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The Opportunity Cost of the Islamic Revolution and War for Iran

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Abstract

We estimate the opportunity cost for Iran due to the Islamic revolution and eight years' war with Iraq (1978/79-1988). We apply the synthetic control method in order to compare Iran with a synthetic Iran and answer this counterfactual question. Our results show that, in total, an average Iranian has lost $34,660 (in constant 2010 US$) from 1978 to 1988. This loss is equivalent to 40% of income per capita, which an Iranian could reach at the absence of revolution and war.

Keywords: synthetic control method, treatment effect, Iran, war, revolution

JEL classification: C23, H56, F51, D74, Q34

1. Introduction

" if this revolution had not occurred, if those thousands screams had not moved everything in this country… then God only knows what state our country would be in today. You can take a look at some of the backward countries in Asia or Africa and you can rest assured that we would be in a worse state than them despite our outstanding geographical, climatic and historical positions. This revolution responded to the cry of this country. It rescued this nation and ensured that it would not go over the precipice"

(From speech of Leader of Iran Revolution-Ayatollah Khomeini-, cited in Maloney, 2015, p. 140).

Four decades ago, one of the major revolutions of 20th century happened in Iran and ended the monarchy system. Maloney and Razipour (2019) illustrate a time line of Islamic revolution. The spark of revolution ignited by popular uprising in Iran in 1978. We observe intensification of mass protests and strikes. In response, the Shah enforced martial law. He fled amid intensifying unrest in January 1979. The monarchy collapsed on 11 February 1979. In September 1980, Iraq invaded Iran and the world observed one of the longest classic interstate wars between two major oil producers; Iran and Iraq (1980-1988).

An often-asked question is that what would Iran's economy have looked like at the absence of revolution and war with Iraq? Where Iran was standing if these conflicts and violence were hindered? Gaining an evidence-based insight on opportunity costs of conflict is getting more important given the current increasing tension between Iran and the US allies.

There are a limited number of studies which have examined the economic costs of the Iran-Iraq war. However, to the best of our knowledge, none of them estimates the opportunity costs of war and revolution for an average Iranian citizen in a term of lost welfare by using a synthetic control method (SCM). This approach will help to identify the effect of conflict on economic development and quantify its economic size by comparing the affected country (e.g., Iran) with a set of similar countries which did not experience the shock (e.g., war and revolution) over the period of analysis.

This is the first study, which uses SCM to examine the impact of Iranian revolution and war with Iraq on economic development of Iran, measuring this effect. This method allows comparison of economic development in Iran before and after popular uprising of 1978-79 and subsequent war with Iraq with the weighted average of economic development constructed from a pool of countries without revolution and war. The weights are calculated such that the synthetic Iran reflects the characteristics of Iran before the revolution/war. The SCM minimizes the gap between the vector of characteristics of Iran and its synthetic before revolution/war.

In this study, we contribute to the public debate about the cost of the Islamic revolution and war with Iraq to the Iranian economy. Section 2 provides a review of related literature. The data and method are presented in Section 3. Section 4 explains the main results and sensitivity checks. Section 5 concludes the paper.

2- A brief review of literature

Among existing descriptive studies, we can refer to an examination by Alnasrawi (1986) who presented the economic losses to both Iran and Iraq within the initial six years of war. He examined the reduction in oil production and export of the war's parties, degree of dependence of both Iran and Iraq to the oil sector and calculated the fall in oil income and economic growth. In addition, he refers to other costs such as changing the trade routes because of risk of war from lower costs to more costly transport routes in both countries, leading to higher transaction costs and consumer prices. He also took into account the burden of military spending in both countries of Iran and Iraq due to war condition. In summary, for case of Iran and up to the end of 1985 (war finished in 1988), the costs was estimated at the level of $ 220 billion. By adding the estimated losses in oil income of $20.5 billion, his study shows a total estimated cost of $ 240.5 billion.

Amirahmadi (1990) also provides an estimation based on secondary information of Iran-Iraq war. He suggests that total economic costs of the conflict amounted some $592 billion which

$210 billion of it is related to damages on infrastructures. These figures exclude human costs, military spending and the reconstruction costs of the war's damages.

