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The effect of Islamic revolution and war on income inequality in Iran

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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 before revolutions and wars or if the results are standalone effects. In this study, we focus on the case of the Iranian Revolution of 1978–1979 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 create 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 under a new political regime for the period of 1970–1988. Our results, based on two different indicators of Iran's Gini index, show a 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 three standard deviations of the index. The main findings are robust to a series of tests, including placebo tests.

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 lower 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 so, how could we then assess the independent effect of revolutions on changes in income inequality? To address this question, 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, resulting in the fall of the Pahlavi monarchy in February 1979. It is estimated that about 10 percent of Iran's population participated in at least one of the protests that led to the fall of the monarchy. Such estimates make the Iranian revolution, with one of the highest participation rates in the twentieth and twenty-first centuries, a paradigmatic case of revolutionary movements (Chenoweth and Stephan 2012; Kurzman 2005). In about a year since the fall of the monarchy, Iraq's invasion of Iran's southwest border resulted in an eight-year war, one of the longest interstate wars in the twentieth and twenty-first centuries. As Walt (1987) 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 we employ in our study, the Gini index based on the Estimated Household Income Inequality Data Set ("EHII") and 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.[1] Nonetheless, a major question remains about what drove this change. Would we have observed a similar result had Iran not experienced 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 et al. (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-differences in various ways, synthetic control provides a helpful approach to case studies with a small number of countries (Hodler 2019).[2]

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 significantly diverged 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 three standard deviations of the index during the 1979–1988 period, which is a sizable effect.

This finding makes at least two important contributions. First, to the best of our knowledge, this is the first analysis on the effects of revolution and war on income inequality that uses the synthetic control method for Iran. Earlier studies have used this methodological approach to estimate the effect of revolutions such as the Cuban

[1] The results related to the SWIID and sensitivity checks are presented in the online Appendix.

[2] 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) and McClelland and Mucciolo (2022).

revolution of 1959 (Jales et al. 2018), the Islamic revolution in Iran (Farzanegan 2022), and political turmoil such as the Arab Spring (e.g., Matta et al. 2019; Echevarría and García-Enríquez 2020) on economic performance (mainly measured by GDP). Distributional effects of regime changes and interstate wars have been absent in these investigations. There are a few exceptions which have examined the development of income inequality in affected countries with the SCM approach: the populist regime in Venezuela (Grier and Maynard 2016), the (Rose) Revolution in Georgia (Lawson et al. 2019), the discovery of natural resources (Hartwell et al. 2022) and the introduction of the European Monetary Union (Bouvet 2021).

Second, while there are studies on the effects and determinants of income inequality in post-revolution Iran (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 study uses the synthetic control method to generally examine and quantify the impact of these events on income inequality and particularly, in the case 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 do not allow for a quantitative analysis of the possible mechanisms, we rely on existing accounts of the Iranian economy during this period, as well as other relevant sources of data to present a discussion of the mechanisms driving this change. Overall, our discussion suggests that the revolution and war reduced 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 contributes to the quantitative studies of contentious politics in the Middle East that have been increasing 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 the 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 income inequality as one of the most structural outcomes for contentious collective action.

This study is structured as follows: Sect. 2 presents a review of related literature on the effects of wars and revolutions on income distribution. Section 3 explains our data and empirical methodology. The main results are presented and discussed in Sect. 4. We discuss drivers of income inequality reduction in post-revolutionary Iran in Sect. 5. Section 6 concludes the study. Further robustness and sensitivity checks are presented in the online Appendix.

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 et al. 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 (Scheidel 2018). 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 bourgeois, 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 USA, 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 show a significant increase in support for higher tax rates for the wealthy after the Pearl Harbor attack in the USA (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 twentieth 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 are mostly based on observational data from the socialist revolutions of the twentieth 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

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. Figure 1 shows the number of domestic conflicts events from the Databanks International's Cross-National Time-Series Data Archive (CNTS) which compiles political instability indicators based on the daily editions of the New York Times (Banks and Wilson 2021). It supports selection of treatment year (1978) for our analysis.

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.

