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The Effects of International Sanctions on Military Spending of Iran: A Synthetic Control Analysis

Abstract

We use the synthetic control method to estimate the effect of international banking and energy sanctions from 2012 to 2015 on military spending of Iran. We create a synthetic control group that mimics the socioeconomic characteristics of Iran before the international sanctions of 2012. We then compare the military spending of the counterfactual Iran without sanction to the factual Iran with sanction for the period of 2003-2015. Over the entire 2013–2015 period, per capita military spending was reduced by about 119 US$ per year on average, which amounts to approximately 54% of the 2012 baseline level. Our findings are robust to a series of tests, including placebo tests.

JEL-Codes: F500, H560, N150, O190.

Keywords: sanctions, military spending, Iran, synthetic control methodology.

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1. Introduction

There is an increasing interest in examining effectiveness of sanctions in changing the political behavior of targeted countries through economic channels. There are a few countries which are still experiencing economic sanctions for variety of reasons. Iran is a prominent example in the literature. In this study, we implement a counterfactual analysis to study the effects of 2012 international oil and banking sanctions on military spending of Iran. The theoretical effects of sanctions on military spending are not clear a priori. Sanctions have two effects of security and income on the target countries (Dizaji and Farzanegan, 2019). If security effect is larger than income effect then the target country invests in its military capabilities to resist the possible attacks by sender(s) of sanctions. By contrast, if the income effects outweigh the security threat then we expect a deterioration of financial capacity of the target country, reducing the allocation of budget to military projects.

Previous studies examine the effect of sanctions on a set of macroeconomic indicators of Iran. For example, using times series regression and nightlight data, Farzanegan and Hayo (2019) show that the negative effect of sanctions on the shadow economy of Iran is stronger than its negative impacts on formal economy. Farzanegan et al. (2016) and Khabbazan and Farzanegan (2016) study the effects of oil and banking sanctions on Iranian household welfare by using social accounting matrix and computable general equilibrium models. Using the Vector autoregressive models, Farzanegan (2011) examines the response of military spending to negative oil revenues shocks as a proxy of oil sanctions in Iran. He shows that the military spending response is negative and statistically significant to such shocks. In a recent study, Dizaji and Farzanegan (2019) use autoregressive distributed lag model and employ a different set of unilateral and multilateral sanction dummies for case study of Iran. They find that multilateral sanctions have a significant negative impact on military spending of Iran. Understanding impact of sanctions on military spending of Iran is important because of significant connections of military and economic output of Iran (Farzanegan, 2014). All abovementioned analyses miss an optimally estimated counterfactual Iran to the actual Iran that experienced the sanction. The counterfactual Iran which is also called the "synthetic Iran" is important because it serves to show what would have happened to the military spending of Iran had the international sanctions of 2012-2015 never occurred. This is the first study which uses synthetic control method (SCM) to examine the impact of international

sanctions on military spending of Iran, quantifying this effect.[1] SCM allows comparison of military spending in Iran before and after international sanctions with the weighted average military spending constructed from a pool of countries without sanctions. The weights are calculated such that the synthetic Iran resembles the characteristics of Iran before the comprehensive 2012 sanctions. The SCM minimizes the gap between the vector of characteristics of Iran and its synthetic before sanctions.

We find that over the entire 2013–2015 period, per capita military spending was reduced by about 119 US$ per year on average, which amounts to approximately 54% of the 2012 baseline level. In 2015, per capita military spending in the synthetic Iran is estimated to be about 69% higher than in the actual Iran.

2. Data and method

We use annual country-level panel data for the period 2003–2015. The international oil and banking sanctions on Iran occurred in 2012, giving a preintervention period of 9 years. Our sample period ends in 2015 because international sanctions were lifted on January 2016. We start from 2003 in order to consider the period after the September 11 Terror Attacks and military intervention of the US in Afghanistan and Iraq. The synthetic Iran is constructed as a weighted average of potential control countries in the donor pool. Our donor pool, after dropping missing observations, includes a sample of 13 member countries of Organization of the Petroleum Exporting Countries (OPEC) and Middle East & North Africa (MENA) region: Algeria, Angola, Bahrain, Ecuador, Egypt, Iran, Israel, Jordan, Lebanon, Morocco, Nigeria, Oman, and Saudi Arabia. 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 oil rents dependency. In order to have an unbiased estimates of post-2012 sanction trajectory of Iran, the control countries for generating synthetic Iran should not have experienced a main exogenous shock (e.g., war, revolution) from 2012 to 2015. Thus, we have excluded Iraq, Libya, and Syria.