Mofid's (1990) analysis based on the official data of the Iranian government and his own calculations reached to $ 644.3 billion as the total economic costs of the war for Iran. This figure includes $445 billion for potential GNP losses, losses incurred in oil sector, industry, agriculture, telecommunications, housing and health. The amount of $84 billion is related to potential losses in foreign exchange reserves due to high military spending; a similar figure for oil income losses; $11 billion for free or discounted oil to Syria; $14 billion for imports of oil products; $3 billion for discounts in selling oil prices; and $3 billion for costs of redirecting imports.

However, these estimations are not answering the questions such as "what would Iran's economy have looked like at the absence of revolution and war with Iraq?". To answer this, we need a comparable set of countries which can reproduce real Iran before the revolution and war as much as possible. The expected development of Iran will be then based on the gap between factual and counterfactual Iran after 1978.

In a more recent study, Jahan-Parvar (2016) aims to obtain a measure of opportunity costs of Iran revolution and its subsequent policies (1979-2010). He does this by focusing on the difference between the actual performance of the Iranian economy in 1979-2010 period against a set of scenario-generated counterfactual outcomes. Some of his assumptions are based on the economic performance of Iran before revolution and some other assumptions are generated based on performance of Iran's neighbors in the period ending in 2010. According to his calculations, an average Iranian opportunity costs due to revolution and policies after the war for the period of 1979-2010 ranges between $59,559 to $732,704.

We use SCM which provides a transparent and robust framework to compare Iran with its synthetic before and after revolution (up to the end of war with Iran in 1988), calculating an

impact of the revolution and war events. We exclude the post war period (post-1988) and focus on the opportunity costs of conflict and instability in Iran. This is the first application of this methodological approach to measure the opportunity costs of revolution and war for Iran.

Earlier recent studies have also used the SCM to measure the economic impacts of conflict and war. The application of this method in this context introduced by Abadie and Gardeazabal (2003) by studying the economic costs of conflict for case study of Basque. They show that per capita GDP in the Basque Country reduced by about 10 percentage points, following the outbreak of terrorism in the late 1960's, relative to a synthetic control region without terrorism.

Horiuchi and Mayerson (2015) used SCM to study the economic impacts of Israel-Palestine conflict (the Second Intifada from 2000 to 2005) for Israel. The period of their analysis is from1980 to 2005, which is divided into pre-treatment (1980 to 1999) and post-treatment periods (2000 to 2005) including the year of the onset of the Second Intifada. They show that per capital real GDP of Israel declined during the Second Intifada (from 2000 to 2005) by an average of about $2,003 per year. Horiuchi and Mayerson conclude that "If Israel were at peace with the Palestinians, it could shift defense spending toward more productive endeavors, such as infrastructure spending and investments in education. Israel could have a smaller standing army, which would allow the labor force to expand. The stability of peace would cause a tourism boom in Israel. Perhaps most of all, peace would boost investment by removing the uncertainty caused by conflict and terrorism".

Earlier applications of this method for case of Iran can be seen for the economic costs of international sanctions by Gharehgozli (2017). Other studies have also employed this method to measure the costs of Palestinian Intifada for Israel (Horiuchi and Mayerson, 2015); the economic costs of separatist terrorism in Turkey (Bilgel and Karahasan, 2017); thirty years of conflict and economic growth in Turkey (Bilgel and Karahasan, 2019); the economic costs of civil war (Costalli et al., 2017); the effect of Arab Spring on the economies of Tunisia, Egypt

and Libya (Matta et al., 2019; Echevarría and García-Enríquez, 2019a & 2019b). For a detailed methodology of the synthetic control model see Abadie and Gardeazabal (2003) and Abadie et al. (2010).

3. Data and methodology

One important challenge in front of comparative studies is to find suitable controls (e.g., countries) which are not influenced by the intervention (e.g., revolution and war) and at the same time have similar socio-economic characteristics as the affected country. We use the SCM to study the trajectory of economic development in Iran before and after revolution. This method employs a weighted average of a set of control units, presenting a synthetic control unit which reflect the treated unit in a term of predictors of outcome before the shock. This is an advantage compared with studies which use only one single control unit (see Salehi-Isfahani, 2019 that uses Turkey as control country to measure the economic effect of Islamic revolution in Iran).