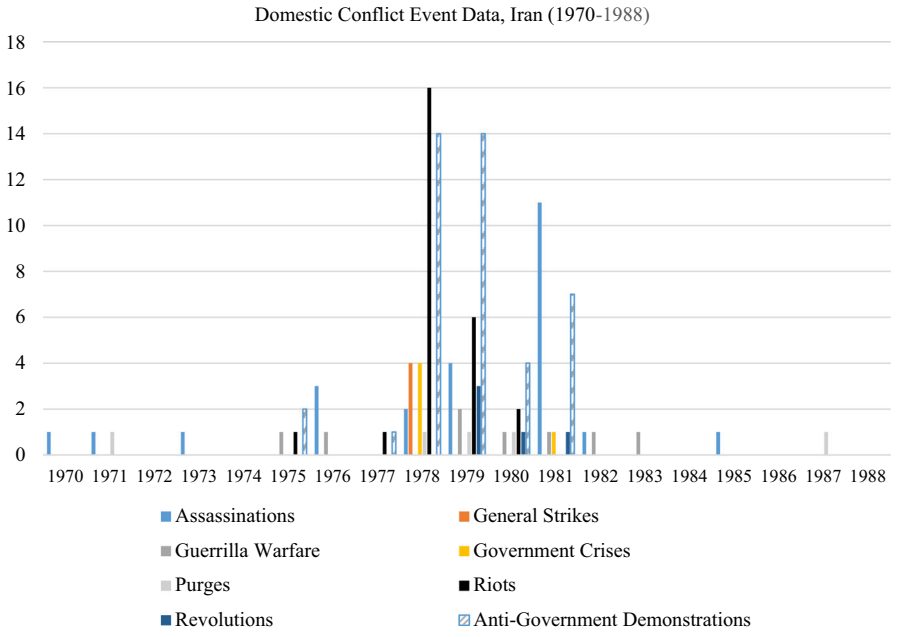

Fig. 1 Domestic conflict events in Iran (1970–1988). *Source* Banks and Wilson (2021). *Note* For definitions of domestic conflict event data see https://www.cntsdata.com/domconflict/c1svs

The synthetic Iran is generated as a weighted average of potential control countries in the donor pool.[3] To have an unbiased estimate of the post-1978 inequality trajectory of Iran, we exclude countries which have had interstate 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 to 1982 has not been described as a revolution, because the government eventually conceded to the opposition and held multi-party protests.

The donor pool, after excluding missing observations and countries with similar experiences of revolution or war, includes a sample of 18 countries: Bangladesh,

[3] 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.

Chile, Colombia, Denmark, Ecuador, Egypt, India, Kenya, Malaysia, Malta, Mexico, Netherlands, Norway, Pakistan, Republic of Korea, Singapore, Turkey, and Venezuela.

3.1 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 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 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 and Squire (1996) 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 and Squire (1996) 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 and Squire (1996) 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 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 (Ferreira et al. 2015). 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 studies 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 and 1988 is 0.65 and statistically significant at 1% level. Figure 2 shows the development of income inequality in Iran from 1970 to 1988. 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.

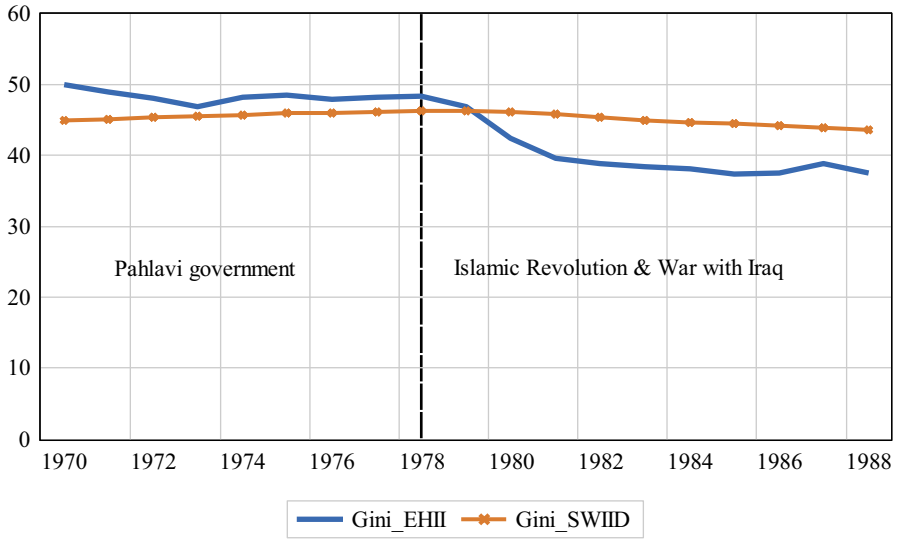

Fig. 2 Income inequality in Iran (higher numbers show higher levels of income inequality). *Source* EHII is from the University of Texas Inequality Project (Galbraith and Kum 2005) and SWIID is from Solt (2020)