[1] There is another study by Gharehgozli (2017) which has examined the effects of sanctions on economic growth of Iran using SCM approach. For more details on applications of SCM see Abadie et al. (2015).

Following Sandler and Hartley (1995), the outcome variable in SCM analysis is military expenditure (current US$) per capita[2]. It is derived from the NATO definition, which includes all current and capital expenditures on the armed forces including peacekeeping forces; defense ministries and other government agencies involved in defense projects; paramilitary forces, if these are judged to be trained and equipped for military operations; and military space activities. For the pre-2012 sanction characteristics, we use a standard set of control variables (see Dizaji and Farzanegan, 2019 for more references): total population, imports of goods and services (constant US$), GDP per capita (constant US$) and real GDP per capita growth rate. All data are from the World Bank (2019). Finally, in order to increase the goodness of fit of the Synthetic Iran with the actual Iran during the pre-2012 sanctions period, we control for the past records of military spending per capita in years 2010, 2008, 2006 and 2004. Following, Kaul et al. (2015), we are not suing all the lags of military spending as predictors because that can wipe out the significance of other control variables and generate bias in estimated effect of treatment.

The per capita military spending of the factual Iran ($Mil_{ir;t}$) and of a counterfactual Iran ($Mil_{syn;t}$), generated as explained below, are compared for the period after the 2012 sanctions, and the impact in each year is calculated as the difference between them. To generate the military spending per capita of counterfactual Iran, we assume that X_r is an (x × 1) vector of observed covariates correlated with military spending 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=2012,…, 2015 is unbiased if the following equations apply:

$$\sum_{r=1}^{R} w_r^* \, Mil_{r,t} = Mil_{Iran,t} \; for \; t = 2003, \dots, 2011 \quad (1)$$

$$\sum_{r=1}^{R} w_r^* \, X_{r,t} = X_{Iran,t} \; for \; t = 2003, \dots, 2011 \quad (2)$$

In simple terms, the optimal Synthetic Iran should not only have the same (or close to) military spending per capita as Iran during the pre-2012 sanctions period but it should also have the same

[2] Results are robust to using military spending in constant PPP prices per capita.

(or close) values of the covariates. Following identifying the optimal weights that satisfy equations (1) and (2), the military spending per capita for the Synthetic Iran is estimated using equation 3:

$$\widehat{Mil}_{Synth,t} = \sum_{r=1}^{R} w_r^* \, Mil_{r,t} \; for \; t = 2003, \ldots, 2015 \quad (3)$$

Finally, the effect of the international energy and economic sanctions can be estimated as in equation 4:

$$Effect_t = \; Mil_{Iran,t} - \; \widehat{Mil}_{Synth,t} \; for \; t = 2013, 2014, 2015 \quad (4)$$

The impact of the sanctions on military spending per capita is equal to the difference, over the period 2013-2015, between the factual Iranian military spending per capita and the estimated counterfactual military spending per capita had the international sanctions not happened.

3. Results

Table 1 shows that Synthetic Iran is best generated by a weighted average of 4 countries with Angola (53%), Nigeria (30.2%), Algeria (12.3%), and Saudi Arabia (4.5%) having the highest weights. Table 2 shows the average pre-2012 values of the covariates for Iran and Synthetic Iran. We can observe that Synthetic Iran reflects the pre-2012 performance of the military spending per capita covariates for Iran closely.

Table 1. Country weight in synthetic Iran

Country	**Weight**
Algeria	0.123
Angola	0.53
Bahrain	0
Ecuador	0
Egypt	0
Israel	0
Jordan	0
Lebanon	0
Morocco	0
Nigeria	0.302
Oman	0
Saudi Arabia	0.045

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

Predictors	Iran	Synthetic Iran
military spending per capita (2010)	183.85	176.87
military spending per capita (2008)	153.66	165.29
military spending per capita (2006)	124.04	119.12
military spending per capita (2004)	76.05	75.75
logarithm of population	18.08	17.51
logarithm of imports (constant US$)	25.18	24.54
logarithm of GDP per capita (constant US$)	8.72	8.04
GDP per capita growth rate (%)	3.16	4.05

Figure 1 shows the per capita military spending trajectory of Iran and its synthetic counterpart for the 2003–2015 period. The synthetic Iran almost exactly reproduces the per capita military spending for Iran during the entire pre international sanctions period. Thus, it is possible to closely reproduce economic characteristics of Iran before the 2012 sanctions without extrapolating outside of the support of the data for the donor pool. Our estimate of the effect of the international sanctions on per capita military spending of Iran is given by the difference between the actual Iran and its synthetic version, illustrated in Figure 2. We can see that two lines diverge from each other significantly since 2012. While per capita military spending decelerates in Iran, for the synthetic Iran per capita military spending keeps ascending at a pace similar to that of the pre-2012 sanctions period. The difference between the two series continues to grow towards the end of the sample period. Therefore, our results imply a significant negative effect of the international sanctions on military spending of Iran.