We use SCM to construct a synthetic control unit for Iran representing expected GDP figures under a scenario in which there had been no revolution and war after 1978/79. We refer to this control unit as ‘‘Synthetic Iran’’. An outcome variable (in our case GDP per capita in constant prices) should be comparable between the treated country (Iran) and its synthetic before the event (revolution and war with Iraq) conditional on successful generation of such a synthetic Iran. In the latter case, we can suggest a causal effect of the revolution and war on the outcome when the trends of outcome show a significant diversion between Iran and synthetic Iran after the shock. We will then able to quantify this diversion as well as the opportunity costs of conflict for an average Iranian.

To generate Synthetic Iran, we use a country level panel data for Iran and a sample of countries from the Middle Eat & North Africa (MENA) and Organization for Petroleum Exporting Countries (OPEC) from 1970 to 1988. Restricting our set of potential control countries to the

MENA region helps to control for cultural, religious and geographical similarities. Also considering OPEC members to generate synthetic Iran makes sense due to their common natural resource rents dependency.

For the outcome variable, we use Gross Domestic Product (GDP) per capita in constant 2010 US$. In order to have an unbiased estimates of post-revolution-war trajectory of Iran, the control countries for generating synthetic Iran should not have experienced a main exogenous shock (e.g., war, revolution) from 1978 to 1988 (see Matta et al 2019 for similar approach). To avoid such a bias, we exclude countries which were affected by Iran revolution and war with Iraq. A natural candidate is Iraq which was in war with Iran. Israel and Lebanon also experienced a series of significant conflicts during the post revolution of Iran. Furthermore, some other countries excluded from the sample of control states due to the missing data in some years for part of covariates or outcome variables. With these adjustments, we reach to the total number of 11 countries (from initial 20) as for possible candidates to generate synthetic Iran.

The generated Synthetic Iran should have comparable economic and demographic structure to Iran prior to the Islamic revolution and subsequent war with Iraq. For this reason, we require Iran and its synthetic to share comparable consumption and gross capital formation as well as trade openness. In addition, it is required to share common demographic profile (population growth) and health indicators (e.g., life expectancy) before the Islamic revolution and subsequent war in Iran. Data for outcome and covariate variables are taken from World Bank (2019). Iran and its synthetic counterpart should share similar profile in mentioned indicators for the average period of 1970-1977 (1978 is selected as treatment year since revolutionary protests and large scale strikes intensified during this year which led to the collapse of monarchy in Feb.1979). Finally, in order to increase the goodness of fit of the Synthetic Iran with the actual Iran during the pre-revolution and war period, we control for the past records of GDP per capita in years 1976, 1974, 1972 and 1970. Kaul et al. (2015) suggest not using all the lags

of outcome variable as predicators because that makes all other control variables insignificant and generate bias in estimated effect of treatment.

The per capita GDP of the factual Iran ($GDP_{ir;t}$) and of a counterfactual Iran ($GDP_{syn;t}$), generated as explained below, are compared for the period after the Islamic revolution and war with Iraq, and the impact in each year is calculated as the difference between them.

To produce the GDP per capita of counterfactual Iran, we assume that X_r is an (x × 1) vector of observed covariates correlated with real GDP per capita (outcome of interest) for each control country r ∈ R (R is the set of selected control countries from the MENA/OPEC). Moreover, consider a vector of weights W = (w_1,…,w_R) such that $w_r \in R \geq 0$ and the sum of these weights equals one: $\sum_{r=1}^{R} w_r = 1$. According to Abadie et al. (2010), the estimated impact by SCM for years t=1978,…, 1988 is unbiased if the following equations apply:

$$\sum_{r=1}^{R} w_r^* \, GDP_{r,t} = GDP_{Iran,t} \; for \; t = 1970, \dots, 1977 \quad (1)$$

$$\sum_{r=1}^{R} w_r^* \, X_{r,t} = X_{Iran,t} \; for \; t = 1970, \dots, 1977 \quad (2)$$

In simple terms, the optimal Synthetic Iran should not only have the same (or close to) GDP per capita as Iran during the pre-revolution & war period but it should also have the same (or close) values of the covariates.

