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Abstract

This paper estimates the economic cost of sanctions on Iran (both aggregate and per capita) and their effect on economic development. Using a synthetic control method (SCM), we find that sanctions cost approximately $1.2 trillion for the period 2011-2022, which is even more than the cost of the Iran-Iraq war (1981-1988) for Iran. Sanctions cost around $150, $450, and $600 billion for the agriculture, industry, and services sectors, respectively. On average, Iran has lost around 23 percent of its economic capacity due to sanctions. Moreover, the cost of sanctions during the Obama, Trump, and Biden presidencies is about $500, $450, and $250 billion, respectively, while the annual GDP per capita loss during the Obama, Trump, and Biden presidencies is, on average, $1,050, $1,316, and $1,428, respectively. Sanctions have changed the production structure in Iran, making Iranian economic development move backwards and resulting in lost years (2011-2022). Defining three alternative scenarios and comparing them with the SCM results, confirm our findings. Finally, by studying the average growth rate of both GDP and GDP per capita for Iran, Saudi Arabia, Turkiye, and the United Arab Emirates (UAE), we find that sanctions are the dominant factor for Iran's accelerating economic divergence from the other three countries.

Keywords: Sanction, Iran, United States, Economic Development.
JEL Classifications: O11, O53, P50.

ملخص

تقدر هذه الورقة التكلفة الاقتصادية للجزاءات المفروضة على إيران (الإجمالية والفردية على حد سواء) وتأثيرها على التنمية الاقتصادية. باستخدام طريقة المراقبة الاصطناعية (SCM)، نجد أن العقوبات تكلف حوالي 1.2 تريليون دولار للفترة 2011-2022، وهو ما يزيد حتى عن تكلفة الحرب العراقية الإيرانية (1981-1988) لإيران. تكلف العقوبات حوالي 150 دولارًا و 450 دولارًا و 600 مليار دولار لقطاعات الزراعة والصناعة والخدمات على التوالي. في المتوسط، فقدت إيران حوالي 23 في المائة من قدرتها الاقتصادية بسبب العقوبات. علاوة على ذلك، تبلغ تكلفة العقوبات خلال رئاسات أوباما وترامب وبايدن حوالي 500 دولار و 450 دولارًا و 250 مليار دولار على التوالي، في حين أن خسارة الناتج المحلي الإجمالي للفرد خلال رئاسات أوباما وترامب وبايدن تبلغ في المتوسط 1050 دولارًا و 1316 دولارًا و 1428 دولارًا على التوالي. غيرت العقوبات هيكل الإنتاج في إيران، مما جعل التنمية الاقتصادية الإيرانية تتحرك إلى الوراء وتؤدي إلى سنوات ضائعة (2011-2022). يؤكد تحديد ثلاثة سيناريوهات بديلة ومقارنتها بنتائج SCM النتائج التي توصلنا إليها. أخيرًا، من خلال دراسة متوسط معدل نمو كل من الناتج المحلي الإجمالي والناتج المحلي الإجمالي للفرد في إيران والمملكة العربية السعودية وتركيا والإمارات العربية المتحدة، نجد أن العقوبات هي العامل المهيمن على الاختلاف الاقتصادي المتسارع لإيران عن الدول الثلاث الأخرى.

1. Introduction

Sanctions against countries attempting to develop weapons of mass destruction, especially ones with nuclear capabilities, started in the 1970s when Canada and the United States (US) imposed sanctions on Pakistan and India in 1974. This type of sanction included South Korea in 1975, South Africa in 1975, Taiwan in 1976, Brazil in 1978, Argentina in 1978, Libya in 1978, Iraq in 1980, Iran in 1984, North Korea in 1993, Ukraine in 1993, and Kazakhstan in 1993 (Hufbauer et al., 2008). Sanctions against Argentina, Brazil, Taiwan, South Africa, South Korea, Iraq, Libya, Ukraine, and Kazakhstan were successful, while they failed for India, Pakistan, and North Korea as these countries declared nuclear testing. The future of the Iranian nuclear program could be a case of success or failure, but we do not cover the sanction's efficiency, or the political and security issues associated with it. In this paper, we evaluate the opportunity cost of sanctions on Iran in both aggregate and GDP per capita, compare it with alternative scenarios to make it more sensible, and show that it is the main factor of Iran's economic divergence from other countries, especially Turkiye, Saudi Arabia, and the United Arab Emirates (UAE).

The US has imposed sanctions on Iran since the hostage problem in 1980 (Laudati and Pesaran, 2023; Katzman, 2015), and it is a significant part of US-Iran policy. In the 1980s and 1990s, these sanctions were first imposed to force Iran to limit its regional influences, but the nuclear program has been a main part of the sanction since 2006. However, the level of sanctions due to the nuclear program has increased sharply since 2011 when they became smart, and they have had a deep impact on the lives of the Iranian people and even the country's economic and political structure. The Joint Comprehensive Plan of Action (JCPOA), or the Iran nuclear deal achieved in July 2015 and approved in January 2016, managed to decline some parts of the UN and US sanctions, but it could not relieve all sanctions (Laudati and Pesaran, 2023) and then its uncertainty continued even in 2016. For example, during the JCPOA, the US did not violate Executive Order No. 12957,[2] which signaled to the market that investment in Iran is a risky activity. The opposition of political groups in both Iran and the US strengthened this signal; therefore, although the JCPOA could reduce the effect of sanctions temporarily, it could not demolish all their effects. The next US president was expected to violate the JCPOA, which is what ended up happening.

The election of Donald Trump as the new US president in November 2016 was a kind of external shock for the Iranian economy, which led to economic instability in Iran even before he officially started his presidency in January 2017. During the Trump era, maximum pressure was imposed on all economic sections; in this paper, we show that this had a huge opportunity cost for the Iranian economy and that the maximum cost of sanctions occurred during his presidency. Following Trump, the Joe Biden presidency was expected to decrease the level of sanctions and revitalize the JCPOA, but this did not occur. Therefore, sanctions during the Biden presidency maintained the main structure they held during the Trump presidency.

[2] "Prohibiting Certain Transactions with Respect to Iran the Development of Iranian Petroleum Resources" approved on 15 March 1995.

Sanctions on Iran have worsened the economic condition for most Iranian people. They acted as a main barrier to economic growth so that the GDP per capita in 2022 is similar to that of 2011, which shows that Iran lost 12 years due to sanctions. In this context, it's important to understand how much they cost for Iranian people in aggregate and per capita terms. Using the Synthetic Control Method (SCM), we find that in 12 years, Iran lost about $1.2 trillion (constant 2015 $), and, on average, more than $100 billion. Moreover, we find that the GDP per capita loss is $1,202 on average. Therefore, as our first contribution, we estimate an aggregate economic cost of 12 lost years. However, other scholars such as Gharehgozli (2017) and Ghomi (2022) estimate the cost of sanctions for the period 2012-15 and find that the lost GDP amounts to around 17 percent and 19 percent, respectively. Ghomi (2022) also finds that the cost of sanctions has continued even after the JCPOA. Eisazadeh et al. (2022) study the cost of sanctions for the period 2010-20 and find that the lost GDP is about 34 percent; however, they construct a synthetic Iran with just two countries (Mexico and Turkiye), which is under question as Mexico shares few economic and political characteristics with Iran. In this paper, we calculate both GDP and GDP per capita loss, which none of them have done. On the other hand, we use more covariate variables, which offer more explanation of economic growth and lead to significant results.

During the period 2011-2022, three US presidents (Barack Obama, Trump, and Biden) were elected, and their strategies for sanctions on Iran were different. Trump in particular completely disagreed with the JCPOA and wanted to violate it and impose harsh sanctions compared to Obama. On the other hand, Biden was expected to relieve sanctions and come back to the JCPOA, but he has not revitalized it and continues the sanctions. As our second contribution, we answer this question: How much is the economic cost of these different strategies?

We find that the aggregate cost of sanctions during the Obama, Trump, and Biden administrations is $505, $453, and $252 billion, respectively. In addition, the annual average cost of sanctions in the era of Obama, Trump, and Biden is $84, $113, and $126 billion, respectively. The annual cost of sanctions in the Trump era is about 35 percent more than in the Obama era, and the annual cost of sanctions in the Biden era is about 50 percent and 11 percent more than the Obama and Trump eras, respectively. This finding shows that the cost of sanctions has increased over time. Moreover, the annual average of GDP per capita lost during the Obama, Trump, and Biden presidencies is $1,050, $1,312, and $1,428, respectively. The maximum cost of sanctions comes back to 2019; during this year, GDP loss was about $136 billion and GDP per capita loss was $1,571. In fact, the strategy of maximum pressure during the Trump presidency is reflected in its result in 2019; however, on an annual average, the cost of sanctions during the Biden presidency is the highest.

As another contribution, we also calculate the cost of sanctions in three main economic sectors and find that the agriculture, industry, and services sectors have lost about $150, $450, and $600 billion, respectively. Additionally, we find that the share of agriculture decreased gradually from 1990 to 2010, which is expected in economic development theories (Acemoglu, 2008), but increased from 2011 to 2022. Therefore, the agriculture output to GDP in 2022 and 1990

becomes similar, which represents a drawback in economic development. We calculate the cost of sanctions in each main sector of the economy during the Obama, Trump, and Biden presidencies, which sheds light on the relative effect of sanctions on three main sectors during the eras of those three US presidents. We also calculate the output loss of each main sector relative to real output.

Using the SCM, we find that the economic cost of sanctions throughout 2011-2022 is about $1.2 billion, but would it be possible to crosscheck it with some scenarios to have a better sense of this cost? We answer this question by defining some scenarios.

As a first scenario, we assume that Iran has not been experiencing huge sanctions since 2011 and that it could follow its average economic performance throughout 1990-2010. In this case, how much would the GDP, GDP per capita, GDP loss, and GDP per capita loss be? We find that in this scenario, GDP loss as an economic cost of sanctions is about $1,190 billion, which is just $11 billion lower than what we calculated in the SCM. Therefore, comparing the cost of sanctions from the first scenario with the SCM shows that the performance of synthetic Iran is very similar to the average economic performance of real Iran during the period 1990-2010.

In another scenario, we calculate the cost of sanctions based on the average performance of some countries as defined in Iran's Vision 2025.[3] We find that the economic cost of sanctions in this scenario is $1,294 billion.

Iran is a middle-income country, and in the next scenario, we suppose that Iran's performance could be similar to that of middle-income countries as a whole and find that the cost of sanctions is about $1,528 billion. These scenarios confirm that our calculation in the SCM seems reasonable and contributes to the literature.

Along with the sanctions, Iran experienced a war with Iraq (1981-1988), which had a negative effect on the Iranian economy (Farzanegan, 2022). As another contribution, we compare the cost of sanctions in 12 years with the cost of the Iran-Iraq war, which lasted for eight years. Using the SCM, Farzanegan (2022) calculates the economic cost (as GDP per capita loss) of the revolution and the war between Iran and Iraq (1979-88). We extract the aggregate cost of war between Iran and Iraq from this study and compare it with the results of the SCM in this paper. The economic cost of war for eight years is $1,174 billion (constant 2010 US$). As the cost of sanctions in this paper is in constant 2015 US$, we change it to constant 2010 US$ and find that it is about $1,203 billion. Hence, the cost of sanctions on Iran is higher than the cost of the Iran-Iraq war for Iran. This finding highlights a huge amount of the sanction's economic cost. On average, one year of the economic cost of the Iran-Iraq war is similar to the economic cost of one and a half years of sanctions. This finding shows why sanctions have drastically affected Iran's economic performance and the welfare of the Iranian people.

[3] Approved in the Khatami presidency in 2005 at the beginning of the fourth five-year plan.

Sanctions have also affected Iran's comparative economic position in the Middle East. During this period, other countries such as Turkiye, Saudi Arabia, and the UAE increased their GDP and GDP per capita, which negatively affected the relative satisfaction of the Iranian people. We analyze the effect of sanctions on GDP and the GDP per capita gap between Iran and these three countries. In order to explain the worsened Iranian economic performance, Laudati and Pesaran (2023) use SVAR models to show that although sanctions affect all macroeconomic variables, other issues such as management and institutions are important too. Our finding supports the results of Laudati and Pesaran (2023), but we also state that sanctions are a major factor that generates an economic gap between Iran and the three main countries in the Middle East. Our findings explain that sanctions are the major reason for Iran's worsening economic performance since 2011, therefore the most urgent priority is the lifting of sanctions, and other policies are secondary.