We find that over the entire 2013–2015 period, per capita military spending was reduced by about 119 US$ per year on average, which amounts to approximately 54% of the 2012 baseline level. In 2015, per capita military spending in the synthetic Iran is estimated to be about 69% higher than in the actual Iran.

Figure 1. Trends in per capita military spending (US$): Iran versus Synthetic Iran

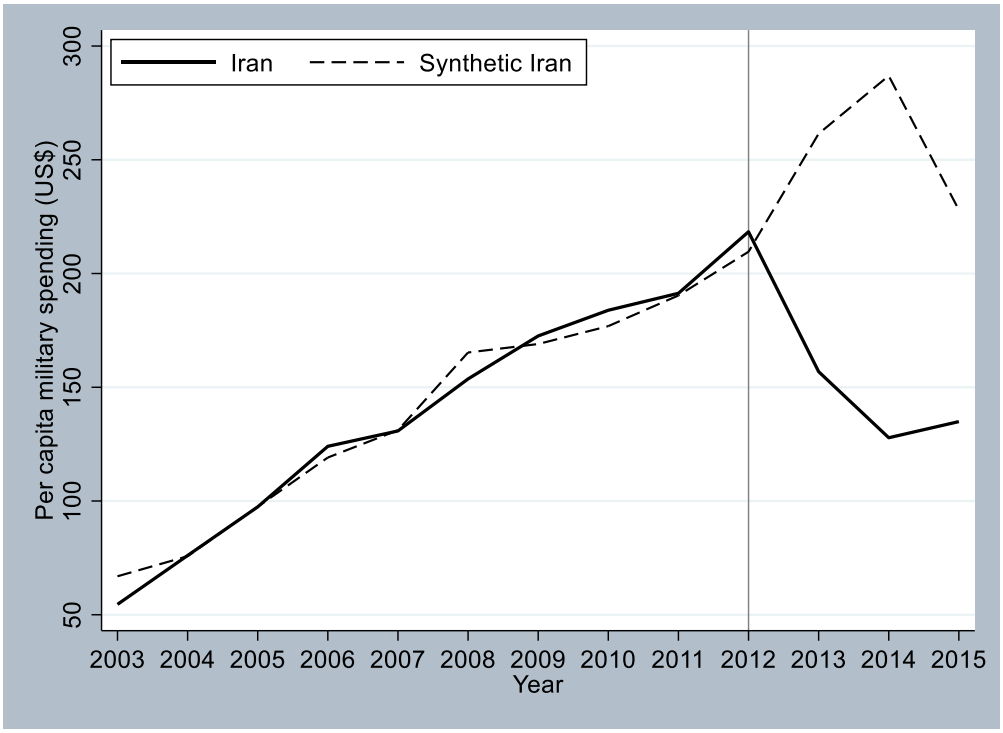
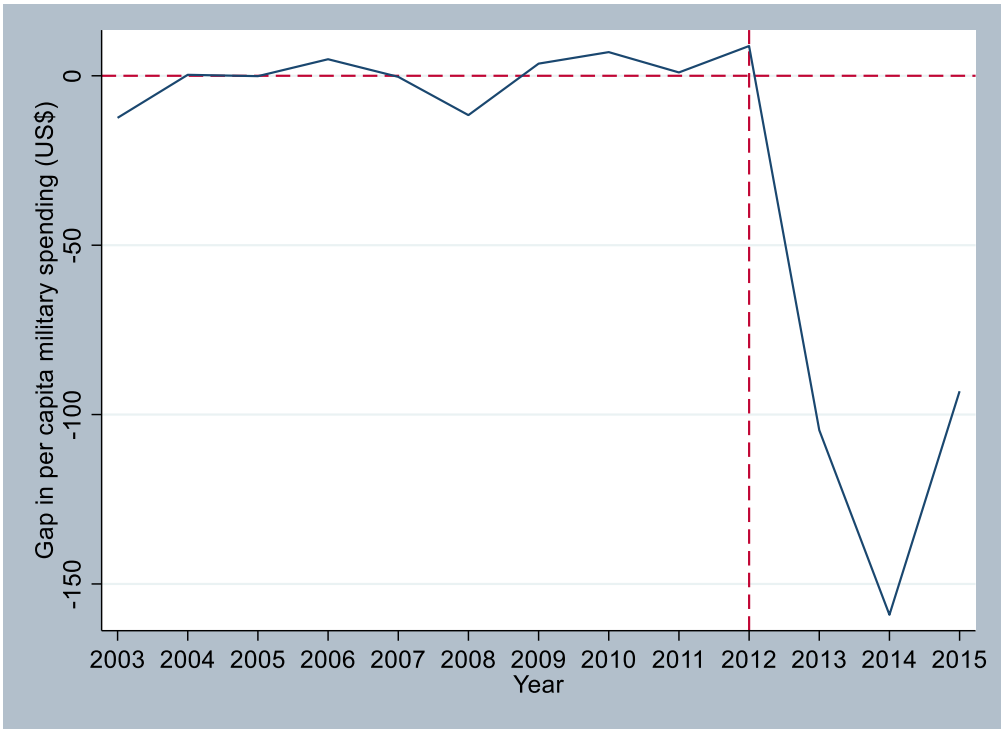