Following identifying the optimal weights that satisfy equations (1) and (2), the real GDP per capita for the Synthetic Iran is estimated using equation 3:

$$\widehat{GDP}_{Synth,t} = \sum_{r=1}^{R} w_r^* \, GDP_{r,t} \; for \; t = 1970, \dots, 1988 \quad (3)$$

Finally, the economic effect of the Iranian revolution and the war with Iraq can be estimated as in equation 4:

$$Effect_t = GDP_{Iran,t} - \widehat{GDP}_{Synth,t} \; for \; t = 1979, \ldots, 1988 \quad (4)$$

The impact of the Iranian revolution and war on real GDP per capita is equal to the difference, over the period 1979-1988, between the factual Iranian GDP per capita and the estimated counterfactual GDP per capita had the Iranian revolution and war not happened.

4. Results

Table 1 shows that Synthetic Iran is best generated by a weighted average of 5 countries with Tunisia (56%), Venezuela (16%), Saudi Arabia (13%), Oman (12%), and Algeria (1.6%) having the highest weights. Table 2 shows the average pre-1978 values of the covariates for Iran and Synthetic Iran. We can observe that Synthetic Iran reflects the pre-1978 performance of the GDP per capita covariates for Iran relatively closely.

Synthetic Iran is similar to actual Iran in terms of pre-1978 GDP per capita as well as the associated shares of imports, gross capital formation, Final consumption (private and public) in total GDP in addition to life expectancy and population growth rate.

Table 1. Country weight in synthetic Iran

Country	weight
Algeria	0.016
Ecuador	0
Egypt, Arab Rep.	0
Gabon	0
Malta	0
Morocco	0
Oman	0.123
Saudi Arabia	0.132
Tunisia	0.563
Turkey	0
Venezuela, RB	0.165

Table 2. The means of predictors during the pre-treatment period

	Iran	Synthetics Iran
GDP per capita (1976)	10266.9	9987.7
GDP per capita (1974)	9524.6	9557.0
GDP per capita (1972)	8706.8	8378.7
GDP per capita (1970)	7015.0	7211.1
Life expectancy	53.7	56.8
Population growth	2.8	2.9
Imports (% of GDP)	25.2	29.1
Gross capital formation (% of GDP)	39.9	33.9
Final consumption (% of GDP)	66.3	66.3

Figure 1 shows the GDP per capita trajectory of Iran and its synthetic counterpart for the 1970–1988 period. The synthetic Iran almost reproduces the per capita GDP for Iran during the entire pre revolution period. Thus, it is possible to closely reproduce economic characteristics of Iran before the 1978 popular uprisings without extrapolating outside of the support of the data for the donor pool. Our estimate of the effect of the revolution and war on per capita GDP of Iran is shown by the difference between the actual Iran and its synthetic (Figure 2 and Table 4).

We can see that two lines diverge from each other significantly since 1978. While per capita GDP falls in Iran, for the synthetic Iran per capita GDP keep its earlier path during early 1980s period. The difference between the two series remains significant towards the end of the sample period. Therefore, our results imply a main negative effect of the revolution and war on economic development of Iran.

Table 4. Opportunity costs of revolution and war for Iran

Year	Gap $ (Iran's GDP per capita-Synthetic Iran GDP per capita)	GDP p.c. Iran	GDP p.c. synthetic Iran
1970	-196	7014.97	7211.139
1971	172	7816.1	7644.25
1972	328	8706.81	8378.715
1973	233	9198.42	8965.014
1974	-32	9524.6	9557.042
1975	-76	9026.3	9102.316
1976	279	10266.9	9987.724
1977	-567	9546.96	10114.03
1978	-1,572	7941.23	9513.032
1979	-2,898	6862.72	9760.384
1980	-4,826	4791.81	9617.41
1981	-5,135	4368.63	9504.105
1982	-2,912	5335.78	8247.514
1983	-1,994	5558.01	7552
1984	-2,593	4865.04	7458.537
1985	-2,470	4773	7242.91
1986	-3,345	4119.41	7464.161
1987	-3,160	3989.53	7149.254
1988	-3,760	3640.31	7399.982

On average, based on our estimations each Iranian citizen has lost $1572 in 1978, $2900 in 1979, $4826 in 1980, $5137 in 1981, $2912 in 1982, $2000 in 1983, $2600 in 1984, $2470 in 1985, $3345 in 1986, $ 3160 in 1987 and $3760 in the last year of war with Iraq (1988). In total, an average Iranian has lost an accumulated sum of $34,660 from 1978 to 1988. This loss is equivalent to 40% of real income per capita, which an Iranian could reach at the absence of revolution and war.

