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Abstract

Existing research has pointed to the decreasing effect of revolutions and wars on income inequality. It is unclear whether this reduction is the result of ongoing changes within countries before revolutions and wars or if the results are standalone effects. In this study, we focus on the case of the Iranian Revolution of 1979 and the subsequent Iran-Iraq war from 1980 to 1988. We use the synthetic control method to study the effect of revolution and war on changes in income inequality levels. Had there been no revolution and war in Iran, how would income inequality have developed? Utilizing the synthetic control method, we created a counterfactual Iran that reproduces the socioeconomic characteristics of Iran before the Islamic revolution. Then we compare the income inequality of the counterfactual Iran, without the revolution and war, to the factual Iran with a new political regime, for the period of 1970-1988. Our results, based on two different indicators of Iran's Gini, show a statistically significant effect of the revolution and war on reducing income inequality. Over the entire 1979–1988 period, on average and per year, the Gini index of Iran was reduced by approximately 3 times of the standard deviation of this index. The main findings are robust to a series of placebo tests.

JEL-Codes: D630, D740, H560, Q340.

Keywords: income inequality, war, revolution, Iran, synthetic control, counterfactual.

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1. Introduction

Social scientists have noted that social revolutions and wars have resulted in reductions in the levels of income inequality (Beissinger, 2022; Scheidel, 2018). Scholars have also argued that revolutions and wars themselves are often the result of ongoing social and economic transformations in the society and state (Beck, 2020; Goldstone, 2014). If revolutions and wars are themselves the outcome of ongoing changes in the society, how could we then assess the independent effect of revolutions on changes in the level of income inequality? To address this puzzle, we use the synthetic control method to assess the joint effect of the revolution and war in Iran on its level of income inequality.

The Iranian revolution began in January 1978 as a series of urban riots, demonstrations, and strikes and led to the fall of the Pahlavi monarchy in February 1979. It is estimated that about 10 percent of Iran's population participated at least in one of the protests that led to the fall of monarchy. Such estimates make the Iranian revolution a paradigmatic case of revolutionary movements with one of the highest participation rates in the 20th and 21st centuries (Chenoweth and Stephan, 2012; Kurzman, 2004). In about a year since the fall of the monarchy, Iraq's invasion of Iran's southwest borders resulted in an eight year war, one of the longest interstate wars of the 20th and 21st century. As Walt (1997) explains, it is quite common for social revolutions to overlap with wars. Since revolutions change the regional balance of threats, post-revolutionary situations are very likely to lead to interstate warfare.

Both indicators of income inequality in Iran which we employ in our study, the Gini index based Estimated Household Income Inequality Data Set ("EHII") or the Gini index based on the Standardized World Income Inequality Database ("SWIID"), show a reduction in Iran's income inequality in the post-revolutionary period. Nonetheless, a major question remains about what has driven this change. Would we have observed a similar reduction in the level of income inequality if Iran had not gone through a revolution and a war? We address this question by using the synthetic control method (SCM), developed by Abadie and Gardeazabal (2003) and extended by Abadie, Diamond, and Hainmueller (2010, 2015), estimating the causal joint effect of a regime change and war on income distribution in Iran. By extending the idea of difference-in-difference in various ways, synthetic control provides a helpful approach to case studies with a small number of countries (Hodler, 2019). [1]

We show that the trajectories of income inequality by the factual Iran and the counterfactual, or synthetic, Iran were largely similar before the revolutionary protests in 1978, but diverged significantly after the revolution and during the war with Iraq. Our estimates, based on both inequality measurements, show that the average annual reduction of the Gini index in Iran was approximately 3 times the standard deviation during 1979-1988 period, which is a sizable effect. This finding makes at least two important contributions. First, this is the first analysis on the effects of revolutions and wars on income inequality

[1] For a review of the distinct advantages of SCM, which according to Athey and Imbens (2017) is "… the most important innovation in the policy evaluation literature in the last 15 years," see Abadie (2021).

that uses the synthetic control method. Second, while there are studies on the effects and determinants of income inequality in post-revolution Iran period (see Farzanegan and Alaedini, 2016 and Salehi-Isfahani, 2009), there is no study on the causal effect of the revolution and war on the distribution of income in Iran. This is the first study which uses the synthetic control method to generally examine and quantify the impact of a revolution and war on income inequality and particularly, the effect of the 1978-79 revolution and subsequent war on income inequality of Iran.

Why did the war and revolution result in a significant reduction in Iran's income inequality? While our data on Iran's Gini does not allow for a quantitative analysis of the possible mechanisms, we rely on existing accounts of the Iranian economy during the revolution and war as well as other relevant sources of data to present a discussion of the mechanism driving this change. Overall, our discussion suggests that the revolution and war reduced the level of income inequality in Iran through their negative effects on the highest income earners in the country, rather than elevating the bottom income strata.

This finding also makes a contribution to quantitative studies of contentious politics in the Middle East that have been once again flourishing after the Arab spring. These studies have explored the drivers of protest, repression, and their interaction in general (Barrie and Ketchley, 2018; Berman, 2021; Ketchley, 2017; Khawaja, 1993; Rasler, 1996). There are also a few studies that explore short term effects of protest on outcomes such as electoral patterns and attitudes about democracy (El-Mallakh 2020; Ketchley and El-Rayyes 2019; Mazaheri and Monroe 2018). We advance this part of the literature by documenting the effect of contentious politics on changes in the levels of income inequality as one of the most structural outcomes for contentious collective action.

This study is structured as follows: Section 2 presents a review of related literature on the effects of wars and revolutions on the distribution of income. Section 3 explains our data and empirical methodology. The main results, robustness and sensitivity checks are presented and discussed in Section 4. We discuss further the possible mechanisms for the effects of revolution and war on income inequality of Iran in Section 5. Section 6 concludes the study.

2. Review of literature on income inequality, war, and revolution

Social scientists from different disciplines and through various methodologies have inquired and debated the drivers of income inequality within and across countries. One approach adopting cross-national analysis emphasizes the internal characteristics of countries such as population growth, percent of the labor force in agriculture, and school enrollment as the main correlates of income inequality (Alderson and Nielsen 1999, 2002). Another approach has investigated the external environment of countries, particularly in the context of globalization and foreign direct investment as a main driver of income inequality between countries (Alderson and Nielsen, 1999; Lee, Nielsen, and Alderson, 2007; Dorn et al., 2021).

A third approach to income inequality emphasizes the institutional context in each country as the main shaper of income inequality within countries. In this approach, scholars have debated whether democratization would decrease income inequality. While earlier theories expected a negative effect for democracy on income inequality, more recent studies indicate that the effect of democracy on inequality is only conditional, and under certain conditions high levels of income and wealth inequality may coexist with democratic rule (Acemoglu et al., 2015; Scheve and Stasavage, 2017). Nonetheless, states are able to decrease income inequality through taxes and transfers. Research on income inequality within industrial and post-industrial democracies contend that leftist parties backed by unions have promoted social policies that redistribute wealth through social security, health, education, and other social safety nets (Bradley et al., 2003; Huber et al., 2006; Huber and Stephens, 2012; Kerrissey, 2015).

A fourth approach to income inequality contends that the most considerable and impactful reductions in inequality throughout history happened through violent outbursts such as plagues, state failure, wars, and revolutions. Violent events, such as plagues or state failure, are among the shocks that have brought down inequality in the pre-modern period (Scheidel, 2018). Existing research also point to the reducing effect of natural disasters on income inequality in modern time (Keerthiratne and Tol, 2018). However, the effect of revolutions and wars on income inequality is only a recent phenomenon. In her comparative analysis of French, Russian, and Chinese revolutions, Skocpol (1979) argued that these revolutions have resulted in more egalitarian societies. Later, Eckstein (1982), through a comparative analysis of Mexican, Bolivian, and Cuban revolutions from below and the Peruvian revolution from above, concludes that these revolutions resulted in more egalitarian societies, although the gains by low-income groups were highest in the consolidation phases of the revolutionary regimes. Later, popular interests were sacrificed to the middle and upper classes. The factor affecting land and income distribution the most is the mode of production adopted by the revolutionary regimes. To the extent that the economy is socialized, the state has gained more power in reallocating the surplus generated in the economy. As historical data about income inequality levels have recently become available, scholars have presented more detailed and better empirically-supported versions of this argument. Scheidel (2018) documents that through coercive policies such as seizing land, collectivizing private firms, organizing production through state allocation, persecuting the bourgeoise, and *dekulakization*, the Russian revolution reduced the level of income inequality in the country. The Chinese communists also were able to reduce inequality through violent crackdowns on the landowning class, land seizure and redistribution, and the expropriation of urban industries. Similar results were achieved by other revolutionary communist governments or ones that were established through soviet occupations after World War II.