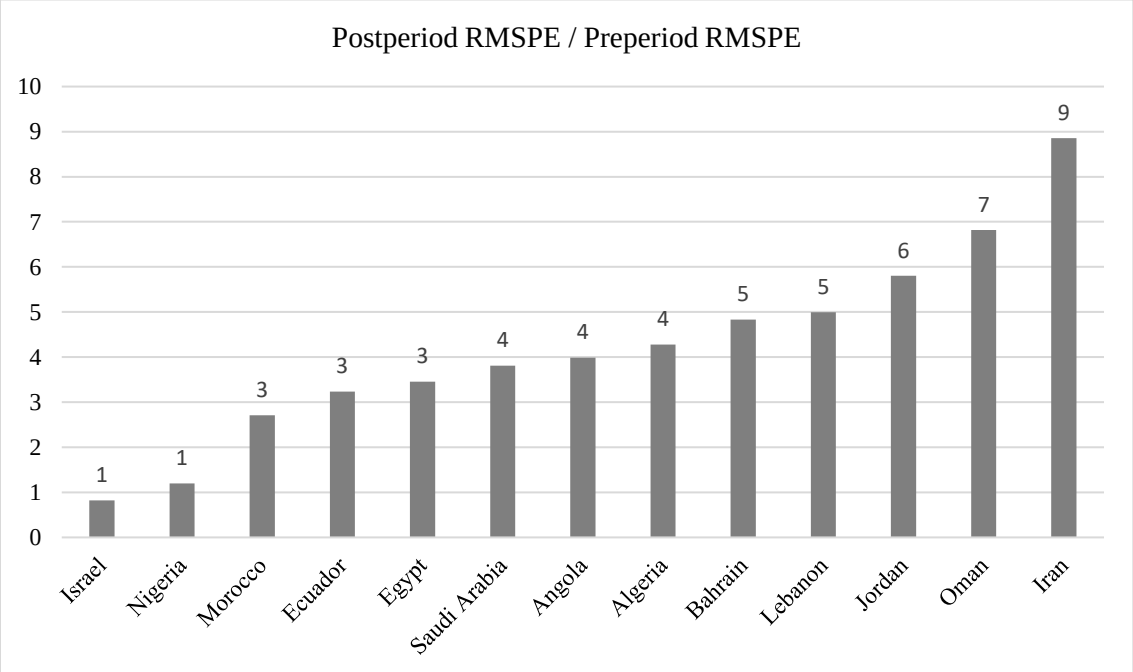
Figure 2. Per capita military spending gap between Iran and synthetic Iran