Figure 1. Factual and counterfactual Iran

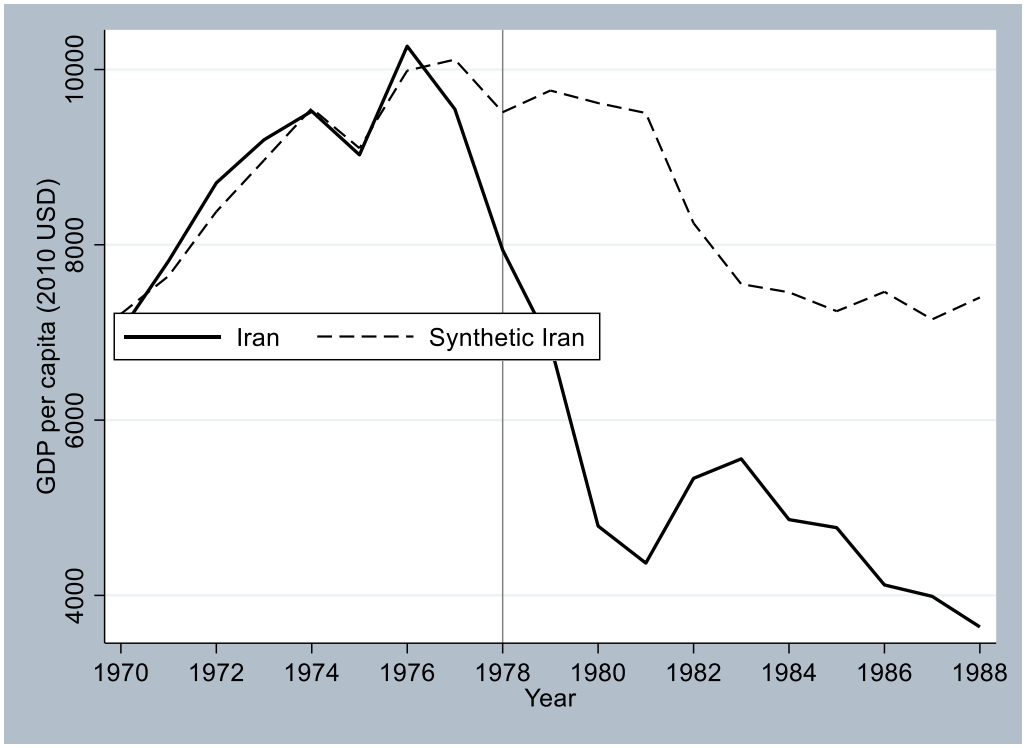
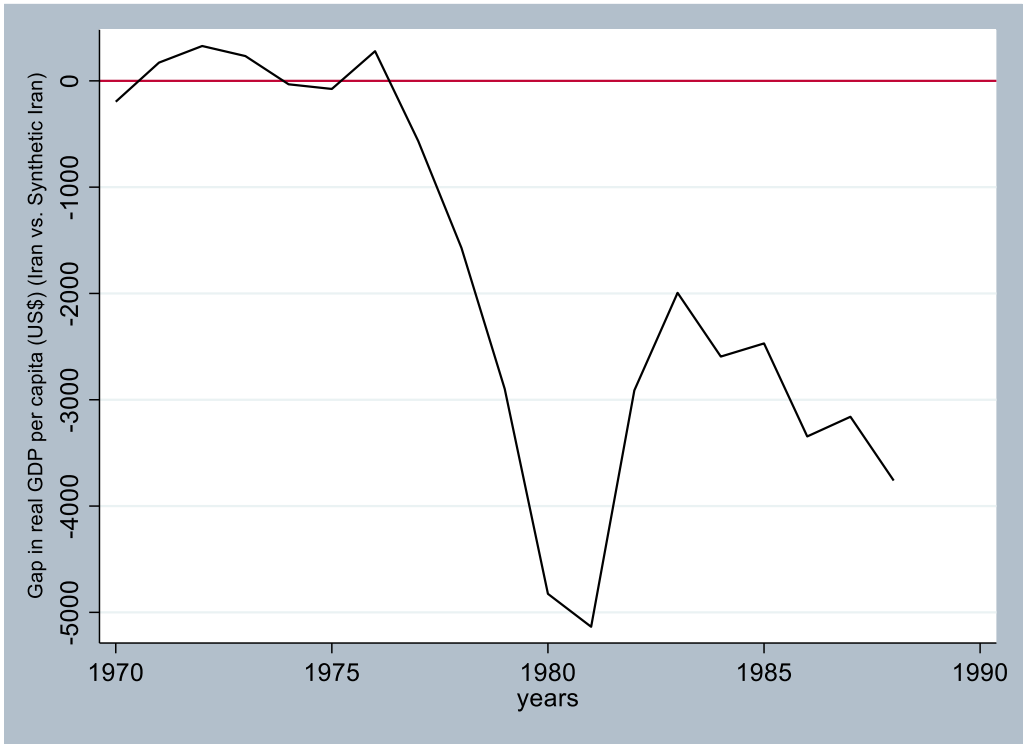