Similar to revolutions, wars that mobilized citizens on a massive scale have also brought down income inequality through different mechanisms such as the physical destruction of wealth, inflation (which devalues wealth), rent control, the nationalization of industries, and adoption of progressive taxation. High taxes and progressive taxation specifically were introduced in Europe, the US, and Japan as part

of the war efforts during the World Wars (Obinger and Petersen, 2017; Scheidel, 2018). A cross-national analysis of four countries that mobilized during World War I and four countries that did not support the argument that mobilization for war led to the demand for and subsequent increased taxation of the wealthy in the mobilizing countries. As the commoners were sacrificing their lives on the war front, an expectation emerged for the wealthy to pay for the costs of the war. This led to the emergence of a new social pact at the advent of the World Wars. At the individual level, also, survey data shows a significant increase in support for higher tax rates for the wealthy after the Pearl Harbor attack in the US (Scheve and Stasavage, 2010). Similarly, a difference-in-difference cross-national analysis of top marginal tax rates in 19 countries from 1816 to 2000 shows that war mass mobilization contributed to the progressive taxation of inheritance, while the extension of suffrage did not have much of an effect on taxation (Scheve and Stasavage, 2012).

The reducing effects of revolutions and war on income inequality are both modern phenomena of the 20th century, as pre-modern wars or rebellions did not occur at the same intense and massive scales. Accordingly, the bulk of the scholarship on the effects of war has focused on the two World Wars, and the main studies have documented such effects for communist revolutions. Earlier revolutions, such as the French revolution, seem to have much more modest effects on income and wealth inequality (Piketty, 2020; Scheidel, 2018).

The conclusions in the literature about the effect of revolutions on reducing income inequality is mostly based on observational data from the socialist revolutions of the 20th century. The argument about the effect of wars on income inequality also mostly relies on the effects of the two world wars. We extend this literature by examining the case of the Iranian revolution and its subsequent war with Iraq. Furthermore, for the first time, we rely on the synthetic control method to construct a counterfactual Iran that does not go through a revolution and war, to compare the level of inequality with the actual Iran that went through a revolution and war. Using this methodology helps us to advance the conclusions of the current literature beyond observational data and correlations.

The next section examines data and methodology to estimate the joint effect of the revolution and war on income inequality in Iran.

3. Data and method

Method

We use annual country-level panel data for the period of 1970–1988. Revolutionary protests including riots, anti-government demonstrations and strikes started in January 1978 peaked later during the year. Treating 1978 as a treatment year, our pre-treatment period in the SCM analysis covers 1970 to 1977.

The sample period in this study ends in 1988, which was the last year of war with Iraq. The post-revolution period (1979-1988) provides sufficient time to investigate the effects of the new administration's policies on the distribution of income in Iran.

The synthetic Iran is generated as a weighted average of potential control countries in the donor pool.[2] To have an unbiased estimate of the post-1978 inequality trajectory of Iran, we exclude countries which have had inter-state and intrastate wars or revolutions during the period of study. In our sample, these are Iraq (which was in war with Iran), Lebanon, Israel, Bolivia, Philippines and South Africa. In Bolivia, Philippines and South Africa, massive protests resulted in regime changes. Scholars of revolutions have noted that the revolution in Iran has served as a template for the popular uprising in the Philippines in 1986 (Parsa, 2000). The upheaval in Bolivia from 1978-1982 have not been described as a revolution, because the government eventually conceded to the opposition and held multi-party protests. In South Africa, the regime change happened after the period of our analysis. The outcome in South Africa has been described as a negotiated revolution (Lawson, 2004). As a result of protests and international pressure, the government and opposition engaged in negotiations from 1990-1994 (Kadivar 2018, 2022). They agreed on a constitution and free elections were held in 1994.

The donor pool, after excluding missing observations and countries with similar experiences of revolution or war, includes a sample of 18 countries: Bangladesh, Chile, Colombia, Denmark, Ecuador, Egypt, India, Kenya, Malaysia, Malta, Mexico, Netherlands, Norway, Pakistan, Republic of Korea, Singapore, Turkey, and Venezuela.

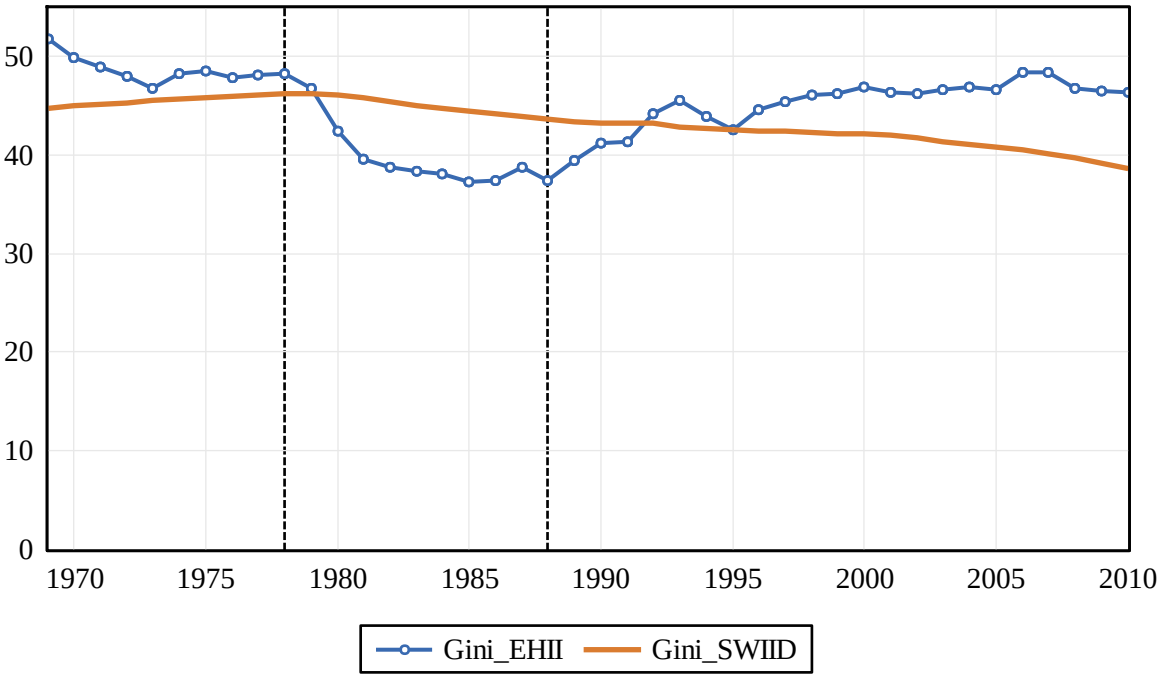
Outcome Variable

The outcome variable in the SCM analysis is the Gini coefficient, which is the most conventional measure of income inequality. A Gini coefficient varies from 0 (perfect equality) to 100 (perfect inequality). Our main choice for outcome of the analysis is Gini coefficients, which are taken from the Estimated Household Income Inequality (EHII) database compiled by the University of Texas Inequality Project (UTIP). Li and Dan Su (2021) provide a detailed comparison between different sources of data for the Gini index, such as the World Income Inequality Database (WIID, maintained and updated by UNUWIDER), the Standardized World Income Inequality Database (SWIID), and the World Bank's

[2] Due to limited data on income inequality especially during the period of analysis (1970-1988) for the Middle East & North Africa, we have not limited our donor pool to this region. Instead, we let the synthetic control approach select the best match for the factual pre-revolution Iran from a global sample. We exclude countries with major political shocks, as in the case of Iran during the period of analysis. The Synth algorithm for Stata needs complete data on the outcome of interest (Gini index) in time series for all countries in the dataset. It can, however, function with missing data on pre-intervention covariates, using the average or data from specific years before treatment. Countries with missing values for the outcome must be excluded unless the missing values are imputed. Imputation would need additional examination and adjustments for imputation errors, which is not done in our case for the sake of parsimony. See Bonander (2018) for a similar approach. To increase the number of countries in our investigation, we started at 1970.

PovcalNet and recommend using of EHII. One problem with WIID, which succeeds the dataset compiled by Deininger and Squire (1996), is the inclusion of mixed data (i.e. gross vs. net, household vs. individual, and income vs. expenditure data) in addition to limited frequency of observations. Gimet and Lagoarde-Segot (2011) also refer to technical concerns on the calculations of WIID. EHII, our first choice in this study, is fully comparable across space and time (Galbraith and Kum, 2005). Moreover, it is available for a large number of countries and a longer time period, which is important for our case study of Iran in 1970s and 1980s. EHII is estimated based on information from the Deininger-Squire data set with information from the UTIP-UNIDO dataset. The UTIP-UNIDO dataset includes measures of manufacturing wage inequality. EHII index is estimated by regressing the Deininger-Squire Gini indices on the UTIP-UNIDO Theil inequality measures, adjusting for a set of other control variables. The predicted values are used as the (estimated) Gini coefficients. This procedure aims to separate the useful and unclear information in the Deininger-Squire dataset (Galbraith and Kum, 2005). EHII is used in a larger number of studies such as Kim and Lin (2018), Gimet and Lagoarde-Segot (2011), Meschi and Vivarelli (2009) and Li and Dan Su (2021), among others. Despite its advantages, EHII is still an estimated measure of income inequality. Therefore, for robustness checks, we also use another alternative measure of the Gini coefficient (based on disposable income) from the Standardized World Income Inequality Database (SWIID) developed by Solt (2020). It uses information from the Luxembourg Income Study (LIS) and UNU-WIDER data and generates a larger dataset with more coverage across space and time. While there are some technical concerns about the imputation method in SWIID mentioned by Jenkins (2015), this Gini index has been also used in many observations such as Sturm and de Hann (2015) and Facchini et al. (2021), among others. The correlation coefficient between EHII and SWIID in the case of Iran between 1970 to 1988 is 0.65 and statistically significant at 1% level. Figure 1 shows the development of income inequality in Iran from 1969 to 2010. The EHII and SWIID Gini indices for our period of analysis (1970-1988) are consistent. Both show higher levels of income inequality before the revolution and a decline after the revolution and during the war. EHII shows an increase in inequality following the end of the war and the start of the reconstruction of the economy and the implementation of different structural adjustment policies in Iran, while SWIID still shows moderate decline. We also checked the Central Bank of Iran's Gini index, which shows a stagnant picture for this index after the war.