The paper is organized as follows. Section two covers the literature review, while section three presents the model and creates a synthetic Iran for the period 2011-2022. Section four estimates the cost of sanctions and covers all related discussions. Finally, the last section concludes.

2. Literature Review

The SCM has been used to study the effect of various economic or political shocks on economies. For example, Born et al. (2019) focus on the costs of economic nationalism and showcase evidence from the Brexit Experiment. Employing SCMs, they show that the Brexit vote has caused a loss of 1.7-2.5 percent for United Kingdom's (UK) output by the end of 2018. In the analysis of factors affecting the reduction of UK GDP due to Brexit, the issue of investment and consumption as well as the uncertainty caused by this policy has been discussed. In fact, the uncertainty caused by the Brexit policy is one of the important factors that has affected the GDP of the UK, even when the Brexit debate became serious. The uncertainty caused by leaving or staying in the European Union (EU) for the UK is an example of the uncertainties that national policies create. This uncertainty has also been studied at the market level. Venâncio and Pereira dos Santos (2022) find that "the Brexit referendum reduced the number of UK citizens working in Portugal, particularly in the case of non-university educated, male individuals with temporary employment contracts." They attempt to understand how UK citizens working and living in the EU reacted to the uncertainty caused by Brexit.

Another example for output loss is the effect of German reunification in 1990 on the economic prosperity of West Germany. Abadie et al. (2015), defining 16 OECD members as the donor pool and using data for the period 1960-2003, find a "pronounced negative effect of the reunification on West German income" over the entire 1990-2003 period. Per capita GDP reduced by about $1,600 per year on average, which was about eight percent of the 1990 baseline level. Additionally, at the end of the period (2003), per capita GDP in the actual West Germany was about 12 percent lower than in the synthetic West Germany, which was the economic cost of German reunification for West Germany. However, the SCM has been used to evaluate the effect of market reforms. For example, Hartung et al. (2018) study the effect of labor market reform and show how the unemployment insurance system affects unemployment rates and

labor market dynamics in Germany through the German *Hartz reforms*. They find that "absent the reform, unemployment rates would be 50 percent higher."

Another branch of study with the SCM is the economic cost of regional reforms or political issues. The economic costs of organized crime in especial regions in Italy (Pinotti, 2015), conflict in Spain (Abadie and Gardeazabal, 2003), civil war (Costalli et al., 2017), the Russia-Ukraine war (Audretsch et al., 2023), the Islamic revolution and war for Iran (Farzanegan, 2022), and nuclear weapons (Mayberry, 2023) are some examples that have estimated the effect of war, crime, conflict, civil war, or even nuclear weapons on economic prosperity. Among different economic and political issues, economic sanctions on Iran are an issue, which started at the beginning of the Islamic revolution in Iran and the hostage problem on 4 November 1979 and has continued until today. However, the level of sanctions since 2011 changed drastically when the UN and the European countries joined the US. As sanctions in the 2010s and at the beginning of the 2020s have sharply affected the Iranian economy, it is a kind of natural experiment and has the potential to be studied with the SCM, as some scholars have studied the effect of sanctions on Iran.

Born et al. (2019) highlight how national policies create uncertainty, as previously discussed in this paper. This uncertainty has affected the Iranian economy since 2011, even during the JCPOA. After the nuclear negotiations and the approval of Resolution No. 2231 in the UN Security Council, the US president issued Executive Order No. 13716 in 2016 and canceled Executive Orders No. 13574, 13590, 13622, and 13645 and the clauses of Executive Order No. 13628. He suspended the implementation of the following laws: the Iran and Libya Sanctions Act of 1996 (ILSA), the Iran Threat Reduction and Syria Human Rights Act of 2012, the Freedom and Counter-Proliferation Act of 2012, the Iran Non-Proliferation Act, and the National Defense Authorization Act for Fiscal Year 2012. Nevertheless, the National Emergency with Respect to Iran was not suspended. This issue caused the situation of international investments in Iran to be ambiguous.

In 2015 and 2016, although Iran had reached the JCPOA agreement, many uncertainties continued to affect the Iranian economy. The first uncertainty came from the fact that the JCPOA was not approved by the US Congress. Another reason for uncertainty was the possibility that the next US president would withdraw from it as the JCPOA was not mandatory for the next president. In addition, the republicans were constantly discussing the possibility or necessity of withdrawing from this treaty. At the same time, there was an internal competition between the presidential candidates in America in 2015 and 2016, and one of the important discussions was the JCPOA issue. In the election debates of parties in the US, the issue of the JCPOA was constantly brought to light, and the possibility of withdrawing from it was constantly emphasized. Moreover, the continuation of the National Emergency with Respect to Iran in these two years showed that some parts of the sanctions are persistent, as it spread uncertainty and raised investment risks. Inside Iran, the opponents of the JCPOA emphasized its limited life and strengthened the uncertainty caused by expectations in the society.

However, sanctions act as a foreign policy tool; the imposers of sanctions try to affect the target country. Various sanctions have had hold during the history, and there are various purposes for them. Hufbauer et al. (2008) divide them into five major goals, including "change target-country policies in a relatively modest and limited way," "change the target country's regime," "disrupt a military potential," "impair the target country's military potential," and "change target-country policies in another major way." In this category, sanctions on Iran (the target country) due to weapons of mass destruction, especially those with nuclear capabilities, fall under "impair the target country's military potential." However, the relative efficiency or inefficiency of sanctions on Iran has been studied in various studies and we do not address them in this paper.

Studies that are more directly related to our study focus on the opportunity cost of sanctions or the effect of sanctions on economic indices and sectors. Using the SCM, Gharehgozli (2017) estimates the opportunity cost of sanctions on Iran from 2011 to 2014 and finds that it was more than 17 percent of the GDP in mentioned period. She finds that in 2012, the GDP decreased by 12 percent, and in 2014, the real GDP per capita suffered about 16 percent. Moreover, in a sensitive analysis, she finds that sanctions after 2011 had a remarkable effect on GDP and GDP per capita. Adeli et al. (2022) estimate the impact of economic sanctions on Iran's export. Using the SCM, they show that Iran lost an average of $74 billion in exports each year from 2012 to 2018. They analyze each year gap between synthetic Iran and real Iran and find that the largest gap in export was about $100 billion (constant 2015 $). Farzanegan and Zamani (2022) also use the SCM to estimate the effect of sanctions on the military spending of Iran from 2012 to 2015. They find that per capita military spending decreases about 54 percent around 2013-15. Moreover, they study the opportunity cost of revolution and war (1979-88) for Iran, and they find that each Iranian lost $34,660 (constant 2010 $) from 1978 to 1988, and that the opportunity cost of revolution and war is about 40 percent of income per capita. The cost of sanctions can be presented in negative economic growth, higher inflation, higher unemployment, and other economic indices. For example, Laudati and Pesaran (2023), using a novel measure of sanctions intensity based on daily newspaper coverage, find that sanctions on Iran since the revolution (1979) have had a significant effect on economic growth, exchange rate, and unemployment. Using the SVAR model, the estimation shows that economic growth could have been around four to five percent in the absence of sanctions. Moreover, they find that inflation and exchange rate (*rial* per dollar) have increased in response to sanctions. Using the Solow growth model, McDonald III and Reitano (2016) find a similar result for the negative effect of sanctions on Iranian economic growth. Katzman (2015) creates a comprehensive history of sanctions on Iran since the Islamic revolution in 1979 and shows that to evaluate the (in)efficiency of sanctions on Iran, we need to study different aspects, such as regional influence, domestic political structure, human rights, and economic effects. Here, we only refer to the economic effects related to our study. He finds that sanctions have a negative effect on GDP and employment, as we will show in this paper. Furthermore, he finds that oil exports dropped dramatically, the banking system was restricted, and—due to accessibility to hard currency—assets were held abroad, leading the rial's value to plummet to 265,000 to the dollar in 2020. He shows that inflation increased during the sanctions and it was about 45 percent as of early 2021. Dastgerdi et al. (2018) divide sanctions on Iran into heavy and light and find that heavy sanctions create

instability in the exchange market that leads to depreciation and higher inflation. Financial and monetary policies are also affected by sanctions. Comparing the Iranian banking system with the benchmark banking system, they find that Iran has slow motion banking crises, and only some part of financial and banking system are related to sanctions, which is reinforced by the findings of Laudati and Pesaran (2023). Moreover, due to the relative importance of oil revenues in the government budget, Iran faces "Dutch disease." In this structure, since the government needs oil revenues to cover the budget (Hemmati et al., 2007) and the sanctions decrease oil revenue, the government pushes the central bank to have an expansionary monetary policy, which leads to higher inflation.

3. Data and Sample

The outcome variable is the GDP (constant 2015 $). Following Abadie et al. (2015), covariate variables are a standard set of economic growth predictors. Physical capital, labor force, government expenditure, population, and consumption are some common factors that affect economic growth (Acemoglu, 2008). Moreover, as Iran and some members of the donor pool are natural resource-rich countries, we include this index as a covariate variable as well (Romer, 2021). Our covariate variables are GDP growth rate (%), total natural resource rent (% of GDP), labor force participation total (% of total ages 15+), general government expenditure (% of GDP), trade (% of GDP), final consumption expenditure (% of GDP), unemployment rate (%), gross fixed capital formation (% of GDP), and population. We also choose the GDP per capita for 2008, 2009, and 2010 as covariate variables to increase the alignment of synthetic Iran with reality.

To construct the synthetic Iran, we need to choose a donor pool (control countries). Iran is a natural resource-rich country, it is an OPEC member, it belongs to MENA region, it has 15 neighbors, and it is a Muslim country. From a historical perspective, at the beginning of the 1970s, its GDP per capita was similar to some countries ranked as developed countries (such as South Korea). Due to the lack of data, some countries such as Qatar are excluded from the donor pool. Moreover, some countries such as Iraq, Afghanistan, Tunisia, Libya, and Egypt that have experienced war, revolution, or internal violence are also excluded from the donor pool. Some of Iran's neighbors, such as Azerbaijan, Turkmenistan, and Armenia (new countries since 1990), are left out as well. Finally, with attention to the donor pool in previous studies, such as Gharehgozli (2017), Farzanegan (2022), Ghomi (2022), and Dizaji and Farzanegan (2021), our donor pool includes Algeria, Angola, Canada, Ecuador, Malta, Morocco, Nigeria, Oman, Pakistan, Saudi Arabia, South Korea, Turkiye, and the UAE.