Figure 2 shows the difference between GDP per capita of actual Iran and its synthetic before and after revolution.

Figure 2. The income gap between Iran and Synthetic Iran before and after revolution

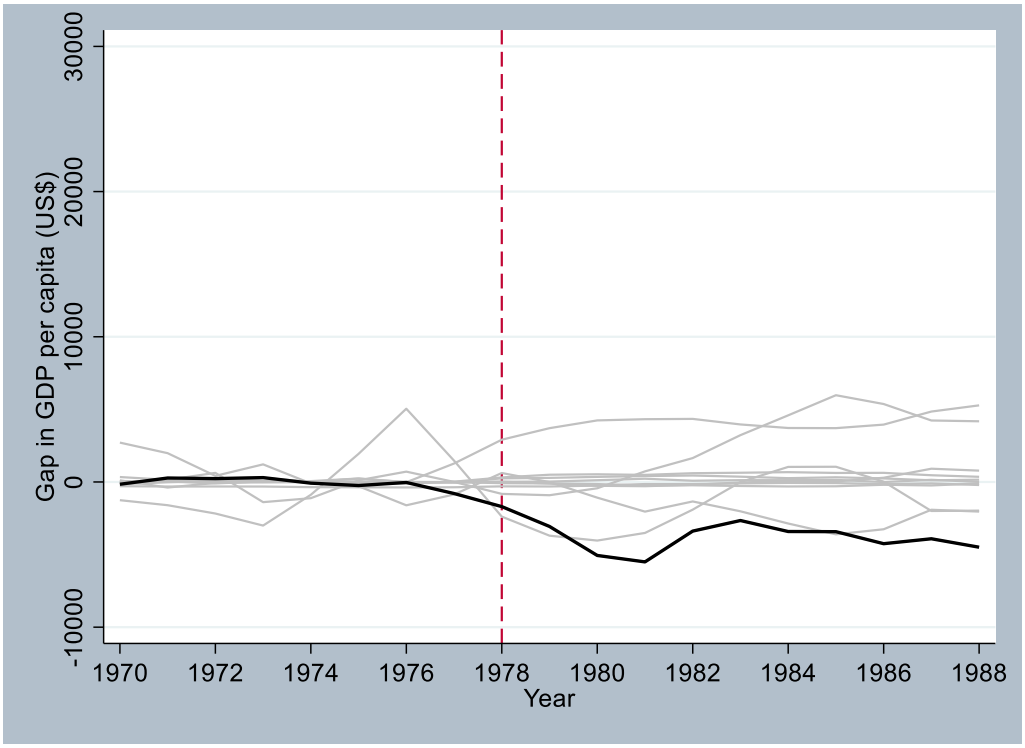


4.1 Inference procedures

In SCM approach, we cannot refer to often used p-values to judge about statistical significance of our estimations. An alternative way to test the robustness of our estimations is through Placebo or Falsification tests. They are also known as Randomization inference tests in statistical fields (Bertrand et al., 2004). Placebo tests have a simple framework: if we apply SCM to other countries which were not under the treatment (revolution and war), then we should logically not observe a similar negative economic outcome as in the case of Iran. If we also see a similar trajectory for other countries, then our estimated effect for Iran cannot be associated with the post revolution shock.