Fig. 1. Income inequality in Iran (higher numbers show higher levels of income inequality).



Source: EHII is from the University of Texas Inequality Project (Galbraith and Kum, 2005) and SWIID is from Solt (2020).

Predictors

The inclusion of covariates and predicators of our outcome of interest in the pre-intervention period helps to find a counterfactual which is structurally more similar to Iran during the period of analysis. As also mentioned by Bonander (2018) and Doudchenko and Imbens (2016), among these covariates, the strongest predicators, which also need fewer assumptions on their data generation process, are observed the pre-intervention outcome (Gini index). Pre-intervention outcomes tend to receive the highest importance weight in SCM analysis, making the inclusion of covariates in SCM less necessary as long as there is a perfect match on the pre-intervention outcome (Botosaru and Ferman, 2019).

For the pre-1978 revolution characteristics, we use a selected set of covariates from the literature on inequality: logarithm (log) of real GDP per capita, general government final consumption expenditure (% of GDP), life expectancy, population growth rate (%), fertility rate, and urban population (% of total population).[3] Real GDP per capita controls for any distributional effects due to different development levels of countries. The link between economic development and income inequality over time is shown by Berg et al. (2012), among others. Demographic structures may also influence income inequality measurements. We control for fertility rates, population growth rates and the share of urban population

[3] We also examined the specification with further predicators. While the estimated results remain robust, this set of predicators resulted in lower Root Mean Squared Prediction Errors.

in the total population. Countries with higher fertility rates and dependent citizens are usually associated with more income inequality and higher demand for more redistribution policies (Dorn et al., 2021). Moreover, there is a negative relationship between high fertility rates and educational attainments and human capital. The latter is a critical factor in explaining the cross-country variation in inequality. Cervellati and Sunde (2017) present a theoretical review of the association between demographic structures and development outcomes. Countries with better health conditions and perspectives captured by higher life expectancies may encourage more spending on education and lower levels of income inequality. We also control for the government spending as a share of GDP. There is extensive discussion on the positive or negative association between government spending and income inequality. Anderson et al. (2017) present findings of a meta-regression analysis on the effects of government spending on income inequality, focusing on low- and middle-income countries.

All data are from the World Development Indicators by the World Bank (2021). Finally, to increase the goodness of fit of the counterfactual Iran with the factual Iran during the pre-1978 revolution period, we control for the past records of income inequality in years 1976, 1974, 1972 and 1970. As suggested by Kaul et al. (in press), we are not employing all the lags of income inequality as predictors because that can eliminate the significance of other control variables and generate bias in the estimated effect of treatment.

Our identification strategy based on the SCM uses countries in the donor pool in order to generate a counterfactual picture of Iran in the post-revolution period. The assumption is that different countries share different degrees of similarities with Iran and thus can contribute in building a synthetic Iran. This approach assigns optimum weights ω_d for each country *d* in the donor pool, assuming that $0 \leq \omega_d \leq 1$ and $\sum_{d=1}^{D} \omega_d = 1$. Pre-treatment information of the outcome variable (income inequality) Y_t and additional predictors Z_t, which are shown to be relevant explanatory variables for income inequality, are used by the SCM to find the best possible counterfactual picture of Iran before the 1978 revolution. The counterfactual Iran is identified by selecting weights ω_d such that $Y_t - \sum_{d=1}^{D} \omega_d^* Y_{dt}$ and $Z_t - \sum_{d=1}^{D} \omega_d^* Z_{dt}$ are minimized for the years before the 1978 revolution ($t < 1978$). The joint effect of the 1978 revolution and subsequent war with Iraq on income inequality $\alpha_t$is calculated as $\alpha_t = Y_t - \sum_{d=1}^{D} \omega_d^* Y_{dt}$ for $t > 1978$.

The effect of the Islamic revolution and war with Iraq on income inequality is the difference between the factual Iran's income inequality and its estimated counterfactual income inequality had the Iranian revolution and war not happened over the period of 1979-1988

4. Results

Table 1 shows that the synthetic Iran is best generated by a weighted average of four countries with Kenya (64 %), Chile (16.8 %), Singapore (11 %) and Turkey (8.2 %) having the highest weights.[4] Table 2 shows the average pre-1978 values of the covariates for the factual Iran and the synthetic Iran. The synthetic Iran closely reflects the pre-1978 performance of the income inequality (based on EHII Gini) covariates of the factual Iran. The synthetic Iran is perfectly similar to the factual Iran in terms of pre-1978 income inequality. As the column 5 in Table 2 shows, the gap between the EHII Gini indices of the factual Iran and its estimated counter-factual is zero. In addition, there is a perfect match between some of the covariates and predicators of income inequality between the factual and counter-factual Iran, such as population growth rates and fertility rates. There are some minor differences for other covariates. However, as is shown by Botosaru and Ferman (2019), an accurate balance on covariates may not be required for the synthetic control method as long as there is a good match on outcomes prior to the treatment. Also note that the optimization process assigns variable weights based on the predictive power of each covariate. Thus, poor predictors of the outcome will receive less importance in the matching process (Bonander, 2018).

To highlight that there would be significant differences if one does not construct the correct weights, in addition to the data on the factual and synthetic Iran and their differences, Table 2 shows the information on the unweighted average of variables for countries with weights > 0 (Kenya, Chile, Singapore, and Turkey), excluding Iran, and countries with weights of 0, during 1970-1977. We observe in column 6 that there is a considerable difference especially in terms of the predicted outcomes (income inequality) between factual Iran and its counterfactual (without considering the optimum weights). This increases our confidence in the application of the SCM approach in the generation of the factual Iran before the revolution. It shows that the unweighted donor pool presents a weak counterfactual, at least in terms of preintervention outcomes (Gini index).

[4] In sensitivity analysis, we ensure that the main findings are not produced as a result of single influential country in the synthetic control unit.

Table 1. Country weight in synthetic Iran

Country	Weight
Bangladesh	0
Chile	0.168
Colombia	0
Denmark	0
Ecuador	0
Egypt	0
India	0
Kenya	0.64
Malaysia	0
Malta	0
Mexico	0
Netherlands	0
Norway	0
Pakistan	0
Republic of Korea	0
Singapore	0.11
Turkey	0.082
Venezuela	0

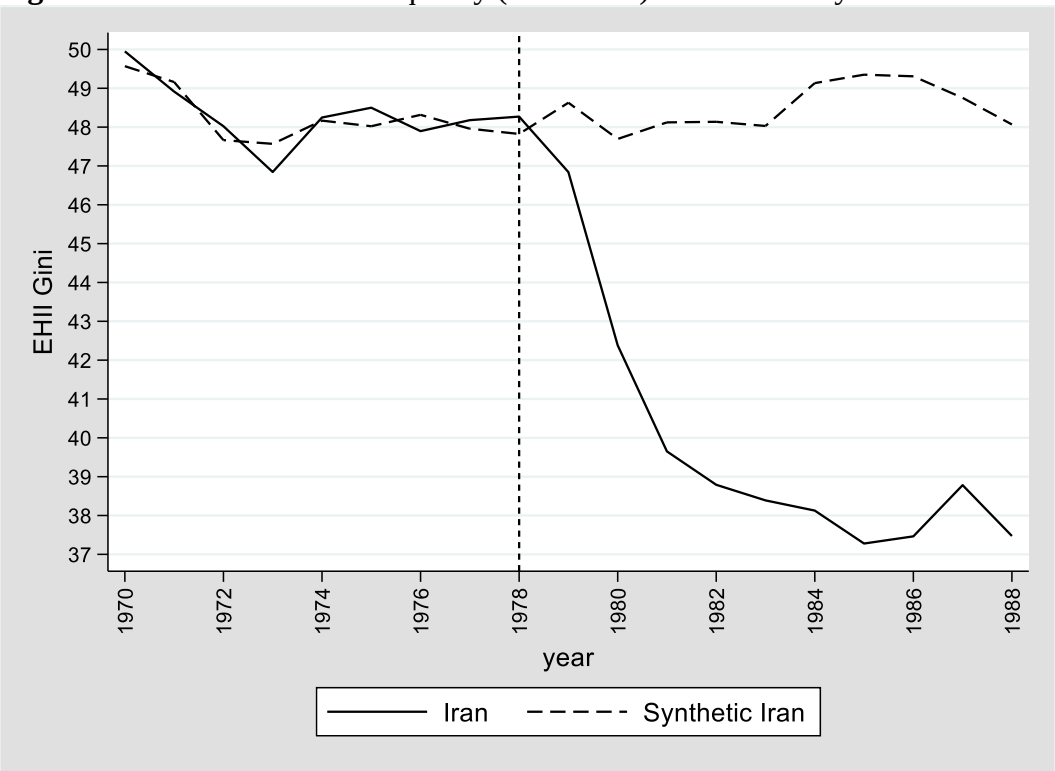
Table 2. Predictor balance during the pre-treatment period (1970-1977)