3.1 Methodology: Synthetic Control Model

Following Abadie et al. (2010) and Abadie and Gardeazabal (2003), we suppose $j = 1,2,\dots,14$ where $j = 1$ refers to Iran, and $j = 2,3,\dots,14$ refers to the "donor pool" (including Algeria, Angola, Canada, Ecuador, Malta, Morocco, Nigeria, Oman, Pakistan, Saudi Arabia, South Korea, Turkiye, and the UAE). Moreover, we define $w = (w_2, w_3, \dots, w_{14})$ as a set of weights that refer to the countries in donor pool and we suppose $\sum_{j=2}^{14} w_j = 1$. We define the synthetic control estimator of the GDP for Iran as equation 1:

$$\widehat{G_{1t}^{\mathrm{NS}}} = w_2\ G_{2t}^{\mathrm{NS}} + w_3\ G_{3t}^{\mathrm{NS}} + \cdots + w_{14}\ G_{14t}^{\mathrm{NS}} \qquad t = 1990, \ldots, 2010 \qquad (1)$$

Where G_t^{NS} refers to GDP prior to sanctions in time t. In the SCM, we define other k covariate variables of Iran prior to the sanction as equation 2:

$$\widehat{Y_{1t}^{\mathrm{NS}}} = w_2\ Y_{2t}^{\mathrm{NS}} + w_3\ Y_{3t}^{\mathrm{NS}} + \cdots + w_{14}\ Y_{9t}^{\mathrm{NS}} \qquad t = 1990, \ldots, 2010 \qquad (2)$$

Where $Y_{\mathrm{jt}}^{\mathrm{NS}}$ is a vector of $(k \times 1)$ for country j at time t, as we have 12 covariate variables $k = 12$. In the SCM, we should solve the model and find $w^* = (w_2{}^*, w_3{}^*, \ldots, w_{14}{}^*)$ as the best weight of countries in the donor pool. For a more mathematical discussion, see [2] and [3]. Afterward, we can estimate the GDP for synthetic Iran as follows:

$$\widehat{G_{1t}} = w_2{}^*\ G_{2t} + w_3{}^*\ G_{3t} + \cdots + w_{14}{}^*\ G_{14t} \qquad t = 1990, \ldots, 2022 \qquad (3)$$

To estimate the cost of sanctions on Iran (GDP loss), we use equation 4:

$$G_{1t}^{o} = G_{1t} - \widehat{G_{1t}} \qquad t = 2011, \ldots, 2022 \qquad (4)$$

and aggregate the cost of sanction as $\sum_{t=2011}^{2022} G_{1t}^{o}$. To calculate the cost of sanction as GDP per capita loss, we use population data then calculate GDP per capita for synthetic Iran from equation 3 and cost of sanction from equation 4. We also want to calculate the cost of sanction on three major sections of economy (agriculture, industry, and services). Using data for their share in GDP from World Bank, we calculate the amount of their output, and then, using the following equations, we extract the cost of sanctions in three main sectors:

$$G_{1t}^{A} = W_{1t}^{A}\ G_{1t}^{o} = W_{1t}^{A}\ (G_{1t} - \widehat{G_{1t}}) \qquad t = 2011, \ldots, 2022 \qquad (5)$$

$$G_{1t}^{I} = W_{1t}^{I}\ G_{1t}^{o} = W_{1t}^{I}\ (G_{1t}) - \widehat{G_{1t}}) \qquad t = 2011, \ldots, 2022 \qquad (6)$$

$$G_{1t}^{S} = W_{1t}^{S}\ G_{1t}^{o} = W_{1t}^{S}\ (G_{1t} - \widehat{G_{1t}}) \qquad t = 2011, \ldots, 2022 \qquad (7)$$

where W_{1t}^{A}, W_{1t}^{I}, and W_{1t}^{S} are the share of agriculture, industry and services in GDP in time t. Then the real output of the agriculture, industry, and services sections are $W_{1t}^{A}G_{1t}$, $W_{1t}^{I}G_{1t}$, and $W_{1t}^{S}G_{1t}$ and the synthetic output of the agriculture, industry, and services sections are $W_{1t}^{A}\ \widehat{G_{1t}}$, $W_{1t}^{I}\ \widehat{G_{1t}}$, and $W_{1t}^{S}\ \widehat{G_{1t}}$, respectively.

3.2 Constructing a Synthetic Version of Iran

Using the SCM explained in the methodology subsection, we construct a synthetic Iran with the weights of countries presented in Table 1 so that the synthetic Iran is the best reproducer for predictors of Iran's GDP in the preintervention period (1990-2010). Synthetic Iran is a weighted average of Algeria, Angola, Nigeria, South Korea, Turkiye, and Saudi Arabia, and all the other

countries in the donor pool have zero weight. Algeria, Angola, Nigeria, and Saudi Arabia are OPEC members, Turkiye is the main country in MENA region, and South Korea is a country that had a GDP per capita similar to Iran's in some years of the 1960s. Table 2 represents the average values of the covariate variables for real Iran and synthetic Iran for the preintervention period (1990-2010). We can observe that most of covariate variables have an approximately similar value for both Iran and synthetic Iran, showing that synthetic Iran closely reflects the real Iran.

Table 1. Countries' Weight in the Construction of the Synthetic Iran

Country Name	Weight	Country Name	Weight
Algeria	0.371	Morocco	0
Angola	0.064	Nigeria	0.33
Canada	0	Oman	0
Ecuador	0	Pakistan	0
South Korea	0.133	Saudi Arabia	0.034
Malta	0	Turkiye	0.068
UAE	0		

Table 2. The Means of Predictors Before the Sanctions (1990-2010)

Index	Iran	Synthetic Iran
GDP Growth (%)	4.4	4.3
Total Natural Resources Rents (% of GDP)	25.3	18.4
Labor Force Participation Total (% of total population ages 15+)	45.4	55.9
Government Expenditure (% of GDP)	11.8	11.2
Trade (% of GDP)	42.9	56.2
Final Consumption Expenditure (% of GDP)	61.5	61.0
Unemployment (Annual %)	11.1	10.9
Gross Fixed Capital Formation (% of GDP)	30.5	29.2
Population	6.57E+ 07	6.50E+ 07
GDP per Capita (2008)	3.79E+11	3.76E+11
GDP per Capita (2009)	3.83E+11	3.85E+11
GDP per Capita (2010)	4.05E+11	4.11E+11

4. Cost of Sanctions

4.1 GDP Loss

Figure 1 shows the GDP trajectory of Iran and synthetic Iran for the period 1990-2022. The synthetic Iran reproduces the GDP preintervention period approximately similarly to real Iran's GDP. The close fit for GDP in the preintervention period in this figure and in Table 2 shows that there exists a very good combination of donor pool countries, thereby reflecting the economic characters of Iran before the preintervention in 2011. Therefore, the synthetic version of Iran can produce the GDP for the entire period (1990-2022), and it is comparable with real Iran as represented in Figure 1. The difference between real Iran and synthetic Iran, known as the effect in methodology, is presented in Figure 1. As we can see, there is a remarkable GDP gap between real and synthetic Iran since 2011.

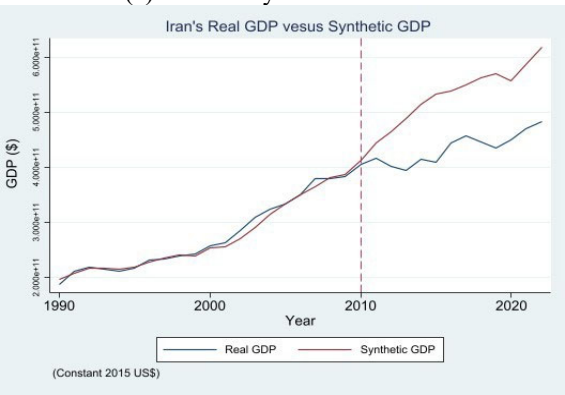
To calculate the cost of sanctions as GDP loss, we focus on the GDP gap presented in Table 3. For example, in 2022, the gap between real and synthetic GDP is -1.35E+11 dollar, which shows that the cost of sanctions in 2022 is $135 billion. To give simple and tractable numbers, we change the scale to US$ billion and present the cost of sanctions in Figure 2 and Table 4. The cost of sanctions in 12 years (2011-2022) is $1,210 billion and, on average, $101 billion for each year. The minimum GDP loss belongs to the first year of sanctions (2011) and the maximum GDP loss happened in 2019 (Table 4 and Figure 2)

4.2 GDP per Capita Loss

Using data from the World Bank for Iran's population, we calculate the effect of sanctions on GDP per capita. Figure 3 shows the results for both real and synthetic Iran and the gap between them, and this gap represents the GDP per capita loss. Table 5 shows the effect of sanctions on the GDP per capita. The aggregate GDP per capita loss in the mentioned period is $14,423 and, on average, the annual GDP per capita loss is $1,202.

Figure 1. Effect of Sanctions on GDP

(a) Real vs Synthetic Iran



(b) GDP Gap

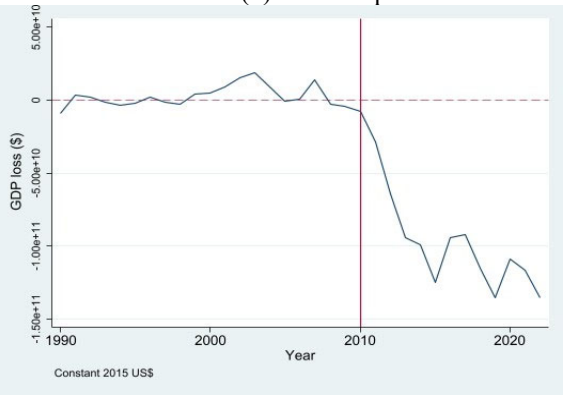


Table 3. Gap Between Real and Synthetic GDP

Year	Gap Between Real and Synthetic GDP	Year	Gap Between Real and Synthetic GDP
1990	-9.21E+09	2004	8.93E+09
1991	3.80E+09	2005	-5.46E+08
1992	2.34E+09	2006	7.24E+08
1993	-1.16E+09	2007	1.42E+10
1994	-3.26E+09	2008	-2.48E+09

Table 3. Gap Between Real and Synthetic GDP (contd.)

Year	Gap Between Real and Synthetic GDP	Year	Gap Between Real and Synthetic GDP
1995	-2.43E+09	2009	-4.25E+09
1996	2.37E+09	2010	-7.55E+09
1997	-1.55E+09	2011	-2.85E+10
1998	-3.03E+09	2012	-6.40E+10
1999	4.00E+09	2013	-9.44E+10
2000	4.81E+09	2014	-9.91E+10
2001	8.89E+09	2015	-1.25E+11
2002	1.54E+10	2016	-9.41E+10
2003	1.89E+10	2017	-9.22E+10
2004	8.93E+09	2018	-1.16E+11
2005	-5.46E+08	2019	-1.36E+11
2006	7.24E+08	2020	-1.09E+11
2007	1.42E+10	2021	-1.17E+11
2008	-2.48E+09	2022	-1.35E+11

Notes: Constant 2015 US$.

Table 4. Cost of Sanctions on Iran (2011-2022): GDP Loss

Year	GDP loss ($Billion)	Year	GDP loss ($Billion)
2011	29	2012	64
2013	94	2014	99
2015	125	2016	94
2017	92	2018	116
2019	136	2020	109
2021	117	2022	135
Total	1210	Average	101

Notes: Constant 2015 $.

Figure 2. Cost of Sanctions, its Trend, and Main Policies

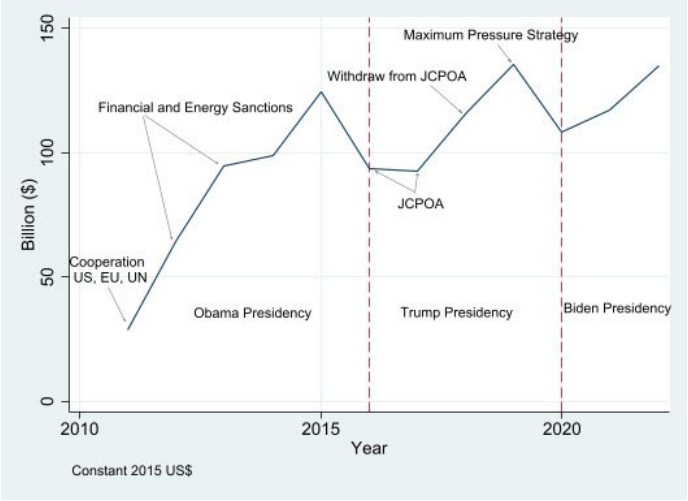
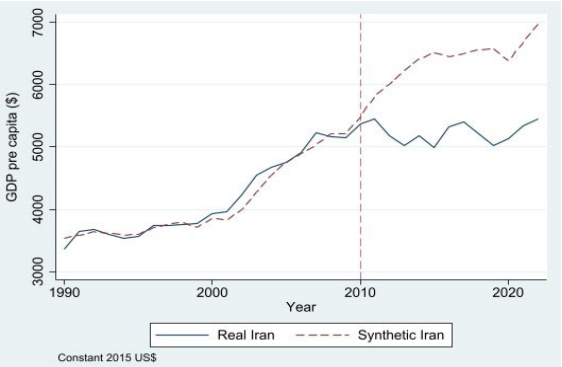


Figure 3. Effect of Sanctions on GDP per Capita

(a) Real vs Synthetic Iran



(b) GDP per Capita Gap

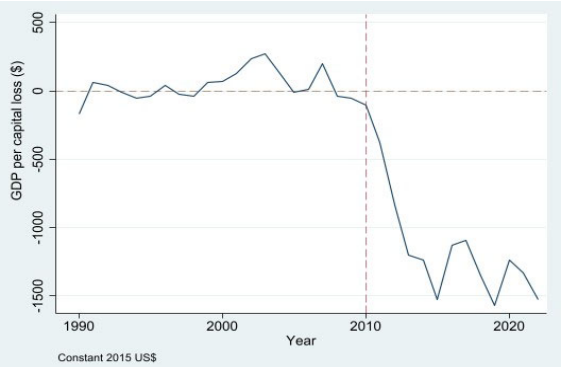


Table 5. Cost of Sanctions on Iran (2011-2022): GDP per Capita Loss

Year	GDP per Capita Loss ($)	Year	GDP per Capita Loss ($)
2011	373	2012	828
2013	1203	2014	1239
2015	1528	2016	1130
2017	1091	2018	1355
2019	1571	2020	1249
2021	1331	2022	1525
Total	14423	Average	1202

Notes: Constant 2015 US$.