The placebo tests are shown in Figure 3.

Figure 3. Placebo Tests



The tests are applied to the other 11 countries in 1978. The thick black line shows the earlier estimated effect for Iran. The other lines represent the gap between the real GDP per capita of each of the 11 countries and their related synthetic counterparts produced by SCM. From Figure

3 we can clearly observe that this is only Iran which shows a significant drop in post 1978 period. There is no other country in this sample which shows a similar negative effect when is subjected to this treatment.

In addition to this visual check, we can calculate a pseudo p-value based on the rank of the treatment unit's post/pre-RMSPE ratio compared to the untreated placebo units post/pre-RMSPE ratios (as in Abadie, Diamond and Heinmuller 2010). As the results in Table 5 shows, the largest ratio of post treatment RMSPE to pre-treatment RMSPE belong to Iran (11.2). The inference procedures show a pseudo *p*- value of 1/12=0.08, meaning that there is no other placebo runs which outperform or equal the effect estimate for Iran when preintervention fit (RMSPE) is accounted for. The evidence for a causal effect of the Iranian revolution and war is strong.

Table 5. Ratio between the postintervention and preintervention RMSPE

	post/pre-RMSPE ratio
Algeria	3.7
Ecuador	3.1
Egypt	0.6
Gabon	0.9
Iran	**11.2**
Malta	8.8
Morocco	8.7
Oman	4.8
Saudi Arabia	0.7
Tunisia	1.8
Turkey	4.4
Venezuela, RB	1.5

4.2. Sensitivity analysis

In this section, we check to ensure that our results are not because of the effect of a single important country in the synthetic control unit. We carry out a leave-k-out analysis in which the most influential countries are iteratively dropped from the donor pool. We perform this test iteratively so that each iteration reduces the number of countries in donor pool by one and refit the synthetic control model by employing the restricted donor pool. In the first iteration, we drop Tunisia from the donor pool based on its unit weight in Table 1. We run the model after this update in donor pool and we find that Morocco received the highest unit weight. Next, we drop Morocco besides Tunisia for the next iteration. We continue this process until only one-country remains in donor pool. However, since we are considering the synthetic controls with low prediction errors, we perform the iterations until the preintervention RMSPE is more than twice of the main estimation. This is achieved after fifth iteration in our case.

Figure 4. Sensitivity analysis

Results from a leave-k-out analysis that iteratively reduces the donor pool by excluding the most influential state from the synthetic control unit until the pre-intervention prediction errors are twice as large as in the main analysis (n = 6 iterations).

Figure 4 shows the results of this sensitivity analysis. We see that the synthetic control results are robust to the exclusion of influential countries and thus supports our initial findings.

5. Conclusion

What would Iran's economy have looked like at the absence of revolution and war with Iraq? We answer this question, using the synthetic control and estimate the opportunity cost of Islamic revolution and subsequent war with Iraq for Iran. We show that trajectories of the economies of factual Iran and its counterfactual were to a large extent similar before revolutionary protests of 1978 but diverged significantly afterward.

Our results show that, in total, an average Iranian has lost an accumulated sum of $34,660 (adjusted for inflation) from 1978 to 1988. This loss is equivalent to 40% of income per capita, which an Iranian could reach at the absence of revolution and war. If Iran was not experiencing the revolution and subsequent war with Iraq, it could allocate the oil revenues from military spending to education and health and physical infrastructure with higher productivity in long run. Revolution and instability increased the risk of investment, hindering financial development and privatization, which at the end can partly explain the gap between factual and counterfactual Iran. The findings of this research can remind us the lost economic opportunities and welfare due to conflict which could be avoided with a proactive diplomacy and a long run horizon in policy making decisions.

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