Since our main interest is the joint effect of revolution and war on income inequality in Iran, we do not extend the analysis beyond 1988. The war with Iraq and its associated economic policies ended in 1988. After that, we observe a significantly different policy in the reconstruction, privatization and liberalization of the economy under the new government of Akbar Hashemi Rafsanjani (1989–1997). Then, Iran experienced a reformist government (Mohammad Khatami between 1997 and 2005) followed by the populist government of Mahmoud Ahmadinejad (2005–2013). Since our analysis is about the joint effect of revolution and war, extending the sample beyond 1988 will engage us with many other policy changes in Iran and at the international level (i.e., the collapse of the former Soviet Union and the increasing trend of globalization). Moreover, going beyond 1988 will add to the technical challenge of finding donor countries without the similar shocks of revolution and war that Iran experienced.

3.2 Predictors

The inclusion of covariates and predictors of our outcome of interest in the pre-intervention period (1970–1977) 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 predictors, 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).[4] 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 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. (2022), 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 α_t is calculated as $\alpha_t = Y_t - \sum_{d=1}^{D} \omega_d^* Y_{dt}$ for $t > 1978$.

[4] We also examined the specification with further predictors. While the estimated results remain robust, this set of predictors resulted in lower root mean squared prediction errors (RMSPE).

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.

The validity of the SCM analysis in providing plausible interpretation of the effect of our events of interest (i.e., revolution and war) is based on two standard assumptions (Gilchrist et al. 2022). First, there should be no prior impact from the events of interest on our outcome of interest (i.e., income inequality). If our events of interest (revolution and war) are predicted, the prior outcome (income inequality) may react to it, which will then violate this assumption. In our case, the Islamic revolution and its subsequent war with Iraq were not anticipated. Kurzman (2005) documents the surprising and unpredictable nature of the revolution in Iran, labeling it as the Unthinkable Revolution. The second assumption implies that the treated country (Iran) should be matched with the group of countries in donor sample which did not experience similar events such as large-scale social revolution and a full-fledged war. We checked carefully our donor sample and exclude countries with similar experiences. The identification assumption of the SCM is that if the synthetic Iran provides a good approximation of income inequality in pre-revolution and war Iran, then any following diversion between the factual and counterfactual Iran can be attributed to the joint effect of revolution and war on income inequality.

4 Results

Table 1 shows that the synthetic Iran is best generated by a weighted average of four countries with Kenya, Chile, Singapore, and Turkey having the highest weights. In sensitivity analysis (available in the online Appendix), we ensure that the main findings are not produced as a result of single influential country in the synthetic control unit. 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 substantially 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 counterfactual is close to zero. In addition, there is a near-perfect match between some of the covariates and predictors of income inequality between the factual and counterfactual 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). As discussed earlier, the identification assumption of SCM is based on a good approximation of the outcome of the treated unit in the pre-treatment period (Bouvet 2021). To check this, we calculate the "Pretreatment Fit Index," introduced by Adhikari and Alm (2016). Their index is based on discussions of Abadie et al. (2010) but allows an easier evaluation