4.3 Output Loss in Agriculture, Industry, and Services

We calculate the output loss in three main sectors of the economy to compare the relative effect of sanctions on the agriculture, industry, and services sectors. Their value added (% of GDP) are presented in Figure 4. As the figure shows, the value added of agriculture (% of GDP) decreased from 1990 to 2011, which is normal in the development process,[4] but after 2011, this share increased sharply and its value in 2022 is approximately equal to its value in 1990. This post-2011 trend shows that Iran has experienced backward economic development due to sanctions. Additionally, Figure 5 presents the output of agriculture, industry, and services for both Iran and synthetic Iran, as well as the gap between them. It shows that synthetic Iran reflects the economic characters of real Iran before 2011 in three sectors. However, the sum of value added (% of GDP) of the three sectors is different from 100 in each year, which shows a calculation error. In the Appendix, we discuss and show that the calculation error is generally about two percent, which does not affect our discussion about the cost of sanctions on the three sectors.

[4] In most cases, the value added of agriculture (% of GDP) decreases during the development process (Acemoglu, 2008).

Figure 4. Value Added (% of GDP) of Agriculture, Industry, and Services

(a) Agriculture (b) Industry and Services

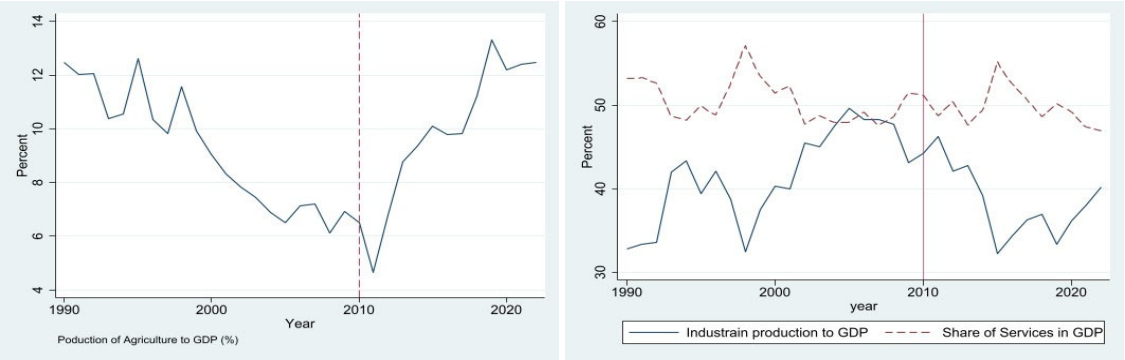
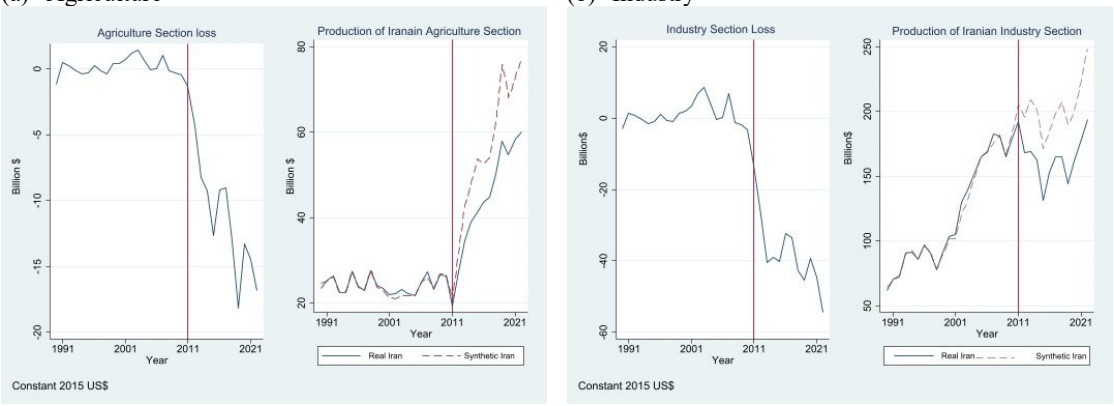
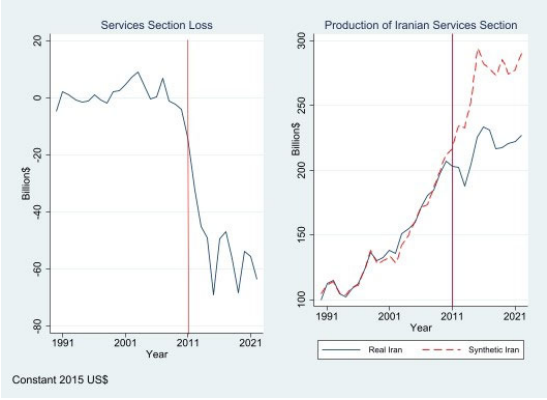


Figure 5. Real and Synthetic Output of Agriculture, Industry and Services; Output gap (loss)

(a) Agriculture (b) Industry



(c) Services



In aggregate, the cost of sanctions on agriculture, industry, and services are $130, 452, and 602 billion, respectively.[5] The annual average cost of sanctions on agriculture, industry, and services is approximately $11, 38, and 50 billion, respectively (Table 6). However, this mechanism to calculate the cost of sanction for three sectors has a two percent error (see the Appendix), but it is normal in national accounts.

[5] The sum of the three sections is $1,183 billion, which is two percent smaller than what we calculated as the total cost of sanction ($1,209 billion).

Table 6. Output loss of Agriculture, Industry, and Services

	Output Loss ($Billion)		
Year	**Agriculture**	**Industry**	**Services**
2011	1	13	14
2012	4	27	33
2013	8	40	45
2014	9	39	49
2015	13	40	69
2016	9	32	49
2017	9	34	47
2018	13	43	56
2019	18	45	68
2020	13	39	53
2021	15	45	55
2022	17	54	63
Total duration (2011-2022)	130	452	602
Annual Average	11	38	50

Note: Constant 2015 US$. This calculation has a two percent calculation error (see Appendix A).

4.4 Cost of Sanctions During the Obama, Trump, and Biden Administrations

During the period 2011-2022, Obama (2011-2016), Trump (2017-2020) and Biden (2021-2022) were presidents of the US. As we calculated in the previous subsections, the aggregate cost of sanctions on Iran is about $1210 billion, but how much of this cost belongs to each respective US presidency? We answer this question in this subsection.

4.4.1 Obama Presidency

GDP Loss

The cost of sanctions during the Obama presidency (2011-2016) was $505 billion. In 2011, as the first year of smart and comprehensive sanctions, the cost of sanctions was $28 billion. This amount increased rapidly, reaching about $95 billion in 2013. After that, it reached about $100 billion in the following year and jumped to its peak in 2015 during the Obama presidency, which was about $125 billion. In 2015, the cost of sanctions (% of GDP) reached 30.6 percent. After 2015, the cost of sanctions (% of GDP) reached this ratio only once in 2019 (during the Trump era) as the peak year of smart sanctions. However, in 2016, the last year of the Obama presidency, the cost of sanctions decreased and returned below $100 billion; nevertheless, this number is still above $90 billion. During the years of sanctions (2011-2022), the cost of sanctions was less than $90 billion in the first two years, and in the rest of the years, it was over $90 billion. From 2018, the cost of sanctions was over $100 billion every year. Looking at the trend of the cost of sanctions (Tables 4 and 5), it increased from 2011 to 2015 but decreased in 2016 because of the JCPOA. If Iran, the P5+1 (China, France, Germany, Russia, the UK, and the US), and the EU could not reach the agreement, the cost of sanctions in 2016 would be more than $125 billion. From 18 October 2015 (the day the JCPOA was adopted), participants began taking the steps necessary to implement their commitments and, finally, it was approved on 16 January 2016 when the Secretary State of the US confirmed the International Atomic Energy Agency's (IAEA) verification about Iran's key nuclear-related measures described in the JCPOA. Although the JCPOA could decrease the cost of sanctions and stop its increasing trend, it could not relieve all the sanctions (Laudati and Pesaran,

2023), and the uncertainty of the sanctions continued even in 2016. Generally, the average annual cost of sanctions during the Obama administration was $84 billion.

GDP per Capita Loss

During the Obama presidency, the aggregate per capita GDP loss was about $6,300. The annual average per capita GDP loss was also $1,050. In the absence of sanctions, every Iranian person could have had an average per capita income of $1,050 more than what they earned in the six years from 2011 to 2016.

4.4.2 Trump Presidency

GDP Loss

During the Trump presidency, the aggregate cost of sanctions was about $453 billion. In 2017, the first year of the Trump presidency, the cost of sanctions was $92 billion, which reached $116 billion in the second year of his presidency and $136 billion in the third year. The cost of sanctions grew by approximately 48 percent in just two years, and this extraordinary growth was a comprehensive economic shock and had a complete impact on the economic welfare of all Iranians, although it had a different distributional effect (Ghomi, 2022). In fact, after the US announced its withdrawal from the JCPOA on 8 May 2018 and reimposed the sanctions lifted under the deal, the cost of sanctions increased sharply and reached its peak in 2019. The cost of sanctions could not reach this peak afterward throughout 2019-2022. In 2019, it was 31.3 percent of GDP and was the highest level of Iranian economic capacity loss in the period 2011-2022. However, during the fourth year of the Trump presidency, the cost of sanctions decreased again and even reached less than the second year of his era. In total, during the Trump presidency, the average annual cost of sanctions was about $113 billion.

GDP per Capita Loss

During the Trump presidency, the aggregate per capita GDP loss was about $5,266. The annual average of per capita GDP loss was also $1,316. In the absence of sanctions, every Iranian person could have had an average per capita income of $1,316 more than what they earned in the four years from 2017 to 2020. The annual average of per capita GDP loss during Trump's presidency is about 1.25 times more than the Obama administration. This means that Trump's policies offered an additional 25 percent cost of sanctions for Iran in comparison with Obama's policies.

4.4.3 Biden Presidency

GDP Loss

During the first two years of the Biden presidency (2021-2022), the aggregate cost of sanctions was $252 billion ($117 billion in 2021 and $135 billion in 2022). In fact, the cost of sanctions in 2022 was only $1 billion less than the highest annual cost of sanctions, which was in 2019. Considering the rising trend of cost of sanctions from 2019, it was expected to reach the highest amount in all the years of sanctions in 2023 and the coming years. The annual average cost of sanctions during the first two years of the Biden presidency was $126 billion, which is the highest average cost among the three American presidents.

The annual cost of sanctions in the Trump era was about 35 percent more than in the Obama presidency, and the annual cost of sanctions in the Biden presidency was about 50 percent more than its value in the Obama presidency and 11 percent more than the Trump era. This shows that the cost of sanctions has been increasing over time.

GDP per Capita Loss

The aggregate GDP per capita loss during the Biden period was about $2,855. Every Iranian person has incurred about $1,428 as an annual cost of sanctions and lost an equivalent per capita income. If there were no sanctions during the first and second years of the Biden presidency, the per capita income of every Iranian person could have been $1,428 dollars higher.

The annual average GDP per capita loss during the Biden presidency was about 36 percent more than the Obama duration and about eight percent more than the Trump presidency. In addition, the annual average GDP per capita loss during the Biden duration was about 18 percent higher than its value in the entire period (2011-2022), while it was nine percent during the Trump presidency. This finding shows that the feeling of decreasing purchasing power has increased in recent years among Iranian people. The comparison of the cost of sanctions among the Obama, Trump, and Biden presidencies is shown in Table 7.