3.1 Inference procedures

To evaluate the credibility of our results, we conduct placebo studies and reassign the treatment in the data to a comparison unit. We obtain synthetic control estimates for countries that did not experience the event of interest. Applying this idea to each country in the donor pool allows us to compare the estimated effect of the international sanctions on Iran to the distribution of placebo effects obtained for other countries. We will accept that the effect of the international sanctions on Iran is significant if the estimated effect for Iran is unusually large relative to the distribution of placebo effects. Figure 3 shows the ratios between the post-2012 RMSPE and the pre-2012 RMSPE for Iran and for all the countries in the donor pool. RMSPE measures the size of the gap in the outcome variable of interest between each country and its synthetic counterpart. A large postintervention RMSPE is not reflecting of a large effect of the intervention if the preintervention RMSPE is also large. Thus, for each country, we divide the post-2012 sanctions RMSPE by its pre-2012 sanctions RMSPE. We can see clearly that Iran has the highest RMSPE ratio. For Iran, the post-2012 sanctions gap is about 9 times larger than the pre-2012 sanctions gap. If one were to randomly select a country from the sample, the probability of obtaining a ratio as high as Iran would be 1/13 (0.07).

Figure 3. Ratio of post-2012 sanctions RMSPE to pre-2012 sanctions RMSPE: Iran and control countries

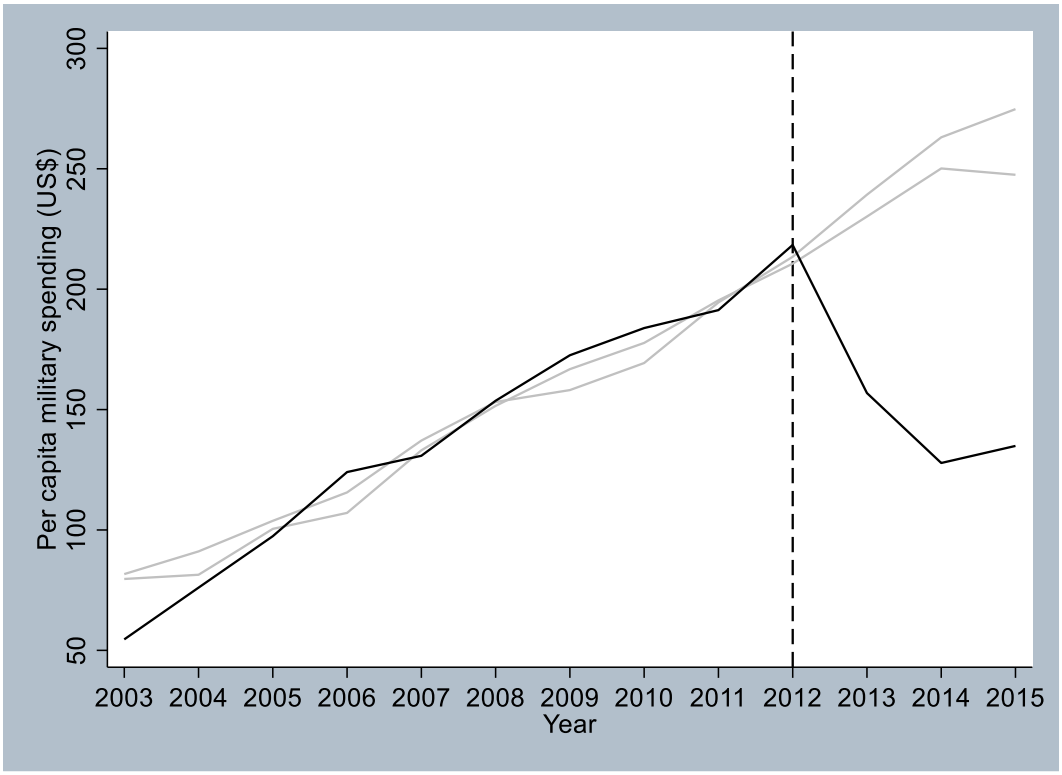


3.2. Robustness Check

We check to ensure that our main results in Figure 1 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 excluded 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 Angola 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 Ecuador received the highest unit weight. Then, we drop Ecuador besides Angola 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 (2*6.48=12.97). We reached this after second iteration in our case. Figure 4 displays the results, incorporating the leave-one-out estimates (gray lines). This figure shows that the results of the earlier estimations are robust to the exclusion of any important country from our sample of donor countries.

Figure 4. Leave-one-out distribution of the synthetic control for Iran



4. Conclusion

We employed the synthetic control method to study the effects of the international sanctions from 2012-2015 on military spending of Iran. We find a significant negative effect when comparing Iran with its synthetic counterpart. Over the entire 2013–2015 period, per capita military spending was reduced by about 119 US$ per year on average, which amounts to approximately 54% of the 2012 baseline level. In 2015, per capita military spending in the synthetic Iran is estimated to be about 69% higher than in the actual Iran.

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