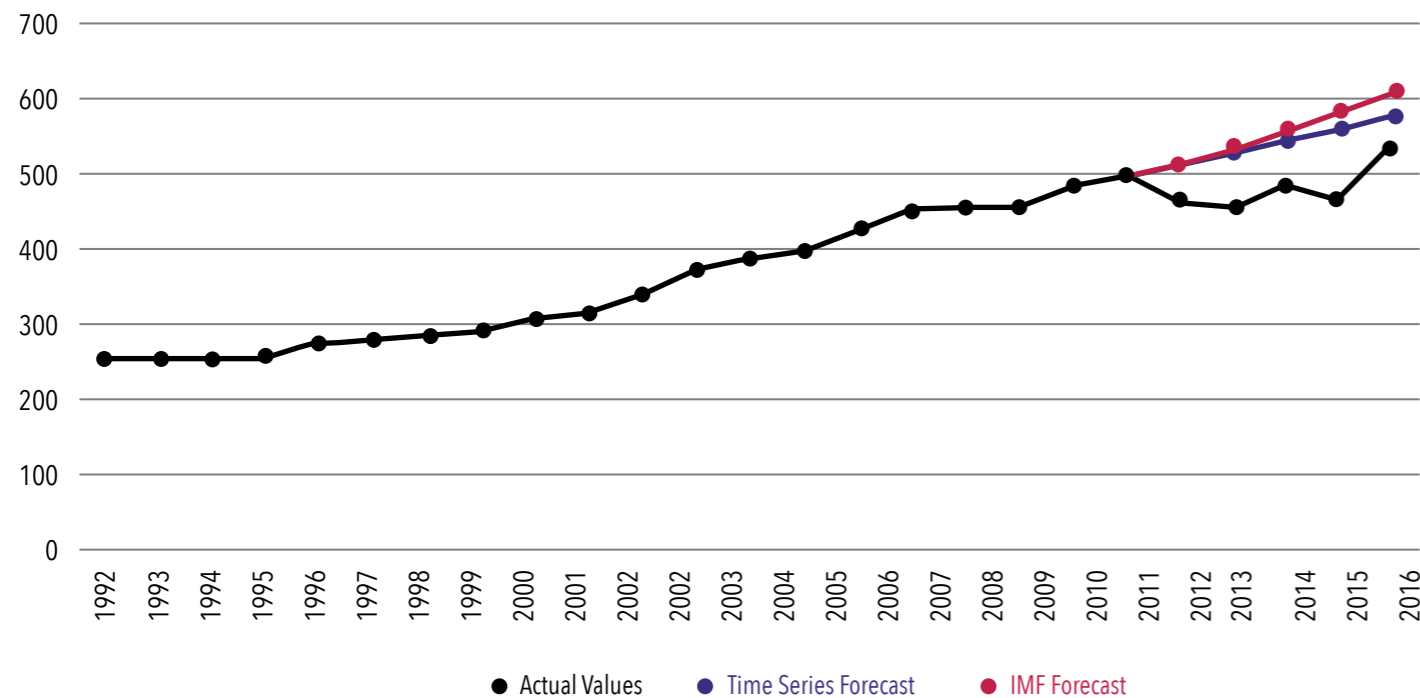
economy would incur losses on the long run even after its growth turns positive again in the following years. That period was the first in which the Iranian economy shrank since the mid-1990s⁶⁶, as the economy did not shrink after the 2006 sanctions, and continued to grow strongly, and did not shrink even during the peak of the financial crisis in 2008 and 2009.

The aggregate Iranian economic losses, that followed the sanctions, or in other word, the indirect costs of the Iranian nuclear program, could thus be estimated through the losses in Iranian GDP, which reflects the damage to different sectors and activities, however they were affected by the sanctions.

it is likely that the economic losses were predominantly during the post-2012 years. Since the Iranian GDP fell the most after the 2012 sanctions, compared to its persistent growth after the 2006 ones, and until the financial crisis. And to capture the aggregate loss in GDP due to the sanctions, it would not be equal to the difference in output before and after the sanctions were imposed, but rather the difference between the actual output after the sanctions, and what it could have reached, if the sanctions were not imposed.

It is possible to construct primary alternative scenarios to the level of Iranian output starting from 2012, if the 2012 sanctions were not imposed. Two scenarios are introduced below, in the figure and table 2, the first scenario is based on the IMF's forecast for the future of the Iranian economy until 2016, which was issued among its world economic outlook database in September 2011, few months before the sanctions in early 2012. And the second is a forecast based on the trend line constructed from the World Bank's data for the Iranian output in constant prices, for the 20 years that preceded 2011.

Iranian GDP in Constant Prices (Billion USD)



Source: constructed based on the IMF WEO database <<http://www.imf.org/en/Data>> and time-series forecast, based on data from 1992 to 2011 from the World Bank data base <<https://data.worldbank.org/>>.

Figure (1) demonstrates the two alternative scenarios for the Iranian output if the 2012 sanctions were not imposed. The green line shows the IMF forecasts for the Iranian GDP at constant prices from 2012 to 2016, which are the last IMF forecasts before the 2012 sanctions were imposed. The red line shows forecasts for Iranian GDP at constant prices, based on trend line forecasts according to data from 1992 to 2011. Thus, the two lines show what the Iranian GDP would have been if the 2012 sanctions had not been imposed. The blue line shows actual Iranian GDP from 1992 to 2016, following the sanctions.

In the figure, the gap between the line of each scenario, and the actual output line after the sanctions, represents the output loss due to the sanctions, compared to each of the two scenarios. The figure shows also that the IMF was more optimistic in its 2011 forecast for the Iranian economy up to 2016, than the trend-line forecast, that is based on the Iranian output data since 1992. This optimism could have resulted from the oil price hike in 2011, and how it could have benefited the Iranian economy according to the forecasts. It could also be noticed that even if the recovery that started in 2016, following the 2015 deal and sanctions relief,

persists, the Iranian output would still need years to catch up with the level that it could have been at, without the sanctions.

Table (2) details the estimated data demonstrated in the graph, which enables the calculation of Iranian output loss compared to the alternative scenarios. Table 2 details the data and findings of the two scenarios in figure 1. The growth and value of Iran's GDP is shown for each scenario at every year from 2012 to 2016, compared to the actual data. The table shows that according both scenarios, the Iranian economy would have had positive growth annually since 2011 if the international sanctions of 2012 had not been imposed, leading to years of output shrinkage. The difference between each scenario's GDP and actual GDP is the output loss for each year since the sanctions.

By adding the annual loss in output, the estimated total loss of the Iranian economy, after the sanctions tightening in 2012, and at least until 2016, is between 310 and 390 billion dollars of potential output. This loss is the result of several factors, including the fall of oil exports and FDI inflow, and blockage of transfer of technology and know-how.

And if the loss of the Iranian economy from 2006 to 2012 is added, which is estimated at nearly 100 billion dollars,⁶⁷ the total indirect economic costs of the Iranian nuclear program, could reach almost 500 billion dollars in one decade.⁶⁸

Iran's Actual GDP and Alternative Scenarios (2016-2012)

| YEAR | GROWTH RATE % | | | GDP AT CONSTANT PRICES (BILLION USD) | | | LOSS IN GDP (BILLION USD) | |
|--------------|---------------|--------------|----------------------|--------------------------------------|--------------|----------------------|---------------------------|----------------------|
| | Actual | IMF Forecast | Time Series Forecast | Actual | IMF Forecast | Time Series forecast | IMF Forecast | Time Series Forecast |
| 2011 | 2.6 | | | 499.9 | | | | |
| 2012 | -7.4 | 3.4 | 3.1 | 462.7 | 517.1 | 515.7 | 54.4 | 52.9 |
| 2013 | -0.2 | 3.8 | 3 | 461.8 | 536.5 | 531.4 | 74.7 | 69.5 |
| 2014 | 4.6 | 4.5 | 3 | 483.1 | 560.9 | 547.1 | 77.8 | 64 |
| 2015 | -1.3 | 4.6 | 2.9 | 476.7 | 586.6 | 562.8 | 109.8 | 86 |
| 2016 | 13.4 | 4.6 | 2.8 | 540.6 | 613.4 | 578.5 | 72.8 | 37.9 |
| TOTAL | | | | | | | 389.6 | 310.4 |