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)	47.9	48.3	44.6	− 0.4	3.3
EHII Gini (1974)	48.2	48.2	44.2	0.1	4.1
EHII Gini (1972)	48.0	47.7	44.9	0.4	3.1
EHII Gini (1970)	49.9	49.6	46.6	0.4	3.3
Log of GDP per capita	9.1	7.4	8.1	1.7	0.9
Government expenditures (% of GDP)	19.9	15.7	13.6	4.2	6.4
Life expectancy	53.7	57.8	60.8	− 4.1	− 7.1
Population growth rate (%)	2.8	3.0	2.3	− 0.2	0.5
Fertility rate	6.3	6.3	4.8	− 0.1	1.5
Urban population (% of total population)	44.4	35.1	57.5	9.3	− 13.2

of the quality of the pre-treatment fit, especially when the RMSPE of the outcome variable to measure fit or lack of fit between the path of the outcome variable for treated unit and its synthetic counterpart is different from zero (as in our case). If the RMSPE is 0, then the fit index will be 0, showing a perfect fit. A fit index larger than one often indicates a poor fit and such a synthetic unit should not be used as the counterfactual. In our case of using the EHII Gini index as the outcome of interest, the pre-treatment fit index is 0.008, supporting the identification assumption of SCM.

In the online Appendix, we also show that our results are robust after bias-correction for inexact matching on predictor values based on the penalized SCM (Abadie and L'Hour 2021; Wiltshire 2021). Abadie and L'Hour (2021) suggest a synthetic control estimator that penalizes the gap between the values of the predictors for the treated unit (Iran in our case) and the values of the predictors for each of the units that contribute to the synthetic Iran.

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 pre-intervention outcomes (Gini index).

Figure 3 shows the income inequality trajectory of Iran and its counterfactual for the period of 1970–1988. The synthetic Iran 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 estimated 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.

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 Fig. 4. 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 et al. (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

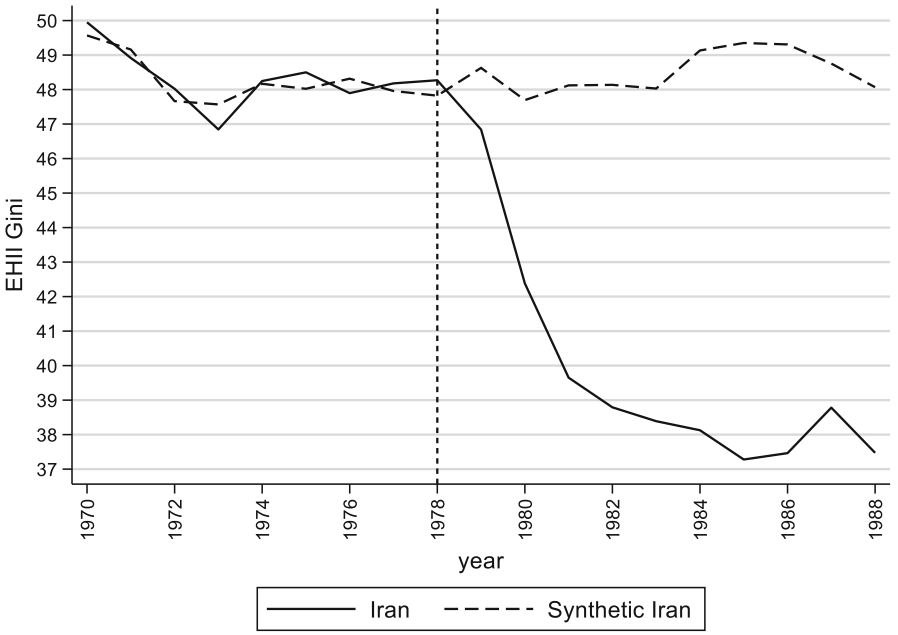

Fig. 3 Income inequality (EHII-Gini): Iran versus Synthetic Iran. Estimated Household Income Inequality Data Set (EHII)—is derived from the econometric relationship between UTIP-UNIDO, other conditioning variables, and the Deininger and Squire (1996) dataset. For more details see Galbraith and Kum (2005)