Table 7. Comparison of the Cost of Sanctions Among the Obama, Trump, and Biden Presidencies, both in GDP and GDP per Capita Loss

Time	GDP Loss ($billion)		GDP per Capita Loss ($)	
	Aggregate	Annual Average	Aggregate	Annual Average
Obama Presidency (2011-16)	505	84	6,301	1,050
Trump Presidency (2017-20)	453	113	5,266	1,316
Biden Presidency (2021-22)	252	126	2,855	1,428
Total duration (2011-2022)	1,210	101	14,422	1,202

Notes: Constant 2015 US$, differences come from rounding numbers.

4.4.4 Output Loss of Agriculture, Industry, and Services During Obama, Trump, and Biden Presidencies

Table 8 represents the cost of sanctions on agriculture, industry, and services in both aggregate and annual average during the Obama, Trump, and Biden presidencies. As the table shows, the annual average cost of sanctions has an increasing trend, with its highest level during the Biden duration in all three sectors. Moreover, the annual average cost of sanctions in the three sectors during both Trump and Biden's presidencies is higher than the annual average of the total duration, while its value for the Obama presidency is smaller than the annual average of the total duration.

During Obama's administration, the cost of sanctions in the industry sector was four times

higher than in the agriculture sector. During Trump's era, the cost of sanctions in industry and services were three and four times more than the agriculture sector, respectively. However, during the Biden administration, the cost of sanctions in agriculture was about 1⁄3 of its value in industry. The annual average cost of sanctions during Biden's duration is the highest amount among all sectors and times.

4.4.5 Output Capacity Loss During Obama, Trump, and Biden Presidencies

As Table 9 presents, the minimum and maximum capacity loss belongs to the Obama and Biden presidencies. This finding shows that sanctions have affected the Iranian economy more deeply during that time. Among all three sectors in the duration of the three presidents, the minimum and maximum capacity loss belongs to the industry sector during both Biden and Obama's presidencies, respectively.

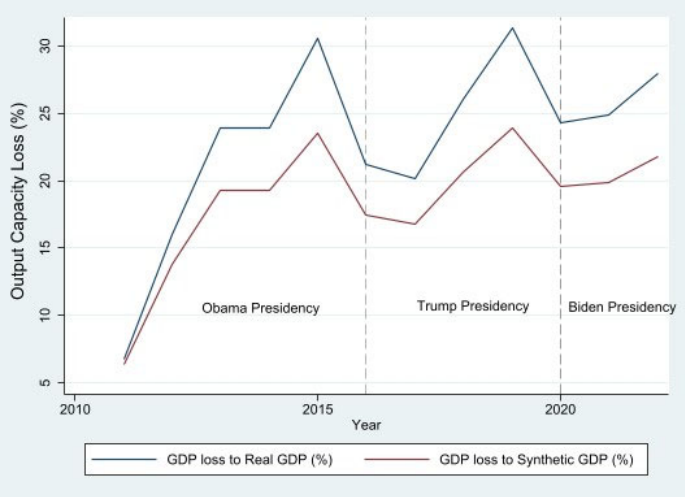
Table 8. Cost of Sanction on the Three Main Sectors of the Economy During the Obama, Trump, and Biden Presidencies

	Output Loss of Agriculture ($Billion)		**Output Loss of Industry ($Billion)**		**Output Loss of Services ($Billion)**	
Time	Aggregate	Annual Average	Aggregate	Annual Average	Aggregate	Annual Average
Obama Presidency (2011-16)	45	8	192	32	259	43
Trump Presidency (2017-20)	53	13	161	40	224	56
Biden Presidency (2021-22)	31	16	99	49	119	59
Total duration (2011-2022)	130	11	452	38	602	50

Note: Constant 2015 $, differences come back to rounding numbers.

Figure 6 presents the output capacity loss (%) as a ratio of the cost of sanctions to real GDP. We also show the ratio of the cost of sanctions to synthetic GDP. During the period 2011-2022, the maximum output capacity loss happened in 2019 during Trump's presidency, representing the maximum pressure of sanctions on the Iranian economy. On the other hand, from 2011 to 2015, the output capacity loss showed an increasing trend and reached 30 percent in 2015. However, because of the JCPOA, this trend was reversed in 2016 and 2017. It increased again in 2018 and 2019 but returned in 2020. This occurred because it was the last year of Trump's presidency and it was predicted that if Biden was elected as the next president of the US, he would return to the JCPOA; however, it has not happened and, therefore, the output capacity loss during Biden's presidency also has an increasing trend.

Figure 6. Capacity Loss (Cost of Sanctions (GDP Loss)) to Real and Synthetic GDP



4.5 Causality and Inference about the Effect of Sanctions

4.5.1 Standard P-Value

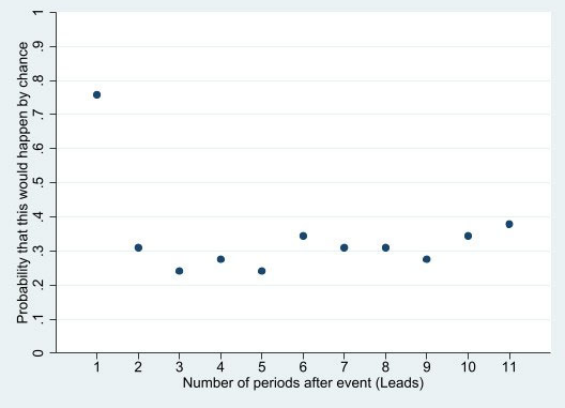
For a causal interpretation of the results, and to show that results are not created by chance, we follow Abadie et al. (2015) and Abadie et al. (2010). In the SCM, the p-value is not valid, but the pvalstd (p-values after standardization) can be a criterion to check the validity of results. Figure 7 (b) shows p-values after standardization, which are pseudo t-statistics (unit's effect divided by its pre-treatment RMSPE) that are at least as large as the main pseudo t-statistic for each post-treatment period. As Figure 7 (b) shows, the probability that the results would have happened by chance is near zero percent. This test is kind of a placebo test.

Table 9. Average Capacity Loss During the Obama, Trump, and Biden Presidencies in Agriculture, Industry, and Services

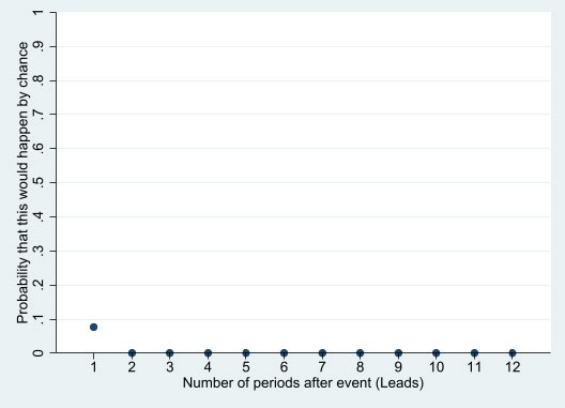
	GDP Loss to Real GDP (Average Capacity Loss)		
Time	**Agriculture (%)**	**Industry (%)**	**Services (%)**
Obama Presidency (2011-2016)	22	20	21
Trump Presidency (2017-2020)	26	25	25
Biden Presidency (2021-2022)	26	27	26
Total Duration (2011-2022)	24	23	23

Figure 7. Pval Graphs: P-Values in the Left Figure and P-Values (Pseudo T-Stats) in the Right Figure

(a) p-values



(b) p-values (pseudo t-stats)



4.5.2 Time Placebos

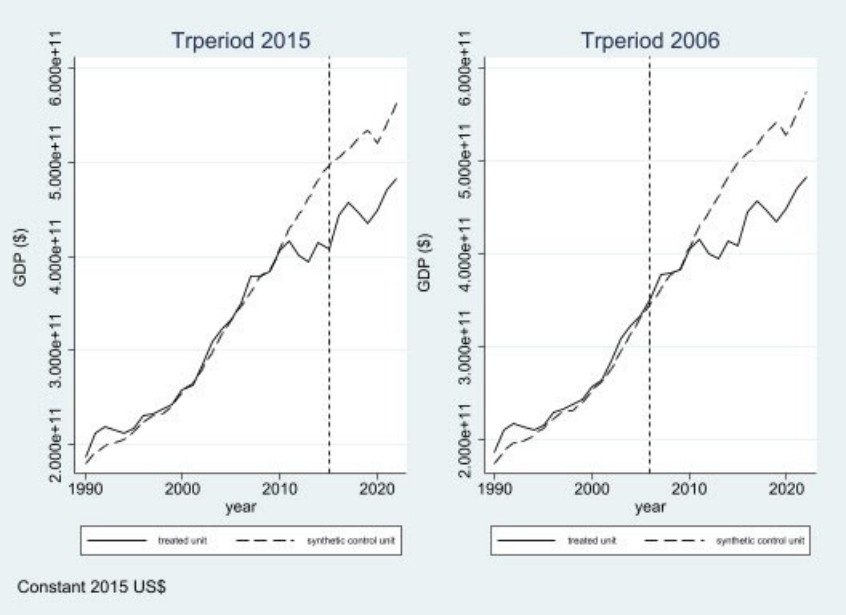
Another approach to verify that the results were not created by chance is to change the time of starting the treatment (here, the sanction), which is known as the "in-time placebo" test. We change the time of smart sanctions to 2006 and 2015 instead of 2011, and as Figure 8 shows, changing the time cannot affect the results; the gap between Iran and synthetic Iran started from 2011, which shows that the time of treatment is correct.

4.5.3 Country Placebos

We can change the country under the treatment, but can we check whether control countries are affected by the treatment (here, the sanction)? Figure 9 shows that other countries have not experienced this kind of treatment since 2011, while there is not a remarkable gap between the real and synthetic trend in control countries (Algeria, Angola, Canada, Ecuador, Malta, Morocco, Oman, Nigeria, South Korea, Pakistan, Turkiye, Saudi Arabia, and the UAE).

It is also possible to check the placebo gap. Figure 10 (a) presents the gap between real and synthetic for all countries (Iran is shown with a black line and others with a gray line), while Figure 10 (b) presents the placebo gap when we drop out countries with per-sanction 2011 MSPE two times higher than Iran's. This shows that only Iran has experienced this shock (sanction) since 2011, and the gap between real and synthetic GDP for other counties (Algeria, Angola, Ecuador, Morocco, Oman, Pakistan, and the UAE) is little.

Figure 8. In-Time Placebo Test



Note: We change the first year of sanction from 2011 to 2006 (left) and 2015 (right). The figure shows that the gap between Iran and Synthetic Iran starts from 2011.

4.5.4 Post-Period/Pre-Period RMSPE

If we accept that only Iran has experienced sanctions since 2011, and that the gap between real and synthetic Iran has increased sharply since 2011, then the post-period/pre-period RMSPE of Iran is expected to be higher than the other countries. As Table 10 shows, the post-2011/pre-2011 RMSPE of Iran is 14.6 and this ratio for other countries is smaller than seven, which shows that Iran was the only country that experienced this shock.