	Iran (1)	Synthetic Iran (2)	Unweighted average of variables for countries with weight >0 (3)	Difference (1-2)	Difference (1-3)
EHII Gini (1976)	48	48	45	0	3
EHII Gini (1974)	48	48	44	0	4
EHII Gini (1972)	48	48	45	0	3
EHII Gini (1970)	50	50	47	0	3
Log of GDP per capita	9	7	8	2	1
Government expenditures (% of GDP)	20	16	14	4	6
Life expectancy	54	58	61	-4	-7
Population growth rate (%)	3	3	2	0	1
Fertility rate	6	6	5	0	2
Urban population (% of total population)	44	35	58	9	-13

Figure 2 shows the income inequality trajectory of Iran and its counterfactual for the period of 1970-1988. The synthetic Iran is perfectly reproduces the picture of income inequality in pre-revolution Iran. The two lines diverge significantly post-1978 and during the Iran-Iraq war. While the income inequality of the factual Iran dropped in post revolution period, the trend of this index for the counterfactual Iran

remains stable and even increased during the war period. This result shows that like the previous socialist revolutions and wars mentioned in the literature, the Iranian revolution and subsequent war with Iraq also resulted in a remarkable decline in the level of income inequality in the country.

Figure 2. Trends in income inequality (EHII-Gini): Iran versus Synthetic Iran



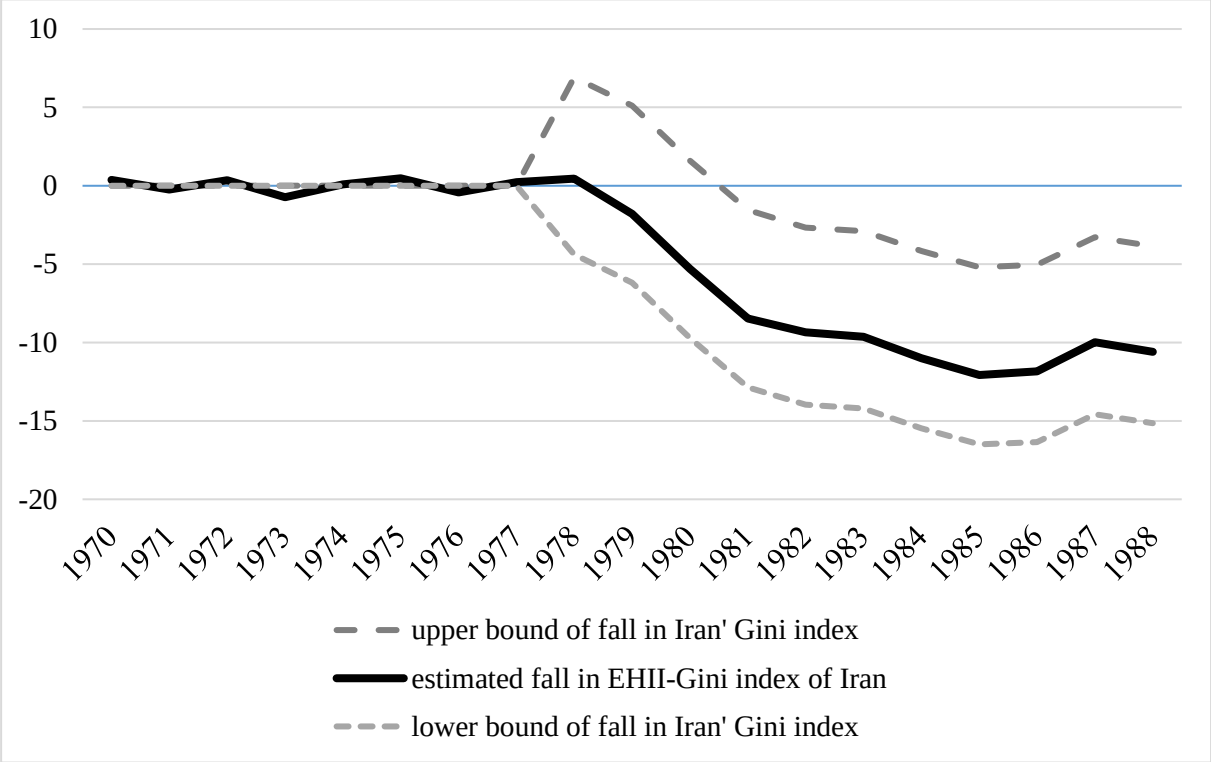
Note: Estimated Household Income Inequality Data Set (EHII) - is derived from the econometric relationship between UTIP-UNIDO, other conditioning variables, and the World Bank's Deininger & Squire dataset. For more details see Galbraith and Kum (2005).

The difference between the factual Iran and its counterfactual shows us the estimated joint effect of the revolution and war on income inequality as shown in Figure 3. We find that during the post-1978 revolution and war with Iraq, income inequality in Iran was reduced by approximately 9 units per year on average. This is a considerable fall in the income inequality of Iran as the standard deviation of EHII-Gini index in post 1978 period was 2.97 units. In the absence of a regime change from a monarchy to an Islamic Republic and war conditions, the average annual income inequality of Iran was approximately 9 units higher.

To what extent is the estimated gap between the income inequality of factual Iran and its counterfactual statistically significant? We follow a methodology developed by Firpo and Possebom (2018) and Ferman, Pinto, and Possebom (2020) and report lower and upper bounds (at approximately 95% confidence interval, which is the highest level of confidence intervals given the sample size of 19

countries) of the estimated gap in income inequality post-1978. We observe that the decreasing effect of the revolution and war on Iran's income inequality is statistically significant (the lower and upper bound exclude the zero line) from 1981 to 1988.

Figure 3. Income inequality (EHII-Gini) gap between Iran and synthetic Iran (with confidence intervals)



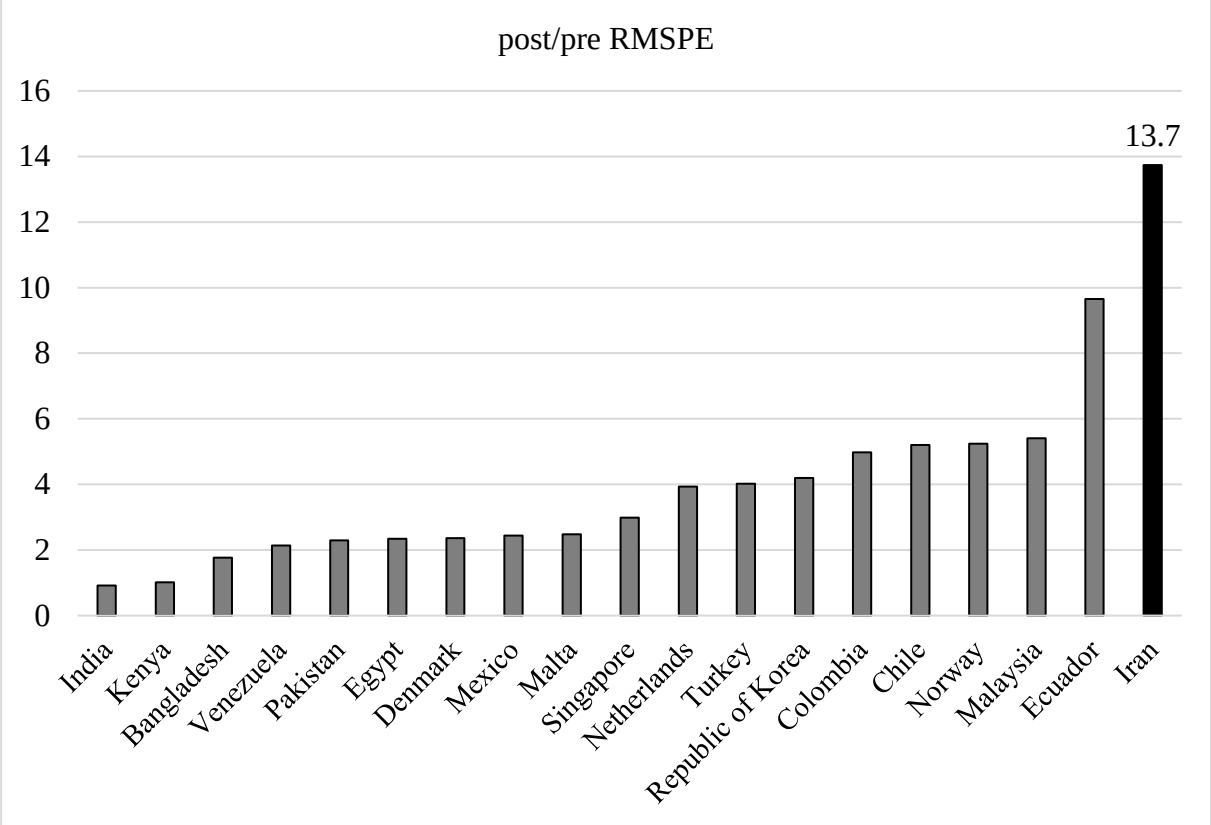
Placebo test

To investigate the reliability of the results, we implement placebo studies and reassign the treatment in the data to a comparable unit (Abadie et al., 2010, 2015). We conduct the synthetic control analysis for countries in the donor pool which did not experience the same treatment as Iran. This strategy helps us to compare the estimated effects of the revolution and war on Iran' Gini index to the distribution of placebo effects on other countries. If the estimated effect for Iran is unusually high relative to the distribution of placebo effects, then we conclude that the joint effect of the Islamic revolution and war was significant.

A measure which can help provide an objective measure of comparison and ultimate conclusion is root mean square prediction errors (RMSPE). RMSPE measures the magnitude of the estimated gap in the income inequality between each country and its counterfactual. A large post-intervention RMSPE is not necessarily an indicator of a significant effect. We need to normalize the post-intervention RMSPE by the pre-treatment of this measure. In other words, we need to consider pre-intervention fit as well. Therefore, to have a reliable indicator, we divide the post-1978 RMSPE by pre-1978 RMSPE.

Figure 4 presents this ratio for Iran and other countries in the donor pool. It is clear that Iran is the country with the highest value for this ratio. For Iran, the post-1978 income inequality gap is approximately 14 times larger than the pre-1978 revolution gap. If one were to randomly select a country from the sample, the likelihood of observing a ratio as high as Iran would be 1/19 (≈ 0.05), meaning that there is no other placebo which outperforms or equals the effect estimate for Iran when pre-intervention fit (RMSPE) is accounted for. In other words, it is unlikely that one would gain a comparable effect as in Iran by randomly assigning the treatment to a non-treated country from the donor pool.

Figure 4. Ratio of post-1978 revolution RMSPE to pre-1978 RMSPE: Iran and control countries



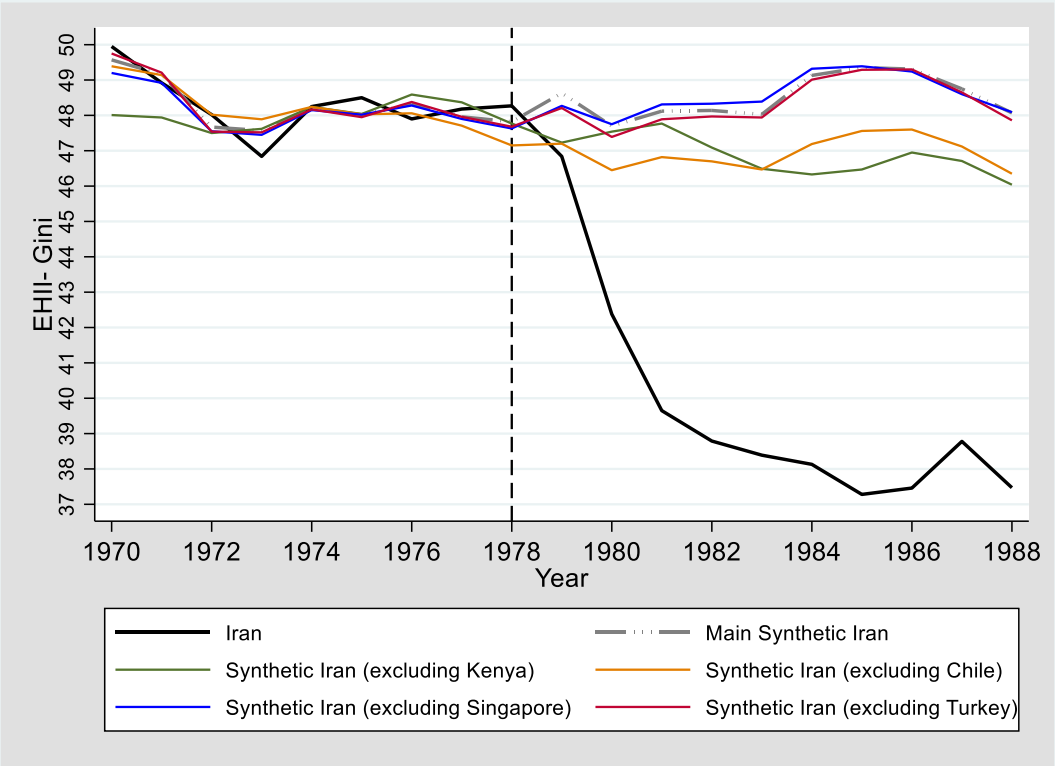
Robustness check: leave-one-out

Is our main finding in Figure 2 sensitive to the inclusion of specific countries from the list of donor countries? To examine the robustness of our results and to ensure that the obtained results are not attributed to a single country in the synthetic control unit, we implement a *leave-one-out* analysis. In this robustness test, the most influential countries are respectively excluded from the donor pool. The main countries which contributed in building the synthetic Iran in our main analysis are Kenya (64 %), Chile (16.8 %), Singapore (11 %), and Turkey (8.2 %).

The *leave-one-out* analysis generates four other synthetic versions of Iran, in addition to the main synthetic version. These counterfactual versions of Iran are estimated after excluding Kenya, Chile,

Singapore, and Turkey, respectively. Figure 5 illustrates that the income inequality of the additional counterfactual versions have considerable gaps compared with the factual Iran.

Figure 5. Leave-one-out distribution of the synthetic control for Iran



Compared with its main synthetic version, this average annual gap is -9 units. The gaps in the average annual EHII Gini index after excluding Kenya, Chile, Singapore, and Turkey are -7.3, -7.4, -9.05, and -8.83, respectively. Thus, we can conclude that the main finding is not sensitive to the exclusion of any particular country from the sample of the donor pool. In all cases, the calculated gap in the income inequality of the factual Iran and its counterfactual in the post-1978 period is significant.

Table 3. Gap between EHII-Gini index of factual Iran and its different synthetic versions in leave-one-out analysis

Year	Gap in main model	Gap in model without Kenya	Gap in model without Chile	Gap in model without Singapore	Gap in model without Turkey
1970	0.38	1.94	0.56	0.75	0.20
1971	-0.25	0.98	-0.22	0.00	-0.30
1972	0.36	0.53	0.01	0.47	0.48
1973	-0.72	-0.77	-1.05	-0.60	-0.68
1974	0.08	0.00	0.00	0.10	0.08
1975	0.48	0.46	0.47	0.48	0.55
1976	-0.42	-0.70	-0.17	-0.38	-0.48
1977	0.22	-0.19	0.47	0.28	0.22
1978	0.45	0.50	1.12	0.64	0.59
1979	-1.79	-0.39	-0.35	-1.43	-1.37
1980	-5.31	-5.15	-4.06	-5.36	-5.01
1981	-8.47	-8.12	-7.17	-8.66	-8.24
1982	-9.35	-8.30	-7.91	-9.54	-9.18
1983	-9.64	-8.10	-8.08	-10.00	-9.55
1984	-11.01	-8.20	-9.06	-11.19	-10.88
1985	-12.07	-9.19	-10.28	-12.12	-12.01
1986	-11.84	-9.48	-10.14	-11.77	-11.84
1987	-9.97	-7.93	-8.34	-9.82	-9.86
1988	-10.60	-8.57	-8.88	-10.62	-10.38
Average gap (1979-1988)	-9.00	-7.34	-7.43	-9.05	-8.83

Alternative measure of income inequality

To examine our conclusion based on EHII- Gini information, in this section we use an alternative Gini index source from the Standardized World Income Inequality Database (SWIID) (Solt, 2020). We use a Gini coefficient for disposable income which considers the level of inequality after taxes and subsidies. As discussed by Krieger and Meierrieks (2019), the disposable Gini index is the kind of inequality actually experienced by the population. It also shows how government redistribution policies have shaped income inequality within a society over time. There are numerous advantages in using of SWIID, such as greater coverage with respect to both time and space compared to other sources like the Luxembourg Income Study (Ferreira, Lustig, & Teles, 2015). According to Solt (2009), standardization of inequality data permits more consistent cross-country research. However, the SWIID's use of imputation methods to increase its coverage and comparability can reduce its reliability, especially in developing countries (Ferreira et al. 2015). For this reason, we used EHII Gini data from University of Texas Inequality Project (UTIP) (Galbraith and Kum, 2005) in our main analysis, which does not rely on imputation methods and thus is expected to be more reliable than SWIID (Krieger and Meierrieks, 2019). In our case study of Iran, there is a positive and significant correlation between SWIID and EHII Gini coefficients for the period of 1970 to 1988 ($r = 0.64$, $p < 0.01$). By using SWIID data, estimation of the SCM shows that the synthetic Iran which perfectly reproduces the outcome of interest (SWIDD disposable Gini index) of the factual Iran in selected years before 1978 is generated by Chile (88.3%), Sri Lanka (10%) and Brazil (1.7%).

Figure 6 shows the disposable income inequality trajectory of Iran and its synthetic for the period of 1970-1988. The synthetic Iran based on alternative measure of inequality perfectly reproduces the situation of inequality in the factual Iran before revolution and war with Iraq. This shows that the trends of inequality in Iran and its synthetic significantly deviate after 1978. The results support our earlier finding using the EHII Gini index. As in our earlier analysis, we also report the confidence intervals of the estimated inequality gap between Iran and its synthetic post-1978 in Figure 7.

We observe that an average fall in Iran's income inequality based on SWIID data is approximately 3 units. The economic size of this estimated fall is comparable to the results obtained using the EHII index. The standard deviation of SWIID Gini index for Iran post-1978 is 0.93. Therefore, the estimate annual fall of 3 units (on average) is approximately 3 times of the standard deviation of this index in the post-revolution period (this is comparable to the average reduction of 9 units using EHII data with a standard deviation of 3). The calculated confidence intervals at (95% level) show the estimated fall is statistically significant in the second half of eight-year war with Iraq.

Figure 6. Trends in income inequality (SWIDD -Gini): Iran versus Synthetic Iran

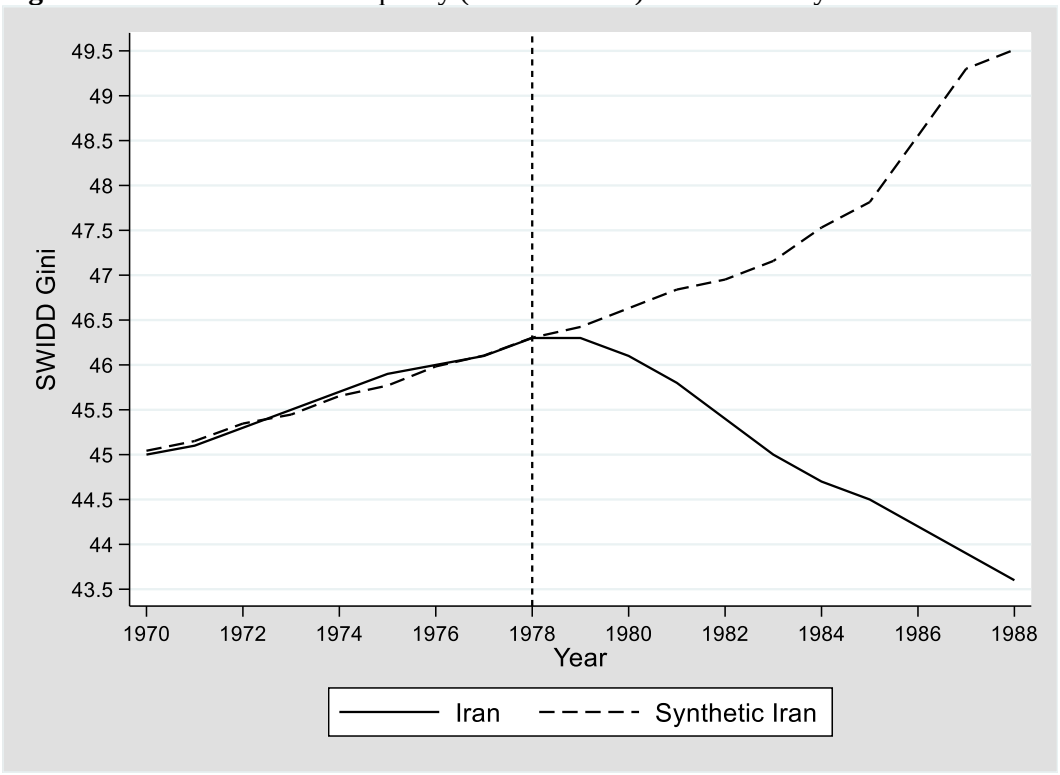
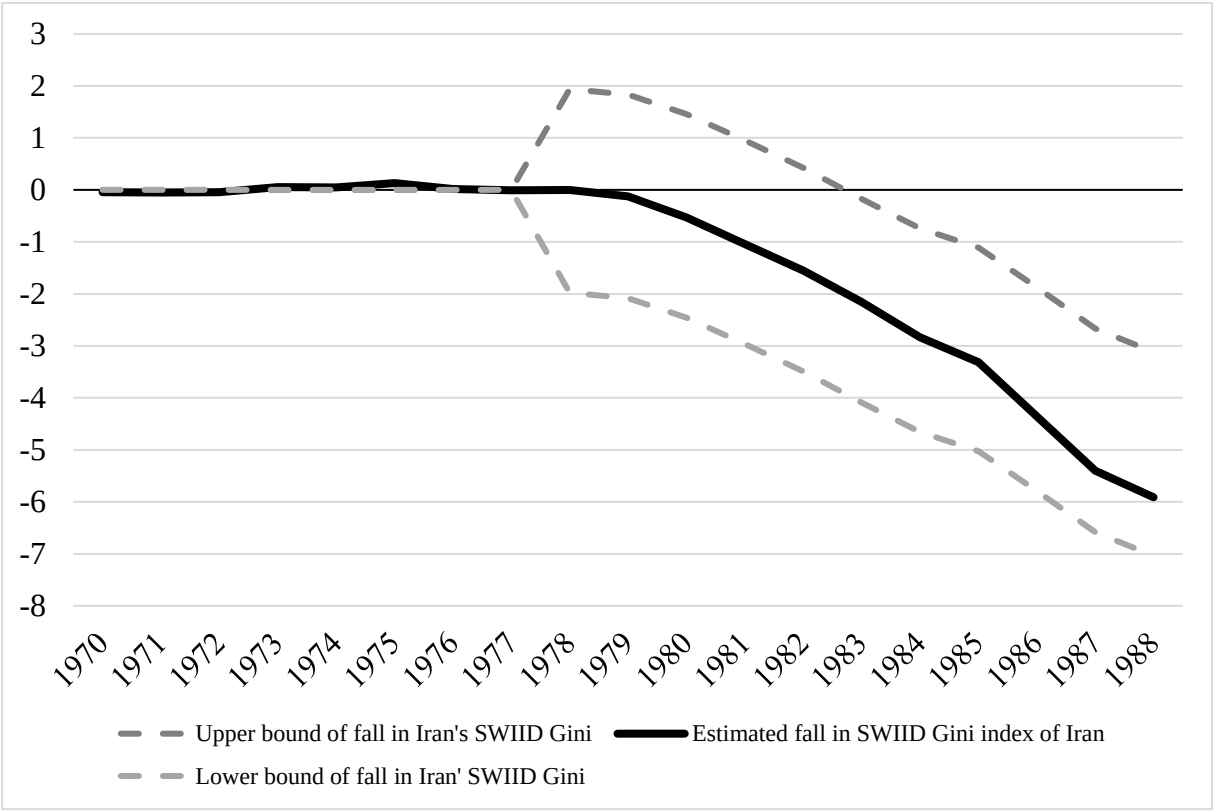


Figure 7. Income inequality (SWIID-Gini) gap between Iran and synthetic Iran (with confidence intervals)