Source: Calculations based on the IMF WEO database <<http://www.imf.org/en/Data>> and time-series forecast, based on data from 1992 to 2011 from the World Bank data base <<https://data.worldbank.org/>>.

The estimates in the table 2 show the economic costs of 2012 international sanctions on Iran, until 2016 following the nuclear deal and sanctions relief, which allowed the Iranian economy to grow by 13.4% and 4.3% in 2016 and 2017 consecutively.⁶⁹

However, as the United States withdrew from the deal in May of this year, and re-imposed sanctions on Iran for its nuclear program, the Iranian economy could suffer new losses as a result, that would be added to the costs that the economy incurred because of the nuclear program, including 13 billion dollars of infrastructure, tens of millions of dollars of annual operational costs, and nearly 500 billion dollars of indirect costs due to international sanctions. And so far, the collapse of the Iranian currency, and the hyperinflation this year, even before the new American sanction are fully effective in November, indicate a powerful effect of the sanctions on Iran's economy, which could lead to more domestic unrest that would add to the frequent protests since the beginning of the year.

Nonetheless, it is still early to estimate the consequences of the new American sanctions, or to formulate forecasts based on the effects of the 2012 sanctions since the situation is currently different from how it was back in 2012. The United States solely withdrew from the nuclear deal and announced new sanctions in 2018, compared to an international embargo on the Iranian economy in 2012, with sanctions from the UN security council as well.

The consequences of the new American sanctions on Iran will depend mainly on how other countries would comply. The United States does not do business with Iran, and thus does not rely on boycotting Iran, but rather on sanctioning third parties that do business with Iran, to force them to boycott such business transactions. In this context, the European Union has not so far imposed new sanctions on Iran, unlike its decision in 2012, and the European countries in the P5+1 group have not withdrawn from the nuclear deal. In addition, the European Union has adopted last June an amendment to its 1996 blocking statute. The amendment aims at protecting European companies and individuals from the recent US secondary sanctions in case they deal with Iran. The

statute allows European entities to seek recovering damage arising from the US sanctions, from the parties causing them. It also forbids EU companies and persons from complying with those sanctions, unless they prove that non-compliance would seriously damage their interests, or the Union's.⁷⁰ However, the blocking statute will not probably be effective in incentivizing the EU companies to keep their business ties with Iran. The statute enforcement depends on the willingness of each individual EU country to force its companies to comply with it, and the complications of seeking legal action against the US government for reparations, including through confiscating assets, might discourage serious enforcement of the statute. And even if some EU countries enforced the statute, and fined the companies that comply with the US sanctions, the damage on the companies would be much less than the damage of the US secondary sanctions on Iran, thus, the European companies would mostly choose to violate the blocking statute, which would harm the Iranian economy throughout the sanctions years.⁷¹

The situation is much different for Asian companies. Asia is the main Iranian economic partner, and since Iran's major Asian partners have large state-owned companies, that do no business with the United States, and thus will be less affected by the American secondary sanctions on them, it is possible for these companies to maintain business relations with Iran. Furthermore, Asian companies could even expand in Iran to compensate for the anticipated withdrawal of European companies, while benefiting from the lucrative opportunities, and the near-monopoly status that they would enjoy in the Iranian market.⁷²

Thus, The United States' success in enforcing its new sanctions, will greatly depend on its administration's ability to isolate Iran from its Asian Partners. This would probably be done through compromises with the Asian countries regarding other issues, on top of them the US – China trade war. However, the extent to which the United states would engage in such compromises in the Iranian crisis, will mainly depend on the US administration's priorities.

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