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Estimating the effects of Syrian civil war

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Abstract
We estimate the effects of the Syrian civil war using a synthetic control method which is based on a counterfactual scenario of an absence of the armed conflict that has led to the humanitarian crisis and one of the largest population displacements without a precedent in modern history. By comparing Syria's growth and development trajectories with the characteristics of a set of sixty-six countries with no armed internal conflict between 1996 and 2021, we can deduce a series of gaps in economic growth, human development, and institutional quality that can be attributed to the civil war. Our analysis shows that the effect of the Syrian civil war on the trajectory of economic growth was temporary and almost disappeared before the start of the COVID-19 pandemic. Conversely, the war led to an unprecedented decline in human development, a high rise in infant mortality, and a prevalent degradation of institutional quality. To the present day, the civil war has led to more than 4500 additional infant deaths with a permanently derailed trajectory of longevity. The unparalleled and permanent deterioration in institutional quality resulting from the war is indicated by a diminished rule of law, civil liberties, government efficiency, and a widespread escalation of corruption. To ensure the internal validity of the findings, the estimated effects were subjected to and passed a variety of placebo checks.

Keywords Civil war · Economic development · Syria · Synthetic control method

JEL Classification C21 · C55 · N94 · O43 · P26 · P51

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1 Introduction

Since time immemorial, economic history has taught us that civil wars cause very large economic, social and environmental costs for the society. Compared to international wars, civil wars are oftentimes more devastating due to large-scale displacement of population, severe causalities, and millions of refugees (Collier 1999; Kang and Meernik 2005; Janus and Riera-Crichton 2015). Without the loss of generality, the notion that civil wars pose a development in reverse, entail severe economic losses and high opportunity costs of conflict is not an overstatement (Elbadawi et al. 2008; Besley and Persson 2009). The economic effects of civil war are traditionally examined through an ex-post evaluation of the costs of armed conflict (Murdoch and Sandler 2002a). The analysis may be carried out at the level of countries, regions or cities that allows us to capture different dimensions of effects (Grobar and Gnanaselvam 1993; Sambanis 2002; Murdoch and Sandler 2002b).

In this paper, we examine the effects of the Syrian civil war, that began to unfold in 2011 after a violent crackdown of public protests during the Arab Spring by the Al Assad regime, on economic growth, human development and institutional quality. The toll of Syrian civil war unveils unprecedented humanitarian and economic losses of the armed conflict between Al Assad regime and Syrian opposition forces. The civil war drained the resources of the population to an unprecedented degree in modern history with estimated 13 million displaced people requiring humanitarian assistance, out of which around five million crossed the borders, leading to one of the most severe refugee crises in history. Although the existing estimates of the impacts behind the civil war provide a clear insight into the humanitarian costs of war, broader economic, social and institutional quality impacts of the Syrian civil war await further analysis and quantification. In particular, we estimate the causal effect of Syrian civil war by estimating the missing counterfactual scenario of growth and development trajectories in the hypothetical absence of war through multiple comparisons of Syria with a group of countries that have not undergone any armed internal conflict in the period of our investigation between 1996 and 2021 using the counterfactual outcome modelling approach.

Our paper conveys a three-fold contribution to the literature. First, we contribute to the extensive scholarly literature on the economic growth and development effects of civil wars (Collier 1999, Reynal-Querol 2002, Blattman and Miguel 2010, Collier and Duponchel 2013, Costalli et al. 2017, Echevarría and García-Enríquez 2019). We partially fill the void in the literature and bridge the gap between theoretical, policy and empirical debate on the growth and development effects by empirically unravelling the effects of civil war in Syria which has led to the largest displacement of population in modern history (Lichtenheld and Schon 2021), has received significant scholarly interest (Sen et al. 2013, Corstange and York 2018, Lundgren et al. 2023) and policy-based attention but its economic and broader development impacts have not yet been comprehensively examined. To the best of our knowledge, our study is the first one that comprehensively examines the economic growth and development impacts of the Syrian civil war beyond the existing studies by a series of World Bank reports that focussed mainly on population displacement and cumulative GDP losses (Ianchovichina and Ivanic 2016).

Second, we contribute to the rapidly growing literature on the social and economic impact of the civil war and armed conflicts using synthetic control method, and multiple components of human development (Chamarbagwala and Morán 2011, Bonneau et al. 2022). By examining the effect of civil war on longevity, human capital formation and infant mortality, we better unravel and disentangle the sources of human development losses that may otherwise be blurred if an aggregate or summary-based index is used. Through the disaggregation of the overall human development into various components, the impact of the civil war on policy-relevant outcomes can be discussed along with the normative implications for the policymakers.

And third, our analysis fills the void in the literature by systematically estimating the effect of civil war on the institutional quality trajectories which has been traditionally neglected in the literature (Lapuente and Rothstein 2014). Therefore, our analysis partially uncovers the impacts of the Syrian civil war on the quality and strength of governance through the examination of outcomes pertaining to the freedom of expression, political stability, rule of law and control of corruption among several others. By highlighting the governance quality impact of the civil war, our analysis contributes to the ongoing discussion on the implications of armed conflicts for the evolution of governance, institutional change and quality and the missing counterfactual scenario (O'Reilly 2021).

Our results show that the civil war has triggered a rampant but temporary decline of per capita GDP that appears to have partially recovered and reached the pre-war level up to the onset of COVID19 pandemic. That said, our synthetic control estimates provide evidence of large-scale drop of per capita GDP until 2013 followed by an accelerated recovery up to the present day. Compared to the earlier studies that focus on labour and housing market effect of forced migration from Syria into Türkiye (Balkan and Tumen 2016; Tumen 2016), our results suggest that a temporary decline of per capita GDP is potentially attributed to the relatively low reliance of Syrian economy on tangible assets, more widespread prevalence of agriculture in the GDP composition and large-scale forced displacement of population which may mitigate part of the GDP loss in per capita terms opposed to the cumulative loss of GDP as a whole.

By contrast, our results provide evidence of a massive and permanent deterioration of human development reinforced by massive increases in infant mortality rate and sharp drop of longevity whereas human capital investment effect of civil war does not appear to be statistically significant. In quantitative terms, our results suggest that the cumulative infant mortality impact of the civil war amounts to more than 4500 additional infant deaths from 2011 to 2019, which confirms unprecedented degree of devastation and loss on the Syrian population and its economy. At the same time, our results show that the civil war has led to a massive erosion of rule of law, widespread escalation of corruption, deepened endemic violence and an unparalleled deterioration of political stability accompanied by a severe weakening of regulatory institutions and government effectiveness. Furthermore, our results provide novel insights into the socioeconomic and institutional quality impacts of armed conflict focussing on the largest population displacement crisis in modern history, and provide noteworthy normative implications to inform both reconstruction and stabilization policy.

The rest of the paper is organized as follows. Section 2 provides conceptual and historical background behind the Syrian civil war. Section 3 outlines the identification strategy. Section 4 discusses the data and samples used in our analysis. Section 5 presents the results and robustness checks. Section 6 concludes.

2 Conceptual framework and background

2.1 Conceptual framework

In the existing literature on evaluating the effects of civil wars, the notion of a counterfactual scenario has become widely accepted in recent years. Under this approach, the economic and social effects of a civil war are evaluated by estimating the missing counterfactual scenario of growth and development in the hypothetical absence of the war by making use of the synthetic control method originally proposed by Abadie and Gardeazabal (2003) and further extended by Abadie et al. (2015) and many others (Gilchrist et al. 2023). The reasoning behind the application of the synthetic control method to evaluate the effect of civil wars is intuitive. By comparing areas affected by war with a plausible control sample of areas that did not undergo internal armed conflict, the civil war's effects on growth and development can be estimated. An example is a study by Bluszcz and Valente (2022) who employed the synthetic control method to estimate the effects of the Donbas war on Ukraine and its most affected territories in the Donbas basin and found evidence of particularly large and devastating effects on both Ukraine and the breakaway regions in the eastern part of the country relative to their control groups, where no armed conflict took place. Furthermore, Echevarría and García-Enriquez (2019) employed the synthetic control method to estimate the effects of the Arab Spring in Libya in 2011—which led to a full-fledged civil war—on the Libyan economy and found evidence of a large cumulative loss of GDP in both absolute and per capita terms. Similar analyses using the synthetic control method have been carried out to evaluate the effects of the Second Intifada on the Israeli economy (Horiuchi and Mayerson 2015), the effects of Kurdish separatism on the economic growth trajectory of Türkiye (Bilgel and Can Karahasan 2017, 2019), the effects of the Arab Spring on the Egyptian economy (Echevarría and García-Enriquez 2020), and the effects of the Yugoslav civil war on the economies of ex-Yugoslav republics (Kešeljević and Spruk 2023) among several other examples (Bove et al. 2017).