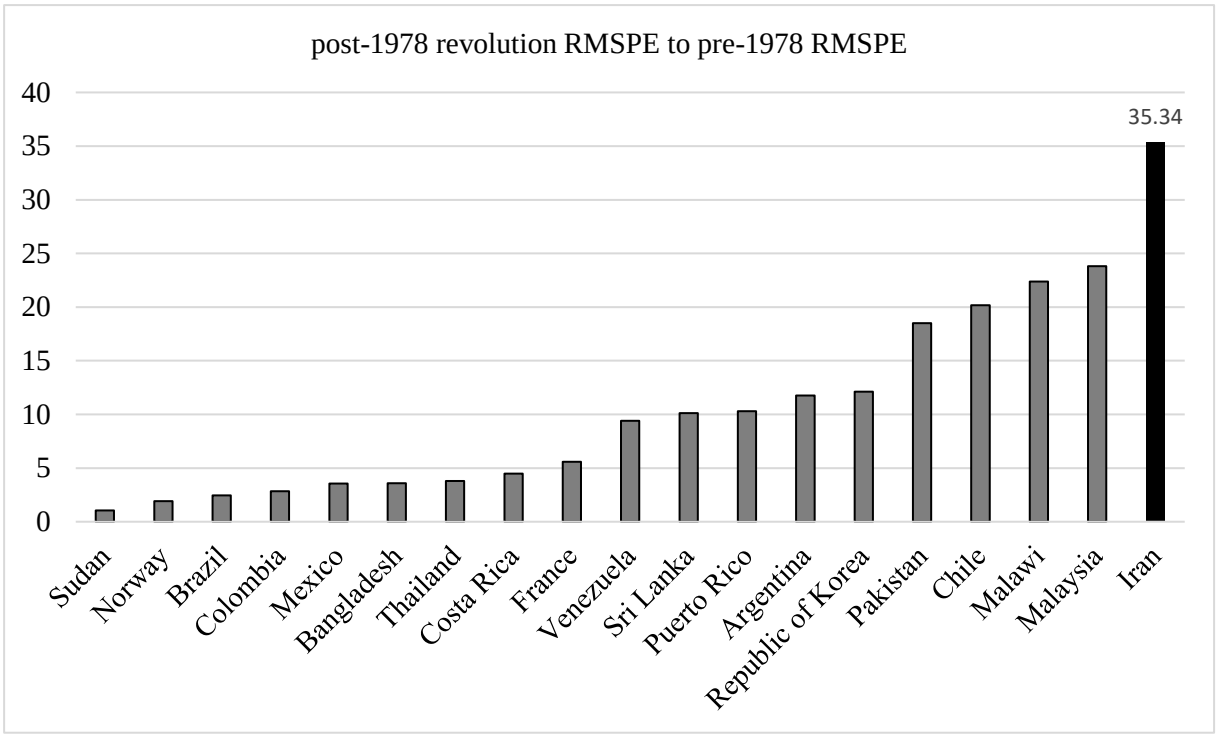


For the placebo test, we reexamine the synthetic control estimations for countries in the donor pool which did not experience the same treatment as in Iran. This procedure is explained in earlier sections.

Figure 8 presents the ratios of the post-1978 revolution RMSPE to pre-1978 RMSPE for Iran and other countries in donor pool. As in previous estimations, it is clear that Iran is the country with the highest ratio, using the alternative measure of income inequality (SWIID).

For Iran, the post-1978 income inequality gap is approximately 35 times larger than the pre-1978 revolution gap. If one were to randomly select a country from the sample, the likelihood of observing a ratio as high as Iran would be 1/19 (≈ 0.05). As in earlier results, even with using of SWIID-Gini data, it is unlikely that one would gain a comparable effect as in Iran by randomly assigning the treatment to a non-treated country from the donor pool.

Figure 8. Ratio of post-1978 revolution RMSPE to pre-1978 RMSPE: Iran and control countries (SWIID-Gini)



Finally, we check if our main results in Figures 6 and 7 are sensitive to the inclusion of a specific country from the list of donor countries. The main three countries which generated a synthetic Iran based on the SWIID-Gini index are Chile, Sri Lanka, and Brazil. We conduct *leave-one-out* analysis and exclude each of these three countries respectively from the SCM analysis. In the end, we compare the Gini gap between Iran and its counterfactual based on the full sample and three other samples which exclude the main contributors to the synthetic Iran. If the estimated gap remains, we can be more confident on the

obtained results and their robustness against the exclusion of influential countries from the donor pool. Figure 9 shows that the income inequality of the additional synthetic versions of Iran using SWIID data have considerable gaps compared with the factual Iran.

Figure 9. Leave-one-out distribution of the synthetic control for Iran (SWIID-Gini)

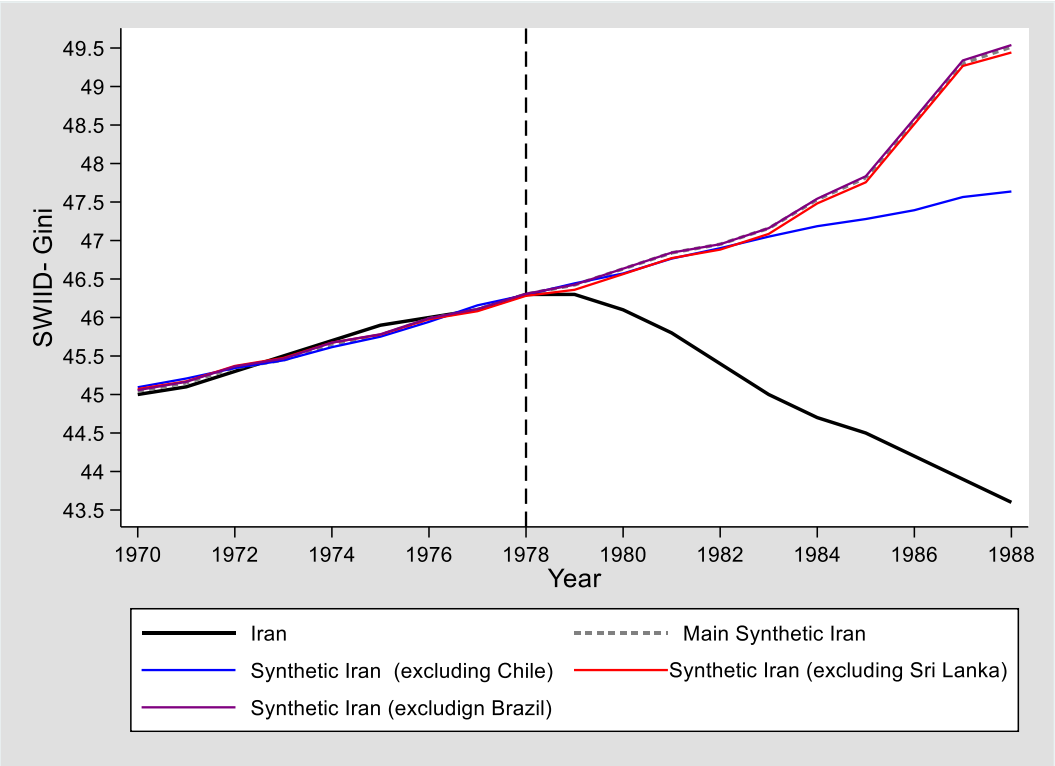


Table 4 summarizes the estimated gap in income inequality of Iran based on the SWIID dataset with the main synthetic (including all 18 countries selected to contribute to the synthetic version) and three other samples (which respectively excludes the main three contributing countries in the main results). The average annual gap in the post-1978 period is comparable across these alternative synthetics. Thus, we can conclude that the main finding is not sensitive to the exclusion of any particular country from the sample of the donor pool.

Table 4. Gap between SWIID-Gini index of factual Iran and its different synthetic versions in leave-one-out analysis

Year	Gap in main model	Gap in model without Chile	Gap in model without Sri Lanka	Gap in model without Brazil
1970	-0.04	-0.09	-0.07	-0.06
1971	-0.05	-0.11	-0.07	-0.06
1972	-0.05	-0.04	-0.07	-0.06
1973	0.05	0.06	0.03	0.04
1974	0.05	0.08	0.03	0.03
1975	0.13	0.15	0.12	0.12
1976	0.02	0.06	0.02	0.01
1977	-0.01	-0.06	0.02	-0.01
1978	0.00	0.01	0.02	-0.01
1979	-0.12	-0.14	-0.06	-0.13
1980	-0.53	-0.47	-0.46	-0.53
1981	-1.04	-0.97	-0.97	-1.04
1982	-1.55	-1.50	-1.48	-1.55
1983	-2.16	-2.05	-2.09	-2.16
1984	-2.83	-2.49	-2.78	-2.84
1985	-3.31	-2.78	-3.26	-3.33
1986	-4.35	-3.19	-4.31	-4.38
1987	-5.40	-3.67	-5.37	-5.44
1988	-5.91	-4.04	-5.84	-5.94
Ave. annual gap in SWIID Gini of Iran and its counterfactual (1979-1988)	-3	-2	-3	-3

Drivers of income inequality reduction in post-revolutionary Iran

A limitation in our study is that we are not able to show quantitatively which parts of the country's income distribution disproportionately gains or loses following the revolution and during the war, resulting in a change in the Gini index. Some studies such as Dorn et al. (2021) have used data on the relative net income shares of the Global Consumption and Income Project by Lahoti et al. (2016). However, this dataset is not useful for our analysis of Iran. Due to using interpolation methods for missing country-year observations, their data on the Gini of Iran and relative income shares in population are constant numbers for years before 1988 and their inequality indicators only begin to show variation after this date. For example, it shows constant Gini index values (income inequality) of 0.60 and of 0.47

(for consumption inequality) for Iran during the entire pre-1987/88 period, which is not correct based on other well-known datasets. To address this shortcoming, we rely on existing accounts of the Iranian economy around the time of the revolution, as well as other sets of data specific to Iran, to shed light on what specific changes to different income groups drove this reduction in Iran's Gini.

The 1978-79 revolution happened in Iran after a decade of economic growth. According to the World Bank (2021), the average annual gross domestic product (GDP) growth rate in Iran between 1960-1969 was 9% and was 5.2% from 1970-1977. In the 1970s, the Pahlavi government enjoyed a large amount of oil revenues and the Iranian economy experienced 2-digit per capita growth rates (adjusted for inflation) in 1971, 1972, and 1975. Nonetheless, income distribution was initially not a priority for policymakers (Salehi Esfahani and Pesaran, 2009). The Gini index, based on estimated Household Income Inequality Data Set (EHII) by the University of Texas Inequality Project (Galbraith and Kum, 2005), show a worsening situation in the pre-revolution period. The worsening of income distribution in the years before revolution is also shown by other data sources such as the Standardized World Income Inequality Database (Solt, 2020) and Central Bank of Iran (Central Bank of Iran, 2021).