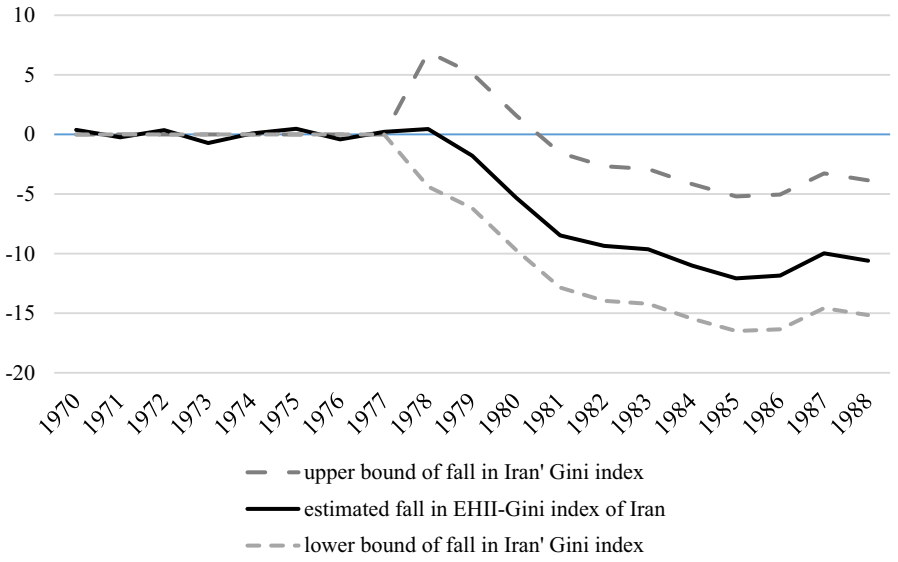

Fig. 4 Income inequality (EHII-Gini) gap between Iran and synthetic Iran (with confidence intervals)

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.

Further analysis on inference procedures and sensitivity checks (with reference to Estimated Household Income Inequality (EHII) analysis) are presented in the online Appendix A. Moreover, online Appendix B presents the SCM results based on alternative measure of income inequality from the Standardized World Income Inequality Database (SWIID).

5 Discussion on Iran's income inequality after the revolution

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. 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 and 1969 was 9% and was 5.2% from 1970 to 1977. 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), shows 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 SWIID (Solt 2020) and Central Bank of Iran (Central Bank of Iran 2021).

The revolutionary upheaval and the war with Iraq created political instabilities that resulted in a decade of economic decline in 1980s (Farzanegan 2022). This was because the situation became unsafe for private investment, many skilled laborers left the country, oil prices fell, and the war imposed additional costs on the already strained economy (Salehi Esfahani and Pesaran 2009: 192–193).

Similar mechanism then also reduced the level of income inequality in Iran. As Salehi-Isfahani (2017) 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). Farzanegan et al. (2021) also point 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. 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 et al. 2020).

While there is more consensus 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 the Imam Khomeini Assistance Committee [*Komite-ye Emdad-e Emam Khomeini*] to provide cash transfers to poor families. Other revolutionary organizations such as Jihad of Construction [*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. As Salehi-Isfahani (2017) 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. 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 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.

6 Conclusion

The literature on social revolutions and large-scale wars maintains that these violent upheavals reduce the level of inequality within countries (Scheidel 2018). However, the revolutions and wars themselves are the result of ongoing internal political and socioeconomic changes (Goldstone 2014; Goldstone et al. 2010). How could one account for the independent effect of revolution and wars while controlling for other socioeconomic changes? In other words, aren't revolutions, wars, and changes in the level of income inequality the result of ongoing endogenous transformations? To address this question, we focused on the case of Iran during the 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 of Iran. This counterfactual, called the "synthetic Iran," shows 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 measure 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 size and statistical significance. A usual concern with the 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 the drivers of income inequality and the literature about the Iranian revolution. To the best of our knowledge, this is the first study on the effect of revolutions and wars on the levels of income inequality that relies on a causal identification method. Previously, most studies relied 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 socialist revolutions and the two World Wars (Eckstein 1982; Scheve and Stasavage 2010). We extend and complement the findings based on 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 detrimental 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 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 twentieth 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 Middle East politics (e.g., Ketchley and Barrie 2020; Ketchley and El-Rayyes 2019). We advance this literature by documenting the effect of revolution and war in Iran on its level of income inequality. As more time passes since the Arab Spring, scholars can rely on the similar methodology in our study to analyze the effect of Arab revolutions on income inequality in different countries in the region that experienced uprisings.

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 drove the change in the levels of inequality. Instead, we relied on existing analyses of the Iranian economy during the revolution and war to present an interpretation of the potential mechanisms. Our review of existing data and analyses suggest that this reduction in Iran's Gini was mostly driven by the negative effect of the war and revolution on high-income earners, rather than the introduction of redistributive policies that would have elevated the lower-income strata.

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Data availability Data will be available upon request.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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