Although the synthetic control method is not immune to scholarly criticism, particularly its distributional assumption and strength of inference, (Hsiao et al. 2012, Gardeazabal and Vega-Bayo 2017, Li and Bell 2017, Wan et al. 2018, Gharehgozli 2021), we emphasize that it has several worthwhile advantages when estimating the effects of civil war compared to alternative methods. When examining the costs of an armed conflict, three major approaches have been proposed.

First, compared to a cost-accounting approach favoured by Arunatilake et al. (2001), Bilmes and Stiglitz (2006), Skaperdas et al. (2009) and several others, the synthetic control method does not require multiple calculations of a broad variety of conflict costs. The general basis of cost-accounting calculations is the inherent reliance on data provided by governments and international agencies which have been subject

to criticism as the quality and reliability may be questionable. The cost-accounting approach is also prone to double counting the costs of a conflict. Conversely, the synthetic control method allows us to perform statistical inference for each outcome directly without double counting the costs.

Second, the costs of a conflict may be examined through the application of both static and dynamic panel-data as well as a basic and advanced time-series analysis favoured by Enders et al. (1992) and Barro and Lee (1994) among several others. However, these estimations are generally vulnerable to the presence of structural confounding variables and the multiple sources of unobserved heterogeneity that co-shape and simultaneously influence the trajectories of economic growth and development. The standard approach to dealing with confounding issues when using a panel-data approach is to add a series of additive and multiplicative fixed effects that capture country-specific variations in geo-political alliances and networks that may over-absorb the effect of civil war in difference-in-differences models of conflict as the preferred estimates in the evaluation of conflict costs.

And third, the synthetic control analysis can generalize difference-in-differences analysis and does not hinge on parallel trend assumption as a prerequisite to estimate the effect of civil war. It also embeds time trends, unobserved effects, and time-varying heterogeneity directly into the factor model used to estimate the counterfactual scenario of the civil war. In a similar vein, the synthetic control method performs well in small samples (Ferman and Pinto 2021), it does not necessitate an arbitrary search for specification (Gilchrist et al. 2023), and avoids the extrapolation outside the range of data (Abadie 2021). Therefore, by applying the synthetic control method to study the effects of the Syrian civil war on the Syrian economy and society, plausible and reasonable estimates of the causal effects of the war can be estimated.

2.2 The Syrian civil war: background and related literature

The economic theory of war suggests that wars incur various types of (in)direct costs for society. Firstly, wars cause destruction which results in a decline in GDP. Secondly, wars result in a loss of human capital. Thirdly, wars increase fiscal deficits and crowd out public expenditures in areas like education and health. Fourthly, civil wars inhibit economic activity due to declining capital stock. And lastly, neighbouring countries are affected by the spillover effects through the impacts of refugee flows.

2.2.1 Decline in GDP

Existing literature on the economic effects of wars shows that regardless of which approach and model is used, the impact of a civil wars on output is always disastrous and results in large economic losses (Mueller 2013; Collier 1999; Gates et al. 2012; Kang and Meernik 2005). The report by The World Bank (2017a) shows that Syria's GDP contracted by 63% between 2011 and 2015 compared to 2010. In terms of a further example, Giovannetti and Perra (2019) estimated Syria's GDP fall at 43% in 2013 through a non-conventional approach by using satellite data (i.e. night light intensity) to calculate the average rate of the decrease in luminosity to approximate the decline

in GDP. A relatively meaningful insight into the costs of war is a comparison of the development trajectories between war zones and areas that were not affected by the civil war (Collier and Hoeffler 2002; Cerra and Saxena 2008; Kešeljević and Spruk 2023). The World Bank's (2017a) estimates of the differences between a counterfactual and actual GDP between 2011 and 2016 show that the cumulative loss of GDP is $226 billion based on 2010 prices, about four times the 2010 GDP of Syria. A disproportionately large decline has been observed in agriculture (World Bank 2017b), manufacturing (Gobat and Kostial 2016), finance, and in the housing and energy sector (World Bank 2017b).

2.2.2 Human capital losses

Civil wars cause an extensive loss in the human capital stock due to psychological traumas (Bratti et al. 2016; Murthy and Lakshiminarayana 2006), educational losses and permanently lower productivity (Lai and Thyne 2007; Eder 2014; Devakumar et al. 2014; Ichino and Winter-Ebmer 2004), and a displacement of people and human capital outflow (Mueller 2013). According to the UNHRC[1] more than 350,000 people have been killed, with 6.2 million displaced, including 2.5 million children within Syria. Furthermore, more than 700,000 Syrian nationals are estimated to have sought political asylum in Europe in 2015 and 2016 (Eurostat 2022; World Bank 2017a). As a result of the war, a pre-conflict population of over 20 million has declined to 18.2 million. Around 11.9 million people have been forcibly displaced within Syria and across its borders, out of which 5.7 million are refugees and 6.2 million are internally displaced. Moreover, a report by The Syrian Center for Policy Research (2015) shows that 80% of the population is now below the poverty line compared to 12.4% in 2007.

2.2.3 Fiscal adjustments and the crowding out effect

Civil war crowds out private investment (Stiglitz and Bilmes 2012) and generally leads to a large-scale diversion of public funds away from expenditures that promote education and public health (Collier 1999; Ghobarah et al. 2003; Mueller 2013). The 2017 report by The World Bank shows that a whole generation of children in Syria has received inadequate education. Families are struggling to meet their basic needs and are increasingly reliant on detrimental practices including pulling children out of school to work, entering young girls into early marriage, and allowing children to become involved with armed groups (Gobat and Kostial 2016). Higher costs of war and declining fiscal revenues, from 23% of GDP in 2010 to less than 3% in 2015, led to a fiscal deficit of over 20% of GDP. The civil war and trade embargo reduced Syrian exports by 92% between 2011 and 2015 and the current account deficit reached 28% GDP in 2016 from 0.65% GDP in 2010 (World Bank 2017a).

2.2.4 Declining capital stock

Reduced connectivity, higher transportation costs, disruptions in supply chains and networks, an increase in people seeking rent, and erosion of trust largely inhibit investment

[1] United Nations Human Rights Council.

activity in Syria. Bridges, water resources, roads and other significant infrastructure assets have become targets and their destruction has precipitated the collapse of economic activities. Damage assessment in three selected cities (i.e. Aleppo, Hama, Idlib) showed that the highest tangible damage is in the housing, energy, and health sectors (World Bank 2017b). Outbreaks of violence inhibit economic activity due to falling investments and reduce the incentives to pursue productive activities. Even replacing the capital stock entirely would not be sufficient to return the Syrian economy to its pre-conflict level without rebuilding institutions and networks (Ford 2019; Gobat and Kostial 2016).

2.2.5 Spillover effects

War-related externalities exist due to the negative effect on other countries by destroying infrastructure and capital close to the border (Murdoch and Sandler 2002b), decrease in trade volume (Martin et al. 2008), and an acceptance of refugees and reputational loss (Brück and Henning 2016). The Syrian civil war has caused refugee shockwaves through many neighbouring countries. According to the United Nations High Commissioner for Refugees, the total number of Syrian refugees in Lebanon, Türkiye, Jordan, Iraq, Egypt, and North Africa is estimated at 5.7 million in 2022. However, this number does not include the 0.4–1.1 million unregistered refugees. The problems arising from refugees also have other consequences for the hosting countries. Syrian refugee inflows led to small but statistically significant informal employment losses and labour cost advantages in Türkiye (Tumen 2016). ISIS terrorist activity blocked transport routes, and increased investment uncertainty and poverty in the Kurdistan region of Iraq. Due to the Syrian civil war from 2011 onwards, the cumulative GDP reductions correspond to 11.3% of the pre-conflict (in 2010) GDP across the Mashreq region (Iraq, Jordan, Lebanon) as shown in the 2020 report by International Bank for Reconstruction and Development. In terms of a further example, Akugündüz et al. (2018) analyse how the inflow of Syrian refugees in Türkiye affected firm entry and performance and showed that hosting refugees is favourable for firms although firm entry rates do not seem to be affected.

Some effects of the Syrian civil war are not easily measurable, as there are many indirect costs involved and several elements in the calculations are missing due to the difficulties in assessing them. Some of the political, social, security-related, and institutional effects are not easily quantifiable. In addition to the damage assessment reported in existing literature, the costs of the war can also be indirectly assessed through counterfactual analysis. A relatively meaningful insight into the costs of war can be made with a comparison of the development trajectories between war zones and areas that were not affected by the war. An overview of existing literature produces two such studies for Syria: The aforementioned report by The World Bank (2017a), which estimates the difference between the counterfactual scenario of the war on Syria's GDP but is limited with the timeframe of until 2016; and the study by Onder et al. (2020) that attempts to isolate the impacts of the Syrian armed conflict and examine its effects on GDP, trade flows, poverty rates, and the debt burden for Iraq, Jordan and Lebanon but does not carry out a similar analysis for Syria.