Table 10. Post-2011 Sanctions RMSPE to Pre-2011 Sanctions RMSPE: Iran and Donor Pool

Country Name	Post-Period RMAPE/Pre-Period RMAPE	Country Name	Post-Period RMAPE/Pre-Period RMAPE
Canada	0.3	South Korea	2.2
UAE	1.2	Morocco	3.1
Oman	1.5	Ecuador	3.5
Saudi Arabia	1.6	Nigeria	4.3
Pakistan	1.7	Algeria	5.8
Angola	2.0	Turkiye	6.9
Malta	2.1	Iran	14.6

Figure 9. In-Space Placebo Test: Treatment for Other Countries in 2011

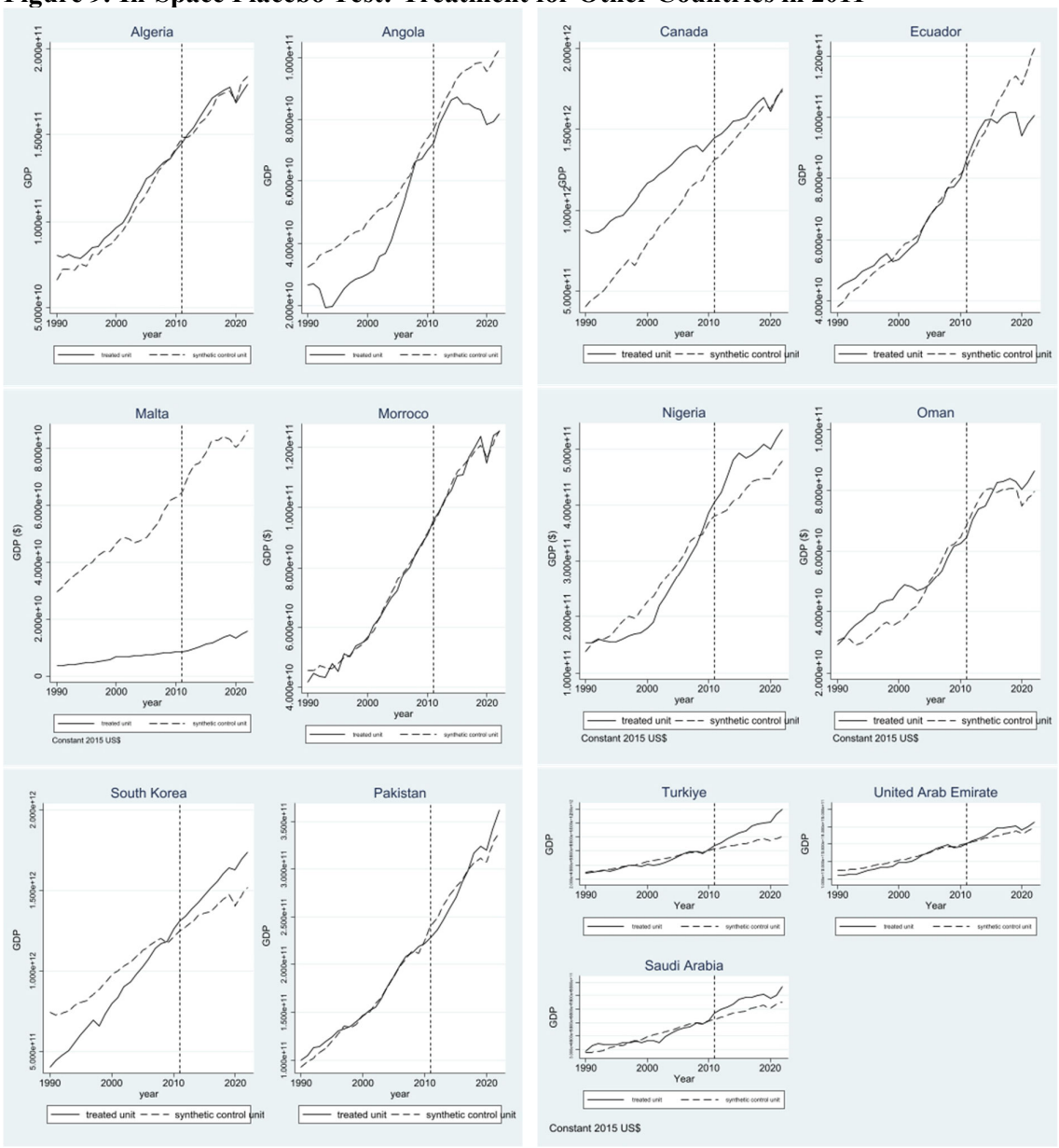
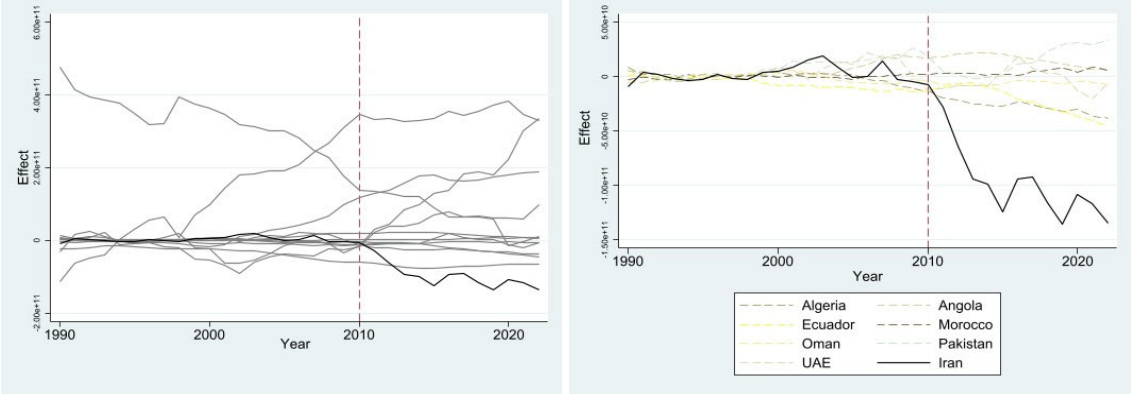


Figure 10. In-Space Placebo Test: Placebo-Gap

(a) Placebo Gap for All Countries, Black Line Represents Iran

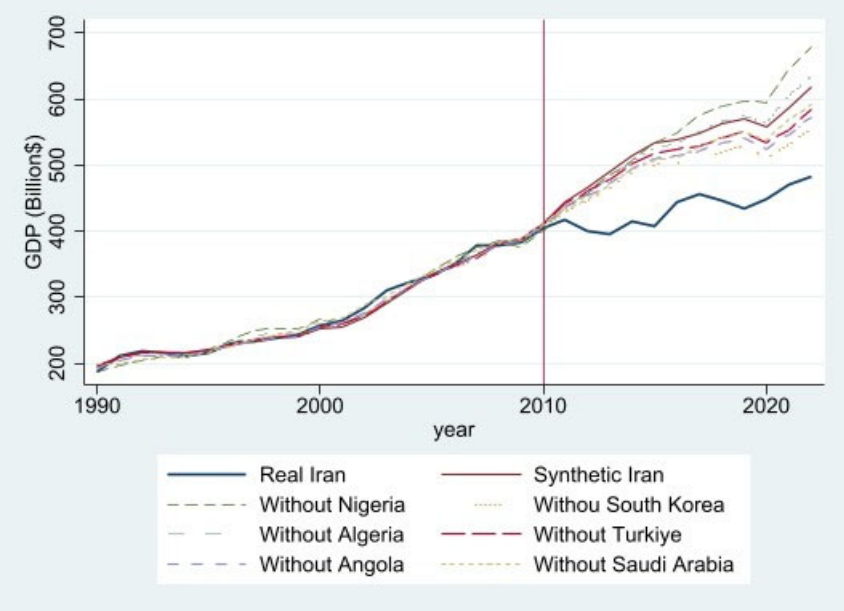
(b) Placebo Gap Leaving Out Control Countries with Pre-Sanction 2011 MSPE Two Times Higher Than Iran's



4.5.5 Robustness Test

Finally, we check the sensitivity of the results to individual countries in the donor pool. We leave all countries, created synthetic Iran, one by one, which is known as the leave-one-out strategy. Figure 11 shows that the results are not independent to one country and a drop of one country cannot affect the results sharply, which shows that the results are not sensitive to an individual country of the donor pool.

Figure 11. Leave-One-Out Distribution of the Synthetic Control for Iran



Note: Figure shows real Iran, synthetic Iran, and other counterfactuals by excluding main countries from the donor pool one by one.

4.6 How Much of Iran's Economic Divergence Since 2011 Can be Explained by Sanctions

Using the SVAR model, Laudati and Pesaran (2023) explain that both sanctions and internal management affected Iran's worsened economic performance, especially in the 2010s. We focus here on the economic performance of three main countries in the Middle East (Turkiye,

Saudi Arabia, and the UAE) and compare their performance with Iran and synthetic Iran in terms of both GDP and GDP per capita in the period 2010-22. Synthetic Iran has the potential to explain the role (and share) of sanctions on Iranian GDP and GDP per capita divergence. We show that sanctions have been the main driver of Iranian economic divergence since 2011. Therefore, without lifting the sanctions, improving the quality of government and economic management in Iran cannot stop the increase in economic divergence with these three countries.

4.6.1 Comparison between Saudi Arabia and Iran Since 2011

i. Difference in GDP Growth Rate and the Effect of Sanctions

In the 12-year period between 2011-2022, the GDP of Saudi Arabia and Iran increased by $258 and $77, respectively. As Table 10 shows, the GDP of Saudi Arabia and Iran has grown by 50.7 percent and 19.1 percent in 12 years, which reveals that the average GDP growth rate (annual) for Saudi Arabia and Iran is 3.47 percent and 1.47 percent, respectively. Therefore, there is a big divergence in GDP between Iran and Saudi Arabia (Table 11). However, it is important to find how much percentage of this GDP gap is due to the sanctions. To answer this question, synthetic Iran should also be included in the analysis.

Synthetic Iran shows the performance of Iran in normal conditions and without sanction. Table 11 shows that the annual growth rate of GDP in the period of 2010-2022 for Saudi Arabia and synthetic Iran is 3.47 percent and 3.42 percent, respectively. This indicates that if Iran had not experienced sanctions, then the GDP growth rate gap between Saudi Arabia and Iran would only be 0.05 percent, but in reality, and due to sanctions, it is 2.1 percent (difference is due to rounding the numbers). This finding shows that 97 percent (out of 100 percent) of the difference originates from sanctions (Table 13).

Table 11. GDP for Iran, Synthetic Iran, Turkiye, Saudi Arabia, and UAE, 2010-2022

	GDP ($Billion)				
	Iran	Synthetic Iran	Saudi Arabia	Turkiye	UAE
2010	405	413	509	614	283
2011	416	445	560	683	302
2012	401	465	590	716	317
2013	394	489	606	776	333
2014	414	513	628	815	347
2015	408	533	654	864	370
2016	444	538	665	893	391
2017	456	549	660	960	394
2018	446	562	677	989	399
2019	434	570	679	996	403
2020	449	557	651	1016	383
2021	470	587	672	1131	398
2022	483	618	767	1194	428

Table 11. GDP for Iran, Synthetic Iran, Turkiye, Saudi Arabia, and UAE, 2010-2022 (contd.)

	Iran	Synthetic Iran	Saudi Arabia	Turkiye	UAE
Difference Between 2022 and 2010 ($Billion)	77	205	258	580	145
Growth Rate (%) 2022 Compared to 2010	19.1	49.6	50.7	94.4	51.3
Average Growth Rate (Annual %) in the Period 2010-22	1.47	3.42	3.47	5.70	3.51

Table 12. GDP per Capita for Iran, Synthetic Iran, Turkiye, Saudi Arabia, and UAE, 2010-2022

	GDP per Capita ($)				
Year	Iran	Synthetic Iran	Turkiye	Saudi Arabia	UAE
2010	5379	5479	8391	17366	33344
2011	5451	5829	9208	18803	35266
2012	5180	6014	9507	19392	36568
2013	5027	6233	10139	19526	38035
2014	5179	6416	10430	19906	39242
2015	4991	6517	10852	20442	41525
2016	5332	6458	11022	20508	43458
2017	5401	6497	11695	20028	43420
2018	5211	6564	11939	20097	43644
2019	5017	6585	11935	19806	43785
2020	5141	6381	12072	18857	41276
2021	5345	6676	13342	19622	42536
2022	5453	6979	13991	21069	45321
Difference Between 2022 and 2010 ($)	74	1500	5600	3703	11977
Growth Rate (%) (2022 Compared to 2010) Average	1.38	27.38	66.74	21.32	35.92
Growth Rate (Annual %) in the Period 2010-22	0.11	2.04	4.35	1.62	2.59

Table 13. Share of Sanctions in Difference of GDP Average Growth Rate Between Saudi Arabia and Iran

	Total Difference (%)	Difference Because of Sanctions (%)	Difference Due to Other Factors
Difference in GDP Average Growth Rate Between Saudi Arabia and Iran	2.01	1.95	0.06
Share of Factors (Sanction or Other Factors)	Total (%)	Share of Sanctions (%)	Share of Other Factors (%)
	100	97	3

ii. Difference in GDP per Capita Growth Rate and the Effect of Sanctions

The GDP per capita of Saudi Arabia reached more than $21,000 in 2022, which is 21 percent more than in 2010, and it has an average annual growth rate of 1.62 percent. Nevertheless, Iran just increased its GDP per capita by $74, which is only one percent more than it was in 2010, recording an average annual growth rate of only 0.11 percent (Table 12). This shows a big GDP per capita gap between Saudi Arabia and Iran. On the other hand, synthetic Iran has a better performance than Saudi Arabia, as well as a 2.04 percent average annual growth rate. This shows that If Iran was under normal conditions without sanctions, its performance could be better than Saudi Arabia, and then Iran could even decrease its GDP per capita gap with

Saudi Arabia. As Table 14 shows, all the differences in the average growth range of GDP per capita between Iran and Saudi Arabia originate from sanctions.

Table 14. Share of Sanctions in Difference of GDP per Capita Average Growth Rate Between Saudi Arabia and Iran

Difference in GDP per Capita Average Growth Rate Between Saudi Arabia and Iran	**Total Difference (%)**	**Difference Because of Sanctions (%)**	**Difference Due to Other Factors (%)**
	1.51	1.92	-0.41
Share of Factors (Sanctions or Other Factors)	Total (%)	Share of Sanctions (%)	Share of Other Factors (%)
	100	100	0

4.6.2 Comparison Between UAE and Iran Since 2011

i. Difference in GDP Growth Rate and the Effect of Sanctions

The UAE's GDP increased by $145 billion in the period 2010-22, while Iran only increased its GDP by $77 billion. To check the effect of sanctions on this GDP gap, we analyze the average annual growth rate of GDP for Iran, synthetic Iran, and the UAE. The difference in this growth rate between the UAE and Iran is 2.04 percent, and 1.95 percent of this difference (out of 2.04 percent) comes back to sanctions (difference between synthetic Iran and Iran) and only 0.09 percent of the gap originates from other factors (Table 11). Therefore, 95 percent of GDP growth (annual and average) gap between the UAE and Iran originates from sanctions. However, the UAE had a better performance than Iran even if Iran was not under sanctions, but its share is only five percent. Moreover, if we suggest that the quality of economic management in Iran may have worsened since 2011, its maximum effect is only five percent (Table 15).

Table 15. Share of Sanctions in Difference of GDP Average Growth Rate Between the UAE and Iran

	Total Difference (%)	**Difference Because of Sanctions (%)**	**Difference Due to Other Factors (%)**
Difference in GDP Average Growth Rate Between UAE and Iran	2.04	1.95	0.09
Share of Factors (Sanctions or Other Factors)	Total (%)	Share of Sanctions (%)	Share of Other Factors (%)
	100	95	5

ii. Difference in GDP per Capita Growth Rate and the Effect of Sanctions

The annual growth rate of the UAE's GDP per capita during the period 2010-22 was 2.59 percent, while Iran only had an 0.11 percent annual growth rate of GDP during this same period. Moreover, the UAE's GDP per capita in 2022 was about 36 percent more in 2010, while it was only one percent for Iran. This data shows that a big gap in GDP per capita between the UAE and Iran has been created since 2011 (Table 11). However, what percentage of this GDP per capita gap originates from sanctions? Comparing the average annual growth rate of Iran, synthetic Iran, and the UAE answers this question, which are 0.11 percent, 2.04 percent, and 2.59 percent. The difference in GDP per capita growth rate between Iran and the UAE is 2.48 percent (= 2.59 percent - 0.11 percent), which is a total gap. The difference in GDP per capita

growth rate between Iran and synthetic Iran is 1.92 percent, which represents the effect of sanctions. Therefore, sanctions are the main driver of the gap in GDP per capita growth between Iran and the UAE and can explain 78 percent (out of 100 percent) of this gap (Table 16).

Table 16. Share of Sanctions in Difference of GDP per Capita Average Growth Rate Between UAE and Iran

Difference in GDP per Capita Average Growth Rate Between UAE and Iran	**Total Difference (%)**	**Difference Because of Sanctions (%)**	**Difference Due to Other Factors (%)**
	2.48	1.92	0.55
Share of Factors (Sanctions or Other Factors)	Total (%)	Share of Sanctions (%)	Share of Other Factors (%)
	100	78	22

4.6.3 Comparison Between Turkiye and Iran Since 2011

i. Difference in GDP Growth Rate and the Effect of Sanctions

Turkiye has made remarkable achievements in terms of its GDP growth rate; it increased its GDP from $614 billion in 2010 to $1,194 billion in 2022, achieving a 94 percent GDP growth in 12 years. Moreover, the annual GDP growth rate in Turkiye averaged 5.7 percent from 2010 until 2022 (Table 11). On the other hand, Iran's average annual growth rate is only 1.47 percent. However, this outstanding gap in growth rate between Iran and Turkiye has two drivers: sanctions and the better performance of Turkiye. As Table 17 shows, the difference in average growth rate between the two countries is 4.23 percent, and only 1.95 percent of this difference belongs to the direct effect of sanctions. Therefore, we can argue that 46 percent of difference between Turkiye and Iran in GDP growth rate originates from sanctions, while 54 percent of this gap comes back to other factors (better performance of Turkiye, worse performance of Iran, or their combination). However, as we saw in the two previous subsections, the worsened performance of Iran has little share in explaining the difference between Iran and Saudi Arabia and the UAE. Therefore, in the case of Turkiye, we suppose that 54 percent of this gap comes back to Turkiye's better performance.

ii. Difference in GDP per Capita Growth Rate and the Effect of Sanctions

Turkiye's GDP per capita increased from $8,391 in 2010 to $13,991, which shows an average growth rate of 4.35 percent. However, during this period, Iran and synthetic Iran have 0.11 and 2.04 percent of the aforementioned growth rate (Table 12).

Table 17. Share of Sanctions in Difference of GDP Average Growth Rate Between Turkiye and Iran

Difference in GDP Average Growth Rate between Turkiye and Iran	**Total Difference (%)**	**Difference Because of Sanctions (%)**	**Difference Due to Other Factors (%)**
	4.23	1.95	2.28
Share of Factors (Sanctions or Other Factors)	Total (%)	Share of Sanctions (%)	Share of Other Factors (%)
	100	46	54

The comparison between 4.35 and 0.11 is a big difference in growth rate between Iran and Turkiye, but about 45 percent (out of 100 percent) of this gap originates from sanctions (see

Table 18). This finding shows that Turkiye has accomplished as extraordinary achievement in average growth rate of GDP per capita during the period 2010-2022.

Table 18. Share of Sanctions in Difference in GDP per Capita Average Growth Rate Between Turkiye and Iran

Difference in GDP Per Capita Average Growth Rate between Turkiye and Iran	**Total Difference (%)**	**Difference Because of Sanctions (%)**	**Difference Due to Other Factors (%)**
	4.24	1.92	2.32
Share of Factors (Sanctions or Other Factors)	Total (%)	Share of Sanctions (%)	Share of Other Factors (%)
	100	45	55

4.7 Cost of Sanctions in Alternative Scenarios

In the previous subsection, we used the SCM to calculate the cost of sanctions and discuss them. Here, we calculate the cost of sanctions in three scenarios and show that the results of two of them are very close to that of the synthetic method.

4.7.1 First Scenario: Iran Continues its Previous Economic Performance (1989-2010)

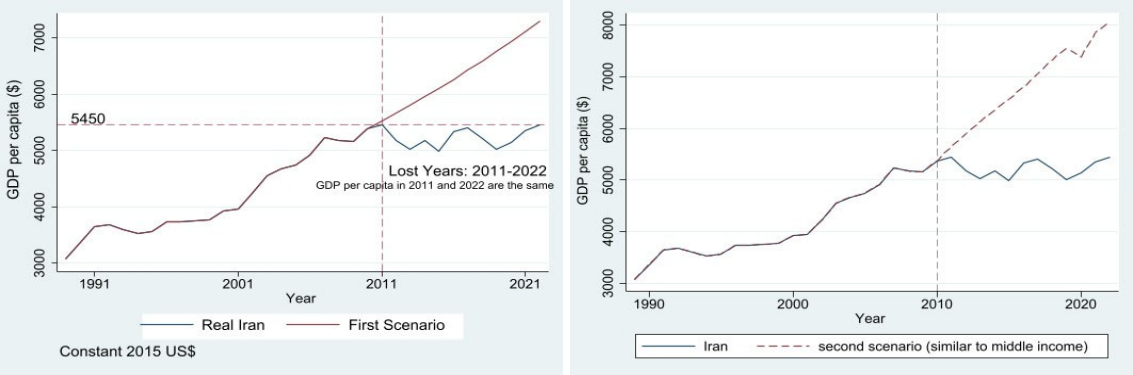
After the end of the Iran-Iraq war (1988), Iran improved its economic performance up to 2010. Although Iran experienced some economic and political shocks in this duration, it still had a positive economic performance on average, where the GDP and GDP per capita grew 4.17 and 2.57 percent, respectively.

To calculate the cost of sanctions in this scenario, we suppose that Iran did not experience sanctions during the period 2011-2022 and that it continued its previous economic performance. We calculate the average annual growth rate of both GDP and GDP per capita in the period 1989-2010 and suppose that each year in the period 2011-2022 could have this growth rate. Figure 12 (a) presents the GDP per capita in the first scenario and shows that the GDP per capita in 2022 could be more than $7,000.

We find that the aggregate cost of sanctions in the first scenario is $1,190 billion, and that the annual average cost of sanctions is $99 billion. In comparison to our SCM results (the aggregate cost of sanctions is $1,210 billion and its annual average is $101 billion), we see that the annual average cost of sanctions in this scenario is only $2 billion lower than the SCM. Moreover, we find that the aggregate GDP per capita loss is $13,668 and the average annual GDP per capita loss in $1,139. The average annual cost of sanctions to GDP is 22 percent, which shows in the first scenario that the average output capacity loss is 22 percent.

Figure 12. GDP per Capita in the First and Second Scenarios

(a) GDP per Capita in the First Scenario (b) GDP per Capita in the Second Scenario



Note: Constant 2015 $. First Scenario: If Iran could continue its average GDP per capita growth rate throughout 1989-2010. Second Scenario: If the growth rate of Iran's GDP per capita in 2011-2022 was equal to that of middle-income countries.

4.7.2 Second Scenario: Iran's Economic Performance is Similar to Middle-Income Countries

Iran is a middle-income country, so in the second scenario we suppose that Iran could have an economic performance similar to that of middle-income countries in each year of the period 2011-2022 instead of facing sanctions. Applying both the GDP and GDP per capita growth rate (annual %) of middle-income countries on the Iranian economy for each year since 2011 and calculating the gap between Iran and this scenario, we find that the aggregate cost of sanctions in this scenario is $1,535 billion, and that the annual average cost of sanctions is $128 billion, while the annual average GDP per capita loss is $1,662. As Figure 12 (b) shows, it was expected that GDP per capita in 2022 be more than $8,000 in the second scenario.

4.7.3 Third Scenario: Iran's Economic Performance is Similar to the Countries Targeted in the Iranian Vision Document

In 2005, Iran issued a document called Iran's Twenty-Year Economic Vision (Madarshahi, 2012). It defined a 20-year roadmap (expected to be implemented with four midterm plans, from fourth to seventh five-year plans). Its target was to reach first place in the Western South Asia region (which includes Central Asia, Caucasus regions, the Middle East, and neighboring countries) in economy, science, and technology.[6] In the third scenario, we create a group of countries that belong to the Western South Asia region. Among 28 countries in this region, we exclude those that experienced war, sanctions, or internal remarkable political instability, while some countries were excluded due to the lack of data. Finally, we include Turkiye, Saudi Arabia, the UAE, Armenia, Azerbaijan, Georgia, Jordan, Kazakhstan, Kyrgyzstan, Oman, Pakistan, Qatar, Tajikistan, and Uzbekistan. We calculate the aggregate GDP and GDP per capita for this group of countries then calculate the annual average growth rate of both GDP and GDP per capita for the period 2011-2022. We suppose that Iran could have a similar growth rate for both GDP and GDP per capita. In this scenario, the aggregate and annual

[6] However, this target will not be achieved as Iran faced sanctions and some internal political groups did not accept this vision. By 2023, Iran had not even approved its seventh five-year plan. Based on the vision, Iran should have approved it in 2020.

average cost of sanctions are $1,228 and $102 billion, respectively.

Table 19 shows the aggregate cost of sanctions and its annual average in the three scenarios and the SCM together. This table shows that the SCM results are very close to the first and third scenarios, which shows that the synthetic donor pool has an economic structure similar to Iran's during the period 1989-2010, or the group of countries targeted in Iran's Vision. However, the second scenario has created higher sanction costs.

Table 19. Cost of Sanction: Synthetic Method and Three Scenarios

	Aggregate Cost of Sanction ($Billion)	Annual Average Cost of Sanction ($Billion)
First Scenario	1190	99
Second Scenario	1535	128
Third Scenario	1228	102
Synthetic Method	1210	101

Notes: First Scenario: Iran in the period 2011-2022 could have an economic performance equivalent to the average of the period 1990-2010. Second Scenario: Iran could have an economic performance similar to that of middle-income countries. Third Scenario: Iran could have an economic performance similar to that of the countries targeted in Iran's Vision Document.

4.8 The Eight-Year Iran-Iraq War and the 12-Year Sanctions: Which Cost More?

Since 1970, Iran has experienced two remarkable shocks. From 1977, Iran was faced with political instability, which led to the revolution (1979), followed by an eight-year war with Iraq (1981-1988), totaling 12 years. The economic sanction throughout 2011-2022 also lasted 12 years. However, political instability, revolution, and war (1977-88), especially the war with Iraq, ruined infrastructures and had an extraordinary economic cost for Iran.

As we have shown that sanctions have had an enormous cost for the Iranian economy, we pose an interesting question on what cost more, the Iran-Iraq war or the 12-year sanctions. Using the SCM, Farzanegan (2022) calculates the per capita GDP loss for the period of the revolution and the Iran-Iraq war. Since we want to have an aggregate cost of war to compare it with the cost of sanctions, we use population data from the World Bank to calculate GDP loss during that period, which is presented in Figure 13. From 1977 to 1988, the total cost is $1,544 billion (constant 2010 $), and the cost of the Iran-Iraq war is $1,174 billion (constant 2010 $).

As we calculated with the SCM, the aggregate cost of sanctions in 12 years is $1,210 billion (constant 2015 $), and now we see that the cost of war is calculated at $1,174 billion (constant 2010 $). However, it is necessary to compare these costs in one base year, so we change our data from the base year (2015) to 2010 and find that the total cost of sanctions in 12 years (2011-2022) is $1,203 billion. In Table 20, we compare the cost of the Iran-Iraq war with the 12-year sanctions and find that the cost of sanctions is greater than the cost of the Iran-Iraq war. Generally, the annual average cost of the Iran-Iraq war is 1.5 times the annual average cost of sanctions.

5. Conclusion

In this paper, we seek to answer the following questions:

a. How much is the aggregate and per capita cost of smart sanctions on Iran since 2011?

b. Which costs more for Iran: smart sanctions or the Iran-Iraq war?

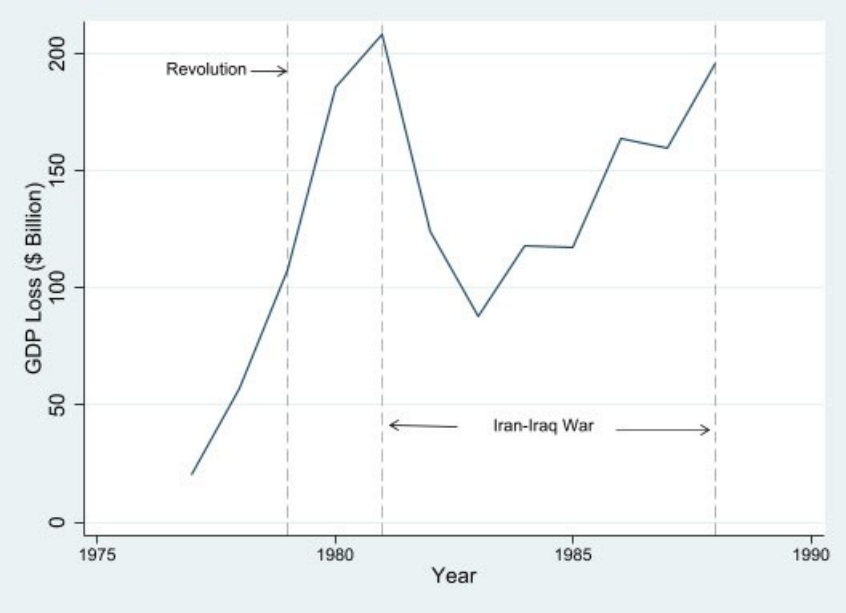
c. How much was the cost of sanctions during the Obama, Trump, and Biden presidencies?

d. How much is the cost of smart sanctions in alternative scenarios?

e. Have sanctions affected the structure of production in Iran?

f. How much (%) of Iran's economic divergence from Saudi Arabia, Turkiye, and the UAE can be attributed to sanctions?

Figure 13. Cost of Revolution and the Iran-Iraq War



Source: Farzanegan (2022) has calculated GDP per capita loss, and, using population data, we extracted the GDP loss.
Note: Constant 2010 $.

Table 20. Cost of Sanctions, the Revolution, and the Iran-Iraq War

Issue	Period	Total Years	Total Cost ($Billion)	Annual Average Cost ($Billion)
Revolution and Iran-Iraq War	1978-1988	11	1524	139
Iran-Iraq War	1981-1988	8	1174	147
Sanctions	2011-2022	12	1203	100

Note: Constant 2010 $.

Using the SCM, we find that smart sanctions on Iran for the period 2011-2022 cost more than $1.2 trillion (about $101 billion per year), which is even greater than the economic cost of the

Iran-Iraq revolution. We also find that sanctions have affected the economic welfare, and that due to smart sanctions, the period 2011-2022 represents lost years for Iranian people because the GDP per capita in 2022 is approximately the same as that of 2011.

Comparing the cost of smart sanctions in 12 years (2011-2022) with the eight-year Iran-Iraq war, which was calculated by Farzanegan (2022), we find that the cost of sanctions in 12 years is a little bit more, but generally the average economic cost of sanctions in one and a half years is equal to the economic cost of the Iran-Iraq war in one year. Then, we answer this question: Which costs more for Iran: Smart sanctions or the Iran-Iraq war? We show that the smart sanctions for 12-years (2011-2022) cost more than the Iran-Iraq war (1981-1988).

Since smart sanctions continued in 2023 and is continuing in 2024, then it would be possible that the economic cost of smart sanctions in the period 2011-24 would be similar or even more than the aggregate economic cost of the political instability, revolution, and the Iran-Iraq war (1978-88). With attention to the trend of GDP loss in Figure 1 and Table 4, cost of sanction for the period 2011-2024 would be around $1.5 trillion. However, sanctions have a different social and distributional effect than war or revolution. Ghomi (2022) sheds some light on the distributional effect of sanctions, but this field of research needs more contributions.

Comparing the economic cost of sanctions during the Obama, Trump, and Biden presidencies, we find that in 2019 (Trump presidency), the economic cost of sanctions is at its peak, while the maximum total cost belongs to the Obama presidency and the maximum average cost happened during Biden's presidency. We also find that the main sectors of the Iranian economy have produced 23-27 percent lower than their potential. However, the strategy of the US presidents and their effect on expectation and economic uncertainty is a main driver of sanctions that affect the Iranian economy as well as an open avenue for future research.

We define three scenarios to compare the economic cost of sanctions and calculate the SCM with them. In the first scenario, we assume that Iran did not experience smart sanctions in 2011-2022 and that it could follow its economic performance in two decades before the start of the smart sanctions (1990-2010). We find that the economic cost in this scenario is $1,190 billion ($99 billion per year), which shows that the economic cost of sanctions calculated with the SCM is similar to this scenario. In the second scenario, we suppose that Iran could have an economic performance similar to that of middle-income countries and find that the cost of sanctions would be even more than $1.5 trillion. In the third scenario, we choose countries that were targeted in Iran's Vision Document and find that the cost of sanctions is $1.228 trillion ($102 billion per year).

In addition to the aggregate cost of sanctions, we estimate their cost in three major economic sectors (agriculture, industry, and services) and find that sanctions have changed the production structure of the Iranian economy. The share of agriculture in GDP has increased while the ratio of industrial production to GDP has decreased, which shows a backwardness in economic development in Iran due to the sanctions. Estimating the economic cost of these

sectors during the Obama, Trump, and Biden presidencies, we find that production loss to real production fluctuated from 23 percent to 27 percent. However, future research can pursue two-digit sectors to study the effect of sanctions on manufacturing, different industries, and subsections of agriculture and services.

Comparing the economic performance of Iran and synthetic Iran with Turkiye, Saudi Arabia, and the UAE, we find that sanctions are the main driver of Iran's economic divergence from these countries and that the other issues such as the quality of government or management are the secondary issues. However, future studies can focus on especial industries or sections and study Iran's comparative performance and how sanctions affect them. Moreover, during the smart sanctions, these countries increased their economic capacity while Iran could not. Upcoming studies can focus on mega projects that shaped the previous decade or are expected to shape the current and next decades to shed more light on the economic cost of opportunities that determine a big difference in performance. For example, Iran could be a transportation or logistics hub in the region, but, due to confrontation policy, other countries such as Turkiye, the UAE, or Qatar play this role now.

For the next few years, Turkiye, Saudi Arabia, the UAE, and Qatar will improve their information and communication technology sector to create more value added and affect the global value chain through both internal investment and foreign direct investment, while, due to sanctions, Iran would lose these opportunities. This field of research would present a big picture of mega projects and Iran's comparative conditions, which offers a more tangible sense of the economic cost of sanctions.

Sanctions have lasted for more than a decade in Iran, shaping its winners and losers, and its winners can affect economic and political institutions to ensure that economic sanctions continue in the coming years. As a subject of political economy, this issue is vital to understand the supporters of sanctions in Iran, as they are among the important barriers to sanction lifting.

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Appendix A

To calculate the cost of sanctions on three major economic sectors (agriculture, industry, and services), we use data from the World Bank, shown in Table 21. As this table shows, the sum of value added (% of GDP) is smaller than 100, which is the prediction error in national account calculations. On average, during the period 1990-2022, the prediction error is about two percent.

Table 21. Value Added (% of GDP) of Agriculture, Industry, and Services, and Calculation Errors

Year	Agriculture	Industry	Services	Sum of three sections	Calculation Error (%)-
	Value Added (% of GDP)	Value Added (% of GDP)	Value Added (% of GDP)	Value Added (% of GDP)	Difference from 100
1990	12.5	32.8	53.2	98.5	-1.5
1991	12	33.4	53.3	98.7	-1.3
1992	12.1	33.5	52.7	98.3	-1.7
1993	10.4	42	48.7	101.1	1.1
1994	10.6	43.4	48.2	102.1	2.1
1995	12.6	39.4	49.9	102	2
1996	10.3	42.1	48.8	101.2	1.2
1997	9.8	38.7	52.5	101	1
1998	11.6	32.5	57.2	101.2	1.2
1999	9.9	37.5	53.4	100.8	0.8
2000	9.1	40.3	51.4	100.8	0.8
2001	8.3	39.9	52.3	100.5	0.5
2002	7.8	45.5	47.7	101	1
2003	7.5	45.1	48.8	101.3	1.3
2004	6.9	47.5	47.9	102.3	2.3
2005	6.5	49.6	48	104.1	4.1
2006	7.1	48.3	49.1	104.5	4.5
2007	7.2	48.2	47.6	103	3
2008	6.1	47.7	48.6	102.4	2.4
2009	6.9	43.1	51.5	101.5	1.5
2010	6.5	44.2	51.1	101.8	1.8
2011	4.6	46.2	48.7	99.6	-0.4
2012	6.8	42.1	50.4	99.3	-0.7
2013	8.8	42.8	47.6	99.2	-0.8
2014	9.4	39.2	49.4	98	-2
2015	10.1	32.2	55.2	97.4	-2.6
2016	9.8	34.4	52.5	96.7	-3.3
2017	9.8	36.2	50.7	96.7	-3.3
2018	11.2	36.9	48.6	96.7	-3.3
2019	13.3	33.3	50.1	96.7	-3.3
2020	12.2	36.1	49.2	97.5	-2.5
2021	12.4	38	47.3	97.7	-2.3
2022	12.5	40.2	46.9	99.6	-0.4