With the advent of the revolutionary movement in 1978, the fall of the monarchy in February 1979, and the Iran-Iraq war of 1980-1988, the economic situation completely changed. With instabilities created by revolutionary upheavals and the burdens of the war with Iraq, Iran went through a decade of lost income (Farzanegan, in press). Existing analyses of the Iranian economy at the time point to similar mechanisms in decreasing national income and reducing income inequality. Discussing the drivers of the post-revolutionary lost income, Iranian economists Hadi Salehi Esfahani and M. Hashem Pesaran (2009) wrote:

> "Many factors account for this decline, particularly the high political risks for private investors after the Revolution, the exodus of large numbers of skilled professionals, adoption of adverse economic policies, falling oil revenues, and the highly destructive war with Iraq."

We then find similar mechanisms discussed by Djavad Salehi-Isfahani (2017) in his description of the post-revolutionary reduction in Iran's Gini:

> "No doubt the Revolution had a lot to do with the fall in the Gini index, but not because of deliberate economic or social policies. Rather, the upheavals of the Revolution and the war with Iraq caused a disproportional decline in incomes at the top, properties were confiscated, richer families fled, and the war economy and rationing spread."

As Salehi-Isfahani notes, a main factor in reducing income inequality was the decline in the country's income and the subsequent damage to the highest earners in the country: both the capital owners and high-skilled laborers. The post-revolutionary government confiscated and nationalized many factories and large enterprises connected with the monarchy. The revolutionary tribunals executed a number of

capital owners under the charges of corruption and support for the monarchy, and the other capitalists that escaped persecution fled the country (Nomani and Behdad, 2006). A historical analysis also points to a reduction in the size of Iran's middle class in the post-revolutionary decade. Many white collar workers were fired, bought out, retired, or left the country (Farzanegan et al., 2021). For example, according to Iran's Statistical Yearbooks, the number of doctors as a main group of high-skill laborers decreased in Iran from more than 16,000 in 1976 to less than 10,000 in 1982 (Kadivar, 2022). Existing data about Iran's migration patterns and brain drain also show a sudden and large increase in the migration of Iranians to North America and Western Europe in the years following the revolution (Azadi, Mirramezani, and Mesgaran, 2020).

While there is consensus among Iranian economists about the negative effect of the revolution and war on high income earners, the evidence about the positive effect of the revolution and war on the lower income earners is less conclusive. Social justice, empowering the downtrodden, and uprooting dependent capitalists were among the main themes of the revolution, which were later codified in the Constitution of the new political regime- the Islamic Republic of Iran. The new constitution emphasized the responsibility of the new administration to provide adequate shelter, employment, and means of subsistence for all citizens. Some peasants took over lands (Behdad and Nomani, 2002), and some workers took charge of running their factories, although such efforts were mostly short-lived as the state soon cracked down on independent workers organizations (Bayat, 1987). New revolutionary foundations were launched such as *Komite-ye Emdad-e Emam* to provide cash transfers to poor families. Other revolutionary organizations such as *Jahad-e Sazandegi* also made considerable efforts in improving literacy in rural areas and in providing services such as piped water and electricity to rural areas (Lob, 2020). Nonetheless, the existing evidence does not show a reduction in poverty in Iran in the decade after the revolution. On the other hand, as Djavad Salehi-Isfahani shows in his analysis of post-revolutionary poverty, there is a rise in absolute poverty in Iran starting after 1984 with a fall in oil prices. The main reduction in absolute poverty in Iran happened in the late 1990s when oil prices rose again (Salehi-Isfahani, 2017). Furthermore, census data also shows that the percent of homeowning Iranian households decreased after the revolution, while it rose before the revolution from about 60% to 80% from 1956 to 1976 (Kadivar, 2022).

While the overall reduction in the level of income inequality in Iran parallels such processes in the cases of the revolution and war reviewed above, some of the main mechanisms of the reduction in income inequality also were not present in Iran, which this is consistent with our observation about the lack of evidence for improvement in the conditions of the lower income strata. For example, a main mechanism of reduction in inequality in the cases of communist revolution was land reform, but land reform in Iran had started before the revolution under the Pahlavi monarchy in 1963. After the revolution, different Islamist factions disagreed on the contours and parameters of the land reform, thus the process did not proceed with the pace and magnitude of the pre-revolutionary land reform. Given the ambivalence of

Islamists about private property, processes such as the collectivization of land or other private prosperities also did not occur in Iran in the same scale that it had happened in the communist revolutions. Furthermore, one of the main effects of the wars in reducing income inequality has been through tax reform and the introduction of fiscal measures, such as progressive taxation. The tax system in Iran also did not go through any major reforms during or after the revolution and war. As a result, while the reduction in the level of income inequality in Iran is noticeable, the decrease appears to be more modest than in the other cases of revolutions and wars reviewed above.

5. Conclusion

The scholarship on social revolutions and large scale wars maintains that these violent upheavals reduce the level of inequality within countries (Scheidel, 2018). The revolutions and wars themselves, however, are the result of ongoing political and socioeconomic changes within countries (Goldstone, 2014; Goldstone et al., 2010). How could one account for the independent effect of revolution and wars, while controlling for other socioeconomic changes happening within countries? In other words, aren't revolutions, wars, and the changes in the level of income inequality the result of ongoing endogenous transformations within countries? To address this question, we focused on the case of the Iranian revolution of 1978-79 and the subsequent war with Iraq and used the synthetic control method (SCM) to estimate the joint effect of revolution and war on changes in Iran's income inequality, measured by the Gini coefficient.

The SCM approach in this study optimally selects a set of weights which are then applied to a group of corresponding countries to produce an optimally estimated counterfactual to of the factual Iran that received the treatment of a revolution and war. This counterfactual, called the "synthetic Iran," serves to show what would have happened to income inequality in Iran had the revolution and war never occurred. It is a powerful generalization of the difference-in-differences strategy (Cunningham, 2021).

Using two data sources for income inequality, which measures income distribution through different methodologies, we show that the joint effect of the revolution and war on the income inequality of Iran was significant both in terms of the size of the effect and its statistical significance. A usual concern with synthetic control method is whether the result is driven by the pool of the donor countries. Donor countries are important since we develop our predictions about the synthetic Iran based on the relationship between the control and outcome variables of these countries, in addition to the pre-revolutionary Iran. We have addressed this concern in two ways. First, we have run a sensitivity test where we re-implemented the analysis dropping one of the countries in the donor list each time. Second, using an alternative measure of income inequality entailed different weights for the countries in the donor list. Our main finding about the statistical significance and the notable size of the effect remained unchanged, even though we tried different modeling strategies in our synthetic control method.

Our findings make two contributions to the general literature about drivers of income inequality and the literature about the Iranian revolution. This is the first study about the effect of revolutions and wars on the levels of income inequality that relies on a causal identification method. The bulk of previous studies rely on observational data to support their arguments about the effect of revolutions and wars on income inequality (Piketty, 2020; Scheidel, 2018). Moreover, existing cases in this literature consist of the socialist revolutions and the two World Wars (Eckstein, 1982; Scheve and Stasavage, 2010). We extend and complement the findings based on these revolutions and wars in the case of the Iranian revolution and the Iran-Iraq war. Finally, existing literature about the Iranian economy has pointed to the reduction of income inequality in Iran after the revolution because of the dire effects of the war and revolution on high income earners through observational data (Salehi Esfahani and Pesaran, 2009; Salehi-Isfahani, 2017). We corroborate this finding by presenting quantitative evidence on the joint effect of the revolution and war on the reduction of the income inequality in Iran after 1979.

The methodology we used here to estimate the effect of the Iranian revolution on income inequality could also be used for other social revolutions in the last half of the 20th century, such as in Nicaragua in 1979, for which data on income inequality exists. This method is specifically more effective than mere observational data when the size of the effect is more modest than in paradigmatic cases, such as the Bolshevik revolution of 1917 in Russia.

Our finding also makes a contribution in the quantitative studies of contentious politics in the Middle East (i.e. Ketchley and Barrie, 2020; Ketchley and El-Rayyes, 2019). We advance this literature by documenting the effect of revolution and war in Iran on the level of income inequality. As more time will pass since the Arab Spring, scholars can rely on similar methodology as in our paper to analyze the effect of Arab revolutions on the level of income inequality in different countries in the region that experienced an uprising.

A limitation of our analysis is that our data on Gini coefficients do not have the income of different income earners, so we were not able to present a quantitative analysis of which income groups have driven the change in the level of inequality in Iran. Instead, we relied on existing analyses of the Iranian economy around the time of the revolution to present an interpretation of the potential mechanisms. Our review of existing data and analyses suggest that this reduction in Iran's Gini has been mostly driven by the negative effect of the war and revolution on high income earners, rather than the introduction redistributive policies that would have elevated the lower income strata.

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