3 Identification strategy

3.1 Basic setup

Our goal is to examine the growth and development cost of the Syrian civil war consistently. To this end, we aim at estimating the missing counterfactual scenario and simulate the trajectories of economic growth and development in the hypothetical absence of the war. In doing so, we apply the synthetic control estimator (Abadie and Gardeazabal 2003, Abadie et al. 2015, Costalli et al. 2017, Echevarría and García-Enríquez 2019, 2020, Abadie 2021, Gilchrist et al. 2023) to estimate the causal effect of civil war on Syrian economy and society. Through the application of the potential outcomes framework (Rubin 1973), we are able to simulate the growth and development trajectories of Syria using the combination of attributes of other countries that have similar characteristics but have not undergone an armed conflict in the respective period of investigation. This approach allows us to estimate a hypothetical scenario of growth and development using weighted averages of outcome-related country-level characteristics before the outbreak of the civil war that best track and reproduce Syrian trajectories. More specifically, the details of the synthetic control approach are described in Supplementary Appendix 2.

It should be noted that the causal effect of the Syrian civil war arises from the outcome difference between Syria after the civil war and the estimated counterfactual without the armed conflict. The synthetic control group that best reproduces the growth and development attributes of Syria prior to the war allows us to predict the plausible level of outcome if the war never happened. Provided that the synthetic control group is not tainted by the presence of armed conflict or insurgencies and the associated spillover effects, the outcome difference plausibly reflects the causal effect of civil war on Syrian economy and society.

The key for internal validity of synthetic control group is that it provides a reasonably good approximation of how the trajectory of the outcome of interest would have evolved if the civil war had not taken place. Therefore, it is vital that Syria and its synthetic control groups fully mimic each other. Therefore, the natural choice of variables to reproduce and track the outcomes' trajectories in the pre-war period is to consider the full path of pre-war outcome variables as the predictors (Hinrichs 2012, Cavallo et al. 2013, Billmeier and Nannicini 2013, Bohn et al. 2014, Bilgel and Galle 2015). Henceforth, the inclusion of the full set of pre-war outcome values per se renders the auxiliary covariates irrelevant (Kaul et al. 2015). For instance, Kaul et al. (2022) show that ignoring the covariates and optimizing only the fit with respect to the full span of lagged outcome variables may better capture unobserved components which may improve the performance of the synthetic control estimator at the cost of ignoring covariates whilst partially mitigating the curse of dimensionality. Based on this insight, we estimate our synthetic control specifications without covariates. Using the full path of pre-war outcome trajectories as the predictor, the synthetic control estimator provides an excellent fit of the trajectories characterized by very low imbalance between Syria and its synthetic peers.

3.2 Inference

Since large-sample asymptotic inference is not possible with synthetic control method, Abadie et al. (2010) advocate the use of treatment permutation method for inference on the treatment effect of interest. In our setup, we undertake a simple (i) in-space and (ii) in-time treatment permutation to detect whether the effect of the civil war on the growth and development outcomes is statistically significant at conventional levels (Galiani and Quistorff 2017). Treatment permutation consists of the iterative assignment of the civil war shock to the unaffected countries and use the outcome gaps to build the appropriate distribution of placebo effect. The details of the placebo analysis are explained in greater detail in in section S.A.2 of the Supplementary Appendix 2.

4 Data

4.1 Dependent variables

Our set of dependent variables to capture economic growth, human development and institutional quality consists of a series of outcomes. First, we proxy the trajectory of economic growth using the GDP per capita denoted in Geary–Khamis international dollar at 2017 prices using recently updated series from *Penn World Tables 10.0* (Feenstra et al. 2015). Second, our proxy for the degree of social and economic development is the human development index and comes from *United Nations Human Development Reports*. More specifically, the index is a static composite index of life expectancy, mean years of schooling and per capita income. A higher score indicates longer lifespan, more affluent levels of education and higher per capita income whilst the index is in the range between zero and one. In addition, we consider infant mortality and life expectancy at birth as separate outcomes in the analysis to disentangle the effect of civil war on specific dimensions of human development. The data on life expectancy at birth is from *World Health Organization*. The rate of infant mortality is measured the number of child deaths under 5 years of age per one thousand births and comes from the updated *World Development Indicators*. Third, to capture the effect of war on human capital, we proxy human capital investment using the composite index of human capital that combines the mean years of education (Barro and Lee 2013) and the returns to human capital (Cohen and Soto 2007; Cohen and Leker 2014). And fourth, to capture the effect of war on the costs in terms of displacement, we use the population density rate as a rough proxy thereof. The density is denoted in the number of residents per squared km^2 of land area, and provides a plausible insight into the extent of displacement induced by the civil war.

Another layer of dependent variables comprises the institutional quality outcomes. To estimate the effect of civil war on the trajectory of institutional quality over time, we use the indicators of quality from updated *Worldwide Governance Indicators* (Kaufmann et al. 2011). First, voice and accountability index reflects the perception of the degree to which the citizens of the country are able to participate in free and fair regular elections as well as the degree of civil liberties. Second, political stability and absence of violence reflects the likelihood that the government will be destabilized or

overthrown by violent and unconstitutional means that include politically-motivated violence and terrorism. Third, government effectiveness index measures the quality of public services, civil service as well as the quality of policy formulation, selection, implementation and the credibility of governments, and its commitment to raise and uphold high-quality policy-making. Fourth, somewhat relatedly, regulatory quality index captures the perceptions of the ability of the government to formulate and implement sound economic policies and regulations that facilitate private-sector development. Fifth, rule of law index reflects the perceptions of the degree to which citizens have confidence in and abide by the rules of society as well as the quality of contract enforcement, security of property rights for non-elites, the reliability of police and quality of the judicial system in resolving disputes as well as the likelihood of crime and violence. And sixth, we also use the control of corruption index. This particular indicator measures the extent to which public power is abused for private gain, including both petty and grand forms of corruption as well as the capture of the state by the political and business elites and the private interest groups.

4.2 Treatment and control samples

Our treatment sample consists of Syria and our time period of investigation is between the years 1996 and 2021. Drawing on the updated dataset of armed conflict (Brecke 1999), we build a donor pool of 66 countries[2] where no armed internal conflict took place in the period 1996–2021. Our treatment and control samples are strongly balanced. It should be noted that neighbouring countries receiving spillover effects of Syria's civil war through the inflow of refugees and the associated humanitarian costs are discarded from the donor pool. Due to the likely violation of stable unit treatment value assumption (SUTVA), it is highly likely that the inclusion of the neighbouring countries into the donor pool would conflate the treatment effect of civil war with severe biases and possibly lead to implausible estimate of the dynamic treatment effect.

4.3 Assessing pre-war outcome path balance

As explained above, we construct the synthetic version of Syria as a convex combination of countries in the donor pool that most closely resemble and track the trajectory of Syrian economic and social development in terms of pre-war values of the outcome variables. Table 1 closely compares the pre-war characteristics of the actual version of Syria with that of the synthetic counterpart. The evidence suggests that the synthetic control estimator provides a very good match between Syria and its synthetic control groups for the full set of economic growth, human development and institutional quality-related outcomes. In the years preceding the civil war, the outcome-specific

[2] Albania, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Belarus, Belgium, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Cape Verde, Cambodia, Canada, Chile, China, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Estonia, Finland, France, Germany, Greece, Honduras, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Namibia, Netherlands, New Zealand, Nicaragua, North Macedonia, Oman, Poland, Portugal, Qatar, Republic of Korea, Russia, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela.

Table 1 Pre-war outcome path balance

	GDP per capita		Human development index		Life expectancy		Infant mortality		Human capital formation		Population density	
	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
Pre-treatment training and validation period	2005–2011		1995–2011		1995–2007		1995–2011		1995–2011		1995–2010	
Post-treatment period	2012–2021		2012–2019		2008–2019		2012–2019		2012–2019		2011–2019	
Pre-war RMSE	127.79		0.004		0.054		0.011		0.005		0.00001	
# Pre-war outcomes	7		16		12		16		16		16	
# Control countries	66		65		66		66		60		65	
Pre-war R2	0.73		0.98		0.99		0.99		0.99		0.99	
Panel A: Pre-war outcome dynamics												
Outcome level in 1996			0.583	0.579	72.21	72.23	2.77	2.77	1.99	2.00	0.0008	0.0008
Outcome level in 1997			0.586	0.584	72.44	72.42	2.64	2.64	2.03	2.04	0.0008	0.0008
Outcome level in 1998			0.587	0.589	72.66	72.64	2.52	2.52	2.07	2.08	0.0008	0.0008
Outcome level in 1999			0.594	0.594	72.88	72.88	2.41	2.41	2.12	2.12	0.0009	0.0009

Table 1 (continued)

	GDP per capita		Human development index		Life expectancy		Infant mortality		Human capital formation		Population density	
	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
Outcome level in 2000			0.601	0.600	73.11	73.15	2.31	2.31	2.16	2.15	0.0009	0.0009
Outcome level in 2001			0.608	0.609	73.37	73.42	2.22	2.22	2.18	2.18	0.0009	0.0009
Outcome level in 2002			0.606	0.619	73.66	73.69	2.14	2.14	2.21	2.20	0.0009	0.0009
Outcome level in 2003			0.621	0.624	73.97	73.95	2.08	2.07	2.23	2.22	0.0009	0.0009
Outcome level in 2004			0.635	0.636	74.25	74.17	2.02	2.02	2.25	2.25	0.0010	0.0010
Outcome level in 2005	5889	5639	0.653	0.646	74.43	74.37	1.98	1.99	2.27	2.28	0.0010	0.0010
Outcome level in 2006	5538	5635	0.663	0.656	74.41	74.54	1.94	1.96	2.29	2.30	0.0010	0.0010
Outcome level in 2007	5685	5839	0.672	0.668	74.15	74.69	1.92	1.93	2.32	2.32	0.0011	0.0011
Outcome level in 2008	5793	5874	0.675	0.672			1.90	1.91	2.34	2.34	0.0011	0.0011

Table 1 (continued)

	GDP per capita		Human development index		Life expectancy		Infant mortality		Human capital formation		Population density	
	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
Outcome level in 2009	5725	5771	0.674	0.672			1.90	1.89	2.36	2.36	0.0012	0.0012
Outcome level in 2010	6208	6111	0.672	0.678			1.90	1.87	2.39	2.39	0.0012	0.0012
Outcome level in 2011	6367	6384	0.678	0.685			1.94	1.84	2.41	2.42	0.0008	0.0008

The table reports pre-war outcome-level balance path between Syria and its synthetic control groups. Pre-war root mean square prediction error (RMSE) indicates the degree of discrepancy between the outcome in Syria and in its synthetic peer during the pre-war training and validation period. R2 denotes the fraction of overall pre-war outcome variation explained by the underlying set of predictors

synthetic control groups are characterized by similar level of per capita GDP and socioeconomic development.

The size of the root mean square prediction error (RMSE) appears to be consistently low across the full set of growth and development specifications both in absolute terms relative to the mean values of the dependent variable as well as in terms of the benchmark level (Adhikari and Alm 2016). It should be noted that our outcome model specifications provide a good quality of the fit between Syria and its synthetic counterpart. In particular, the full path of pre-war outcomes tends to explain around 73% of the overall cross-country variation in per capita GDP, and consistently more than 90% of the corresponding cross-country variation in human development outcomes. As the imbalance between Syria and its synthetic control group in terms of pre-war outcomes appears to be low, our interpretation is that the synthetic control estimator provides a good quality of the fit and is unlikely to be contaminated by pre-existing shocks or suffer from the omission of important predictors.

5 Results

5.1 Effect of civil war on economic growth and social development

Figure 1 reports the estimated effect of civil war on the trajectory of Syria's economic growth and social development. To capture economic growth and some of its mechanisms, several variables are used in the empirical analysis through the application of synthetic control estimator. The solid line indicates the actual outcome path whilst the dashed line represents the synthetic counterfactual. The evidence invariably suggests

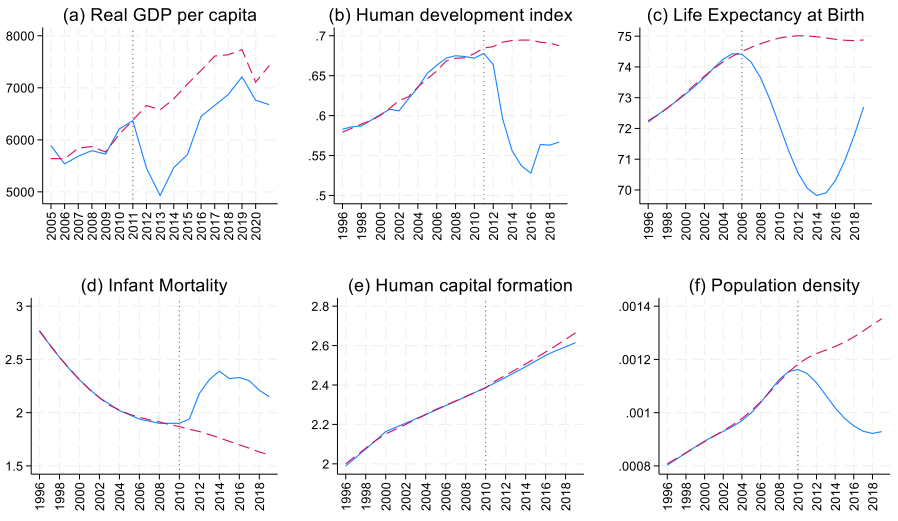

Fig. 1 Economic growth and social development effect of civil war on Syrian economy, 1995–2021

large losses of per capita GDP along with a rampant deterioration of social development in the years after the civil war. Without the loss of generality, the key insights can be drawn from the analysis of the effects of war on Syrian economy. First, in the light of the general effects of civil war reported in the existing literature (Collier and Sambanis 2005), Syrian civil war appears to be a temporary shock for the trajectory of economic growth with no discernible long-term effect on per capita GDP. That said, the trajectory of growth uncovers a steady and rapid deterioration of output in the first 3 years of the war. After 2013, Syria's GDP appears to rebound and gradually approach the trajectory of its synthetic control group before the onset of COVID19 pandemic. In the end-of-sample year, our estimates suggest that Syria's GDP per capita is 974 international dollars below the level of its synthetic control group, or roughly 14% relative to the level of its per capita GDP. Contrary to more recent evidence on impact of civil wars and armed insurgencies (Fearon and Laitin 2003; Chamarbagwala and Morán 2011, Bluscz and Valente 2022, Keseljevic and Spruk 2023), the war in Syria inflicted a deep but temporary shock onto the trajectory of growth with no evidence of permanent structural breakdown.

Several possible mechanisms behind a temporary decline can be established from the stylized facts and prior findings. First, Syria's pre-war GDP composition may have been particularly less exposed to prolonged negative effects that could exacerbate a permanent breakdown of the growth trajectory. For instance, through widespread destruction of the capital stock, civil war causes capital-intensive sectors to contract more rapidly than sectors with opposite characteristics such as arable agriculture (Collier 1999). Since around 20% of the GDP before the war consist of agriculture, the rate of capital intensity has been sufficiently low to offset possibly dramatic GDP losses if the capital-intensive sector were the major GDP component. And second, large-scale war losses may be counteracted by intensified external recovery and development assistance from major donors. From 2013 onwards, Syria has received around $14 billion in humanitarian assistance, $ 1 billion in stabilization assistance from US Agency for International Development, €2 billion from EU Regional Trust Fund, and around $4 million of emergency humanitarian aid from China. The estimated official development assistance from Russia and Iran has been constrained by the lack of transparency and poor disclosure. Hence, a combination of less capital-intensive pre-war GDP composition and relatively broad international humanitarian and stabilization assistance possibly explain why Syrian civil war appear to be a temporary GDP shock instead of the permanent one. The economic growth trajectory of Syria before the civil war is best reproduced as a convex combination of countries' growth and development attributes that fall within its convex hull such as Honduras (78%), Bolivia (18%), and Belgium (4%), respectively.

Second, the effect of the civil war on human development appears to be particularly devastating and mimics the characteristics of the structural breakdown. For instance, our estimates of the average treatment effect suggest that the civil war has stymied the human development index by 0.119 basis points compared to its synthetic control group. The deterioration of human development index tends to unfold in a gradual manner that becomes noticeably stronger up to the present day. Compared to its synthetic control group, the trajectory of human development exhibits a large downward sloping trend with sign of the mild reversal in 2017 followed by a stagnation in the

year preceding the COVID19 pandemic. Our synthetic control estimates highlight a pattern of steady growth and reinforced improvement in human development index in the hypothetical absence of the war. Pre-war trajectory of Syria's human development index can be best reproduced as a convex combination of the implied attributes of Venezuela (32%), Honduras (26%), Cambodia (26%), Finland (10%), and Armenia (5%), respectively. A pervasive drop in human development appears to be permanent with no sign of substantial reversal that would indicate a long-lasting but temporary shock to human development induced by the civil war.

By examining the effect of civil war on specific components of human development, it becomes apparent that the negative effect of civil war on human development materializes mainly through a drop of longevity rather than human capital deterioration. For instance, before the civil war, Syria's life expectancy at birth was around 74 years. Until 2015, life expectancy decreased to 69 years which entails around one life year deterioration for each year of the armed conflict. Our synthetic control estimates invariably suggest that in the hypothetical absence of the war, life expectancy trajectory would reach 75.2 years. In comparative perspective, such life expectancy threshold is comparable with Türkiye and Argentina. By 2019, our estimates thus imply that Syria's life expectancy is around 2.5 years (i.e. RMSE = 0.054) lower compared to its synthetic control group. The deterioration of longevity during the civil war tends to be permanent and underpinned by the accelerated closing of the gap up to the final year of our investigation. The composition of synthetic control group invariably suggests that pre-war trajectory of Syria's life expectancy is best reproduced by the implicit attributes of Venezuela (65%), Singapore (20%), Cape Verde (12%), and Japan (3%), respectively.

On the contrary, the effect of civil war on human capital formation appears to be weak. The trajectory of human capital index of Syria is almost identical to the trajectory of its synthetic control group before and after the war with minimal predictive discrepancy (i.e. RMSE = 0.005). A very low gap between Syria and its control group further reinforcing the notion of almost zero effect of war on human capital. The trajectory of Syria's human capital formation can be best synthesized as a convex combination of the implied attributes of United Arab Emirates (41%), Brazil (33%), Cambodia (25%), and Singapore (< 1%).

By contrast, the effect of civil war on infant mortality appears to be very large. Our synthetic control estimates invariably suggest that in the hypothetical absence of the war, infant mortality would continually exhibit a downward trajectory reaching the level of 16 deaths per 1000 live births which is comparable with countries such as Brazil and Ecuador by the end of our sample period. By 2019, the observed rate of infant mortality reached 21.5 deaths per 1000 live births which is one of the highest rates of mortality in our sample and is comparable with Venezuela. Considering the estimated number of births from *Worldwide Development Indicators*, our estimates suggest that the number of infant deaths in the first year of the war amounts to around 95, raises to 357 in the second year of the war and reaches 516 infant deaths in the third year of the war. The highest number of infant deaths is estimated in 2017 when the toll reaches 633 deaths and gradually decreases to 545 additional deaths in 2019 as

our end-of-sample year. This implies that the cumulative infant death toll of the civil war is around 4574 additional infant deaths from 2011 to 2019.[3]

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of additional infant deaths	95	357	516	626	589	632	634	580	545

The deterioration of infant mortality is further underpinned by its permanency relative to the estimated counterfactual. The trajectory of Syria's infant mortality prior to the civil war is best reproduced as a convex combination of the implicit characteristics of Malaysia (49%, Dominican Republic (39%), Serbia (10%), and Cape Verde (3%), respectively.

In addition, our analysis uncovers evidence of large-scale population displacement in response to the civil war. Although a more nuanced and informative analysis would necessitate the use of data on the outflow of migrants, our approach is to capture the effect of war on displacement using population density rate and estimate the appropriate counterfactual scenario. The evidence suggests that a synthetic Syria provides an excellent fit of the population density trajectory in the period before the civil war. The discrepancy between the observed density trajectory and its synthetic peer appears to be minimal (i.e. RMSE = 0.00001). Our synthetic control estimate of the treatment effect of civil war indicates a continuously increasing trajectory of population density in the hypothetical absence of the war. After the onset of the civil war, population density exhibits a persistent decrease that appears to be permanent. In the initial year of the civil war, the estimated treatment effect indicates 100 fewer people per km2 which tends to increase up to 400 people per km^2 by 2019. The average treatment effect of the civil war on population density is 300 fewer people per km2. By the end of our sample, the estimated population density gap tends to increase considerably, leading to the cumulative loss of slightly more than 7.4 million people displaced for the entire duration of war up to 2019. Our estimates appear to be in the range of official estimates of displaced population between 6 million and 8.5 million as reported by *United Nations High Commissioner for Refugees* (UNHCR). The population density trajectory of Syria before the civil war is best reproduced as a convex combination of demographic and auxiliary characteristics of Costa Rica (85%), United Arab Emirates (12%), Bosnia and Herzegovina (3%), Bahrain (1%), and Singapore (< 1%), respectively.

Figure 2 unveils the composition of synthetic control groups in greater detail and omits zero-weight countries for the sake of clarity and transparency. In the supplementary appendix, Figure A1 in Supplementary Appendix 1 depicts the estimated treatment effect of civil war on economic growth and social development in greater

[3] The annual number infant deaths reconstructed from our synthetic control mortality estimates combined with the data on the number of live births is presented in the following table:

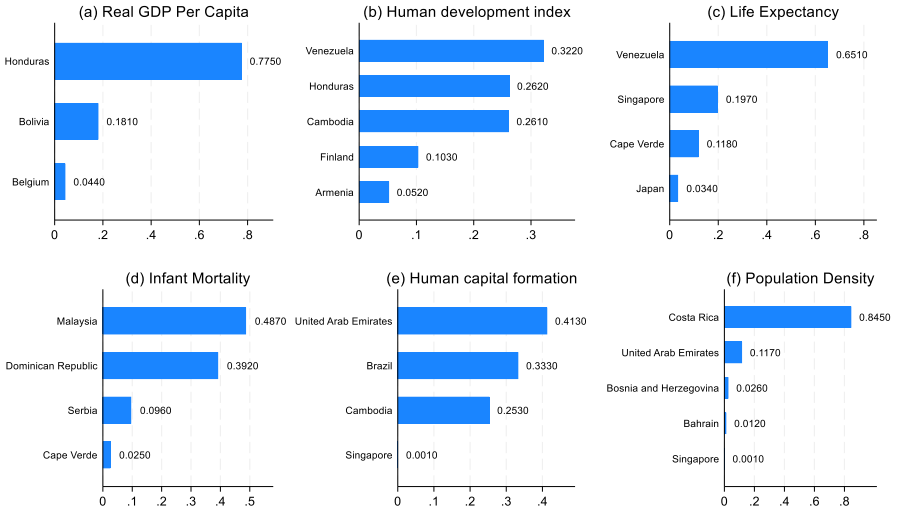

Fig. 2 Composition of synthetic control groups and optimal country-level weights

detail. Furthermore, it should be noted that variables used to measure the discrepancy between Syria ($\mathbf{X}_{\text{Syria}}$) and its control groups ($\mathbf{X}_0$) comprise pre-war economic growth and social development outcomes reported in Table 1. Furthermore, Figure A2 in Supplementary Appendix 1 reports the optimal pre-war outcome weights used to construct the synthetic version of Syria across the full spectrum of outcomes.

The most obvious question behind our analysis is whether the trajectories of economic growth and social development between Syria and its artificial control groups follow a differential and statistically distinguishable trend in the post-treatment period. Was the differential trend triggered by the onset of the civil war or by the pre-existing dynamics? In ideal circumstances, the trend in the outcome-related gap between Syria and its control group should be statistically indistinguishable from zero in the pre-war period. If the estimated average treatment effects are internally valid, the outcome trajectories between Syria and its control groups should exhibit a differential and statistically significant change of the trend after the beginning of the war. Following Spruk and Kovac (2020), we assess the differential trend assumption through a triple-difference setup.

More specifically, we ask whether the civil war triggered a differential change in the trend of the economic growth and social development trajectories. That is, we compare the change in the slopes of actual Syria in pre- versus post-war period with the corresponding change in the slopes of synthetic Syria in the pre- versus post-war period which invokes a setup of triple-differences specification leveraging a change in the outcome induced by the civil war against the outcome change between Syria and its synthetic control group. Table 2 reports triple-differences test of the differential trend assumption. It reports outcome-specific p-values on the exact F-test statistics using Chow (1960) structural break test to determine whether the civil war induced a statistically significant break in the trend of the outcome gap trajectory. The

Table 2 Testing differential post-war trend assumption in economic growth and social development

	Real GDP Per capita	Human development index	Life expectancy	Infant mortality	Human capital formation	Population density
Wald-Chow test statistics (p-value)	7.07 (0.000)	13.07 (0.003)	10.31 (0.005)	200.17 (0.000)	8.02 (0.045)	153.35 (0.000)

The table reports Spruk and Kovac (2020) test of the differential trend assumption. Under the null hypothesis, the treatment-related shock (i.e. civil war) fails to induce a differential trend of the outcome difference between the treated unit and its synthetic control group, and both units exhibit similar gap trend between pre- and post-treatment period. The table reports the p-values on the exact Supremum Wald test statistics of the Chow (1960) structural break in the triple-differences structural setup of the model. Two-sided p-values are reported in the parentheses

evidence suggests that the null hypothesis behind the differential trend assumption is consistently rejected. That said, our synthetic control analysis provides reasonable evidence in support of the notion that the civil war triggered a statistically significant and differential gap trend in economic growth and social development trajectories. By making use of simple Chow test on the triple-differences coefficient, we consistently reject the null hypothesis on the differential trend (p value $= 0.000$) at conventional 1% and 5% levels, which allows us to conclude that the civil war drastically deteriorated the trajectories of economic growth and human development of Syria.

Figure 3 reports the in-space placebo analysis of the Syrian civil war on economic growth and social development trajectories. As a simple permutation test, the civil

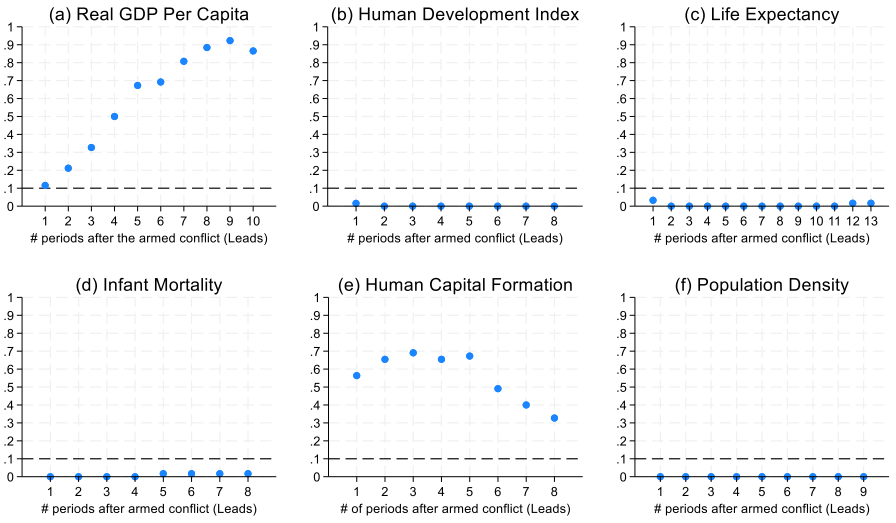

Fig. 3 In-space placebo analysis of the civil war effect on economic growth and social development

war is iteratively assigned to the full set of countries from the donor pool that have not undergone any armed conflict. In the next step, the distribution of placebo gaps is constructed such that $\hat{\theta}_{1,t}^{\text{Placebo}} = \{\theta_{j,t} : j \neq 1\}$. In the next step, the inference on the effect is conducted by assessing the dis-similarity of the estimated gaps between Syria and the placebo distribution, and computing the corresponding p-values from Eq. (7) of the Supplementary Appendix 2. The vertical axis reports the probability of obtaining the estimated effect at random. Our rule of thumb is simple. If the probability of chance-based effect is greater than 10%, the notion that our analysis provides ample evidence of the significant effect is not credible. Higher values indicate greater probability that the effect is obtained by chance. Our placebo analysis excludes countries having pre-war RMSE more than four times the pre-war RMSE of Syria to compare the latter only to those countries that match nearly as well as Syria prior to the onset of the civil war.

The evidence confirms a temporary negative effect of the war on GDP per capita. The underlying *p*-values tend to be considerably low up to the third year after the beginning of war, and rebound upward to the level above 75% which rule out the notion of permanent breakdown of the growth trajectory. Similar evidence can be found with respect to the effect of war on human capital formation as the intertemporal distribution of *p*-values fails to indicate statistically significant effect. Taken altogether, the evidence confirms a weak effect of armed conflict on the trajectory of economic growth that seems to be temporary at best, as well as no effect whatsoever on human capital formation. By contrast, our placebo analysis uncovers substantial evidence in support of the permanent deterioration of life expectancy, infant mortality and population density after the beginning of civil war. In particular, the estimated *p*-values on the human development effects of civil war are both immediate and appear to be clearly within the 10% threshold with no sign of the reversal up to the present day.

We also undertake in-time placebo analysis by falsely assigning the year of the civil war to the deliberately wrong date by making use of Zivot and Andrews (2002) single structural break test to select the placebo year. The evidence suggests that the estimated economic growth and human development gaps tend to diverge precisely by the beginning of civil war, and not by deliberately false dates of treatment unrelated to the civil war. In the Supplementary Appendix 1, Table A2 reports the selected false treatment dates based on Zivot–Andrews test along with the breakpoint test statistics. Furthermore, Panel A in Figure A6 reports the in-time placebo analysis of the economic growth and human development effect of civil war.

5.2 Effect of civil war on institutional quality

Figure 4 reports the effect of civil war on the trajectories of institutional quality. The dashed line indicates the estimated counterfactual against the actual realization of the outcome indicated by the solid line. As the set of dependent variables to capture the institutional quality, six disaggregated governance indicators from Kaufmann et al. (2011) that partially reflect the quality and strength of public governance and

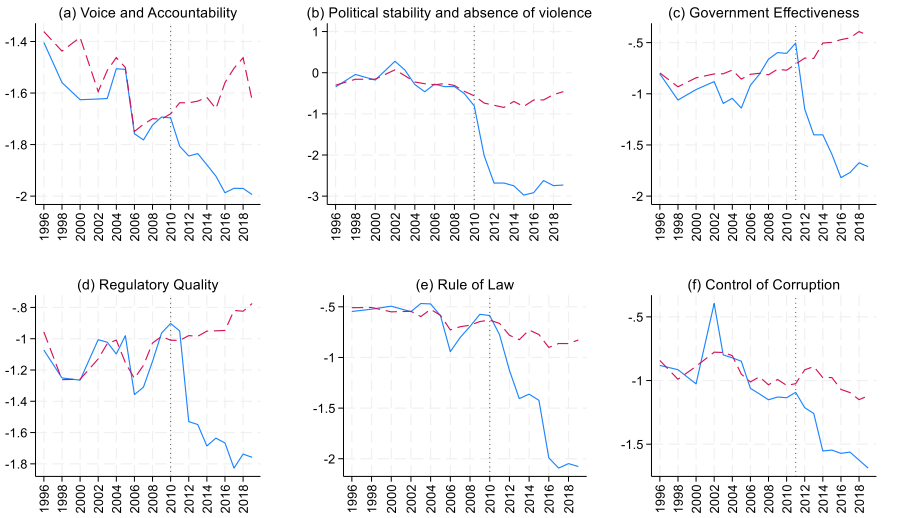

Fig. 4 Effect of Syrian civil war on institutional quality trajectories, 1996–2020

institutional framework are used. It should be noted that the synthetic control estimator provides a very good fit of institutional quality trajectories between Syria and its synthetic control groups. The evidence from our synthetic control analysis unveils persistent and rampant deterioration of institutional quality after the war towards more extractive and exclusionary institutional framework titled in favour of the ruling elite network. In search of the missing counterfactual scenario, synthetic control estimator provides a reasonably good quality of the institutional quality fit between Syria and its synthetic control group across the full set of specifications. The estimated institutional quality gap after the beginning the civil war is both large and negative, indicating a pervasive worsening and weakening of the institutional framework in both enshrining and ensure the rule of law, effective functioning of government administration and safeguarding the control over corruption whilst failing to uphold the strength and freedom of the civil society in monitoring the elites in power. In the Supplementary Appendix, Table A1 presents pre-war institutional trajectories' path balance whilst Figure A3 depicts the dynamic treatment effect of civil war on institutional quality in greater detail.

In terms of further example, Panel (a) in Fig. 4 exhibits the impact of civil war on the trajectory of voice and accountability. The estimates indicate a large-scale institutional breakdown with discerned evidence of weakened and further curtailed freedom of expression, freedom of association and continually hindered ability of citizens to participate in the selection of government. On the contrary, the synthetic version of Syria is characterized by some improvement in the voice and accountability trajectory which we interpret as evidence of the debilitating impact of civil war on the freedom of expression, association and information. The negative gap between Syria and its synthetic peer unfolds immediately after the civil war and tends to deepen up to the present day with no sign of recovery. Syria's trajectory of voice and accountability

prior to the civil war can be best synthesized as a weighted combination of implicit attributes of China (100%).

The effect of civil war on the trajectory of political stability and absence of violence is particularly devastating. The underlying trajectory exhibits a sharp and immediate drop at the beginning of the civil war. The deterioration of political stability and widespread escalation of violence and terrorism increases substantially up to the present day and appears to be permanent. Furthermore, our synthetic control estimates uncover additional evidence indicating a widespread deterioration of government effective and regulatory quality. The deterioration of both trajectories is underpinned by its permanency. The estimated counterfactual scenarios jointly indicate small-scale but mutually reinforced improvements in the quality of civil service, quality of public services as well as their independence from the political pressure, and further highlight devastating effect of war on the government capacity to formulate and implement public policies to promote private-sector development. The pre-war trajectory of political stability and absence of violence is best reproduced through a convex combination of the implied characteristics of Bahrain (40%), Greece (28%), Russia (24%), and Venezuela (8%), respectively. By contrast, Cambodia (52%) appear to the dominant donors with non-zero weight in the government effectiveness specification alongside Ecuador (14%), Azerbaijan (13%), Serbia (11%), and Bosnia and Herzegovina (9%), having noticeably smaller weight shares. It should also be noted that the composition of Syria's synthetic control group that best tracks its regulatory quality trajectory largely consists of the authoritarian regimes such as Belarus (55%), Azerbaijan (25%), Venezuela (16%), and Bolivia (3%), respectively.

Panel (e) exhibits the effect of civil war on the trajectory of the rule of law. The evidence suggests that the synthetic control estimator provides a very good quality of the fit between Syria and its synthetic control group prior to the war. Our synthetic control estimates provide evidence of widespread decay and collapse of the rule of law that appears to be irreversible up to the present day. Without losing generality, our estimates suggest that the civil war has both decimated and almost entirely eroded the confidence in the rules of society through drastic worsening of the quality of contract enforcement, escalated insecurity of property rights and fallout of trust in courts and the police forces that jointly reinforced the likelihood of crime and violence. Furthermore, Syria's rule of law trajectory prior to the war is best synthesized as a convex combination of the implicit attributes of Honduras (50%), Oman (22%), Venezuela (18%), Brazil (6%), Bolivia (2%), and Croatia (1%). Lastly, panel (f) portrays the effect of civil war on the control of corruption trajectory. The evidence indicates a massive deterioration in the ability to control corruption in response to the civil war. The estimated gap between Syria and its synthetic peer is both immediate and tends to widen substantially over time. Our evidence invariably pinpoints a rapid escalation of both grand and petty corruption at all levels of government through the exercise of public power for private gain as well as through the state capture by elite and private interests. Through the erosion of strength and effectiveness of institutional framework to prevent and combat corruption, our synthetic control estimates highlights several sources of substantially increased corruption such as nepotism, cronyism and patronage in the civil services, irregular payments in obtaining permits and public services. The civil war appears to have decimated the institutional processes for both accountability and

transparency in decision-making. Through the abuse of public power for the pursuit of private gain, the economic effects of corruption are well known and include increasing costs of labour and capital, lowered productivity, depressed investment, reduced confidence and trust in public institutions, limited private sector development of small and medium-sized enterprises, weakened fiscal capacity and undermined public investment in health and education (Mauro 1995, Ades and Di Tella 1999, Friedman et al. 2000, Johnson et al. 2000, Del Monte and Papagni 2001, Kaufmann and Kraay 2002, Anderson and Tverdova 2003, Lambsdorff 2003a,b, Fisman and Svensson 2007).

The erosion and weakening of the institutional framework unveiled by our synthetic control estimations in response to the civil war has particularly devastating consequences for the middle-income countries. Heightened instability, weakened rule of law and widespread corrupt behaviour increase poverty (Ravallion and Chen 1997, Gupta et al. 2002), tilt public expenditure in favour of economic and political elites (Mauro 1998, Rajkumar and Swaroop 2008), prolonging investment in unproductive projects as well as a more regressive tax system that typically diverts funds away from key public services which reinforces higher level of risk, especially for more vulnerable individuals, as well as higher income and wealth inequality (Olken 2007; Olken and Pande 2012). It should be noted that the drop in the ability to control corruption pales noticeably smaller in comparison with the estimated gaps in political instability, rule of law, and government effectiveness. The counterfactual trajectory of the control of corruption trajectory consists of the weighted average of the implied attributes of Cambodia (64%), Nicaragua (20%), Russian Federation (9%), Bahrain (6%), and Dominican Republic (< 1%), respectively. Figure 5 summarizes the composition of synthetic control groups across the full series of institutional quality specifications

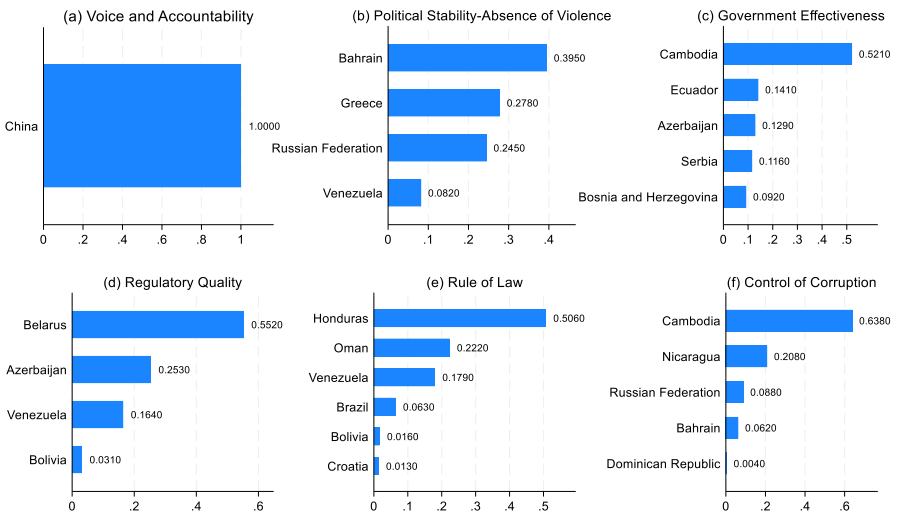

Fig. 5 Composition of synthetic control groups

Table 3 Testing differential post-war trend assumption across institutional quality specifications

	Voice and accountability	Political stability and absence of violence	Government effectiveness	Regulatory quality	Rule of law	Control of corruption
Wald-Chow test statistics (p-value)	8.61 (0.035)	126.97 (0.000)	342.90 (0.000)	107.15 (0.000)	59.94 (0.000)	23.41 (0.000)

The table reports Spruk and Kovac (2020) test of the differential trend assumption. Under the null hypothesis, the treatment-related shock (i.e. civil war) fails to induce a differential trend of the outcome difference between the treated unit and its synthetic control group, and both units exhibit similar gap trend between pre- and post-treatment period. The table reports the *p*-values on the exact Fisher test statistics of the Chow (1960) structural break in the triple-differences structural setup of the model. Two-sided *p*-values are reported in the parentheses

and omits the donor countries with zero weight. Furthermore, Figure A4 in the Supplementary Appendix depicts optimal outcome-level weights across the institutional quality specifications.

Table 3 presents the test of differential trend assumption in the institutional quality trajectories in response to the civil war as the underlying treatment-related shock. By comparing the change in the slopes of actual Syria in pre- versus post-war period with the corresponding change in the slopes of synthetic Syria in the pre- versus post-war period, we examine whether the civil war triggered a differential change in the trend of the trajectories of institutional quality that may be attributed to the war itself. Our evidence suggests that the null hypothesis behind the differential trend assumption is consistently rejected. The Chow test statistics on the triple-differences coefficient is statistically significant at 1% across the full realm of institutional quality specifications. It thus provides plausible evidence in support of the notion that the civil war aggravated significant and differential gap trend in the trajectories of institutional quality.

Figure 6 presents the in-space placebo analysis of the impact of Syrian civil war on institutional quality trajectories. More specifically, the figure reports the *p*-values associated with the post-treatment effect of the civil war on institutional quality trajectories. The evidence indicates a reasonably strong and statistically significant institutional quality effect of the Syrian civil war. The empirical p-values on the estimated post-treatment effect of the civil war are consistently low and within the conventional 10% significance threshold across the full spectrum of institutional quality specifications. Inference on the post-treatment effect of the Syrian civil war suggests that the post-treatment effect of civil war on the institutional quality trajectories is both immediate and appears to be permanent. The erosion of the civil liberties, political stability, control of corruption and government effectiveness appears to have unfolded immediately after the beginning of the war whilst the post-treatment effect of civil war on the regulatory quality tends to become statistically significant in the second year after the beginning of the armed conflict. Up to the most recent year of our investigation, the

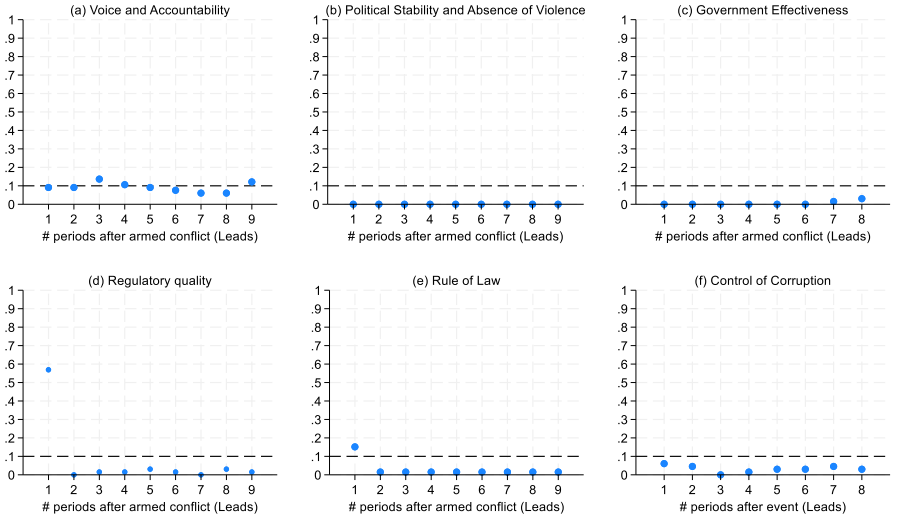

Fig. 6 Inference on the post-treatment effect of civil war on institutional quality of Syria, 2011–2019

evidence fails to bolster the notion of a temporary derailment of institutional quality in response to the war, and highlights a potentially severe institutional quality breakdown after 2011 with no discernible signs of recovery. Notice that the proportion of countries with an estimated placebo gap similar to that of Syria is extremely low. Moreover, the underlying proportion is zero in the specifications of political stability, government effectiveness and rule of law which suggests that no other country in the donor pool has undergone such a bold and tumultuous deterioration of institutional quality as Syria after 2011, which we interpret as reasonably clear evidence of the statistically significant impact of the civil war. In addition, the empirical *p*-values for the post-treatment effect of war on regulatory quality, voice and accountability and control of corruption are exceptionally low, and further reinforce the notion of deep and significant negative effect of civil war on institutional quality.

Furthermore, we examine the stability of the institutional quality effect of the civil war and the sensitivity of the estimated post-treatment effects to the choice of variable. This, we compute the first principal component of the six governance variables to extract the most powerful latent variable of institutional quality that exhibits the most common variation across the indicators, and calculate the corresponding Raleigh quotient. In the next step, Syria is synthetically matched with other countries in the donor pool on past values on the Raleigh quotient to re-estimate the missing counterfactual scenario. The results are reproduced in Figure A5 in the Supplementary Appendix. Evaluating the evidence against our baseline estimates in Fig. 4, the synthetic control estimator yields an excellent quality of the fit of the first principal component trajectory prior to the civil war. The estimated post-treatment effect of the civil war is entirely consistent with our baseline estimates and highlights a severe breakdown and deep erosion of institutional quality in response to the armed conflict. The trajectory of Syria's first principal component of institutional quality in the pre-war period is best

reproduced as a convex combination of both implicit and explicit attributes of Russian Federation (40%), Cambodia (24%), Venezuela (19%), and Azerbaijan (17%), respectively. The erosion of institutional quality appears to be both immediate and tends to amplify strongly over time with no discernible sign of the transitory effect. By assigning the civil war to every other country not undergoing the armed conflict during our sample period, the distribution of placebo gaps is obtained. The inference on the estimated post-treatment effect indicates that no other country approaches Syria in the estimated post-2011 institutional quality gap, and yields exceptionally low empirical *p*-value. In the light of the empirical *p*-values in the post-intervention period, our interpretation of the result is that the post-treatment effect provides plausible evidence of the institutional quality effect of Syrian civil war which highlights a heighted divergence from the rest of the world towards less pluralistic, more extractive and less participatory institutional framework that has become even more biased in favour of the elites and well-connected private interests. Furthermore, by falsely assigning the year of the civil war to the wrong date, we show the estimated institutional quality gaps survive a battery of in-time placebo checks. In this respect, Table A2 in Supplementary Appendix 1 reports the selected break dates based on Zivot and Andrews (2002) single structural break test whilst Figure A6 reports the in-time placebo gaps, indicating no association between the estimated gaps and the placebo years.

5.3 Discussion

Estimating the missing counterfactual growth and institutional development scenario highlights plausible trajectories of economic growth and institutional quality in the eventual absence of the civil war in Syria through the convex combination of growth and quality attributes of the countries directly unaffected by the civil war. Through the application of synthetic control estimator, the missing counterfactual scenario indicates pervasive and unprecedented losses of human development, particularly reduced longevity and substantially increased infant mortality. In addition, we find evidence of severe population displacement whilst the effect of war on per capita GDP appears to be rather temporary.

The obvious question behind the array of estimated gap concerns the comparative context of the results uncovered in our investigation in comparison with the previous findings in the literature on civil war. Similar to the armed conflicts in former Yugoslavia, sub-Saharan Africa, Colombia and Middle East (Collier and Sambanis 2005), the civil war in Syria appears to be a large-scale and negative shock with a sizeable and non-trivial effect on the trajectory of economic growth. Our synthetic control estimates show that the negative effect of war is particularly strong in the first 2 years of the conflict. After 2013, the growth trajectory of Syria unfolds into a recovery and down to the beginning of the COVID19 pandemic, the respective growth path almost fully converges with the synthetic control group that is dominated by countries such as Honduras and Bolivia. In contrast to the armed conflict in former Yugoslavia (Keseljevic and Spruk 2023), the negative effect of civil war on economic growth gradually weakens over time.

One of the most plausible mechanisms behind a relatively temporary effect of war on per capita GDP arises from the economic specialization prior to the armed conflict. In particular, the GDP share of industries relying on tangible assets before the war has been estimated at less than 20% whilst the share of agriculture and services stood at 20% and 60%, respectively. This implies that a large-scale cumulative loss of GDP has been somewhat lower given that the presence of tangible assets and capital-intensive sectors has been relatively scarce compared to the conflict areas in former Yugoslavia where capital-output ratio to the conflict stood at around 40% (Kukić 2018) whilst the size of the manufacturing sector has been estimated at 50% of the GDP. Our point estimates that by 2021, Syrian per capita GDP would be 974 international dollars lower than it would be in the absence of the civil war. On a comparative ledger, such difference implies that had the civil war been avoided, Syria's per capita GDP down to the present day would be at the bar of Namibia and Bolivia. Given a large-scale drop in the investment rate and export share of GDP indicated by Penn World Tables (Feenstra et al. 2015) and a relatively small share of sectors relying on tangible assets, it is plausible to note that the recovery has been driven by substantial increases in government consumption used to rebuild the damaged infrastructure, private domestic consumption, agricultural production and large-scale informal economy which has been estimated at around 20% of the GDP (Medina and Schneider 2018).

Contrary to the popularized perception, our results cast a shadow of doubt on the effectiveness of international sanctions imposed on Al Assad regime by European Union and United States that hinged on the prohibition of trade in goods and services, a series of embargos and freezing of financial assets among several others. Our evidence shows that, in terms of per capita GDP, the imposition of sanctions has not stifled the economic recovery after the formal ceasefire. On the other hand, the imposed sanctions on humanitarian and public health outcomes only seem to have prolonged the protracted and deep negative effects of war on various metrics of human development (Friberg Lyme 2012, Sen et al. 2013, Moret 2015). One possible mechanism in counteracting deleterious effect of international sanctions may be the increased military and development assistance of countries such as China and, to a lesser extent, Russia and Iran (Burton et al. 2021).

In terms of further example, the humanitarian impact of the civil war appears to be devastating. Our synthetic control estimates uncover evidence of considerably reduced longevity and massively increased infant mortality in the light of ailing and weakened public health capacity to provide the basic public goods and services to the civilian population. Up to the present day, the average life expectancy at birth in Syria is around 3.3 years lower than it would be in the hypothetical absence of the civil war. Through the lens of comparative perspective, our estimates imply that under no-war scenario, Syria's life expectancy in 2019 would be comparable with Türkiye and Argentina, and less than 2 years lower compared to the United States. In terms of further example, before the civil war, Syria was project to reach the rate of infant mortality of the least developed EU member states in about 15 years under the pre-war demographic scenario. The civil war led to an unprecedented increase in infant mortality by 51% compared to the synthetic control group. In real terms, the quantitative estimates of infant mortality gap imply that the cumulative mortality toll is around 4572 infant deaths during the war. Before the onset of the civil war and sectarian violence, Syria's

human development index was comparable with China whilst we show that without the war, it would be 23% higher up to the present day whilst today it is comparable with countries such as Pakistan and Cameroon. Without the loss of generality, our estimates show that the civil war in Syria has destroyed and decimated an otherwise reasonably strong growth and development potential of a country, which would join the club of upper-middle income countries by 2025 in the absence of the armed conflict.

Furthermore, our evidence also bolsters the notion that the civil war led to a more extractive and exclusionary institutional structure. In retrospect, comparing the evolution of the institutional quality trajectory with that of the estimated counterfactuals, it becomes apparent that the civil war led to a protracted suppression of civil liberties and freedom of expression, widespread state-sponsored violence against the civilian population and political opponents, weakened effectiveness of government administration, rampant deterioration of the rule of law, deleterious regulatory quality and more widespread corruption.

6 Conclusion

Civil unrest in Syria began in 2011 in a wave of Arab Spring protests in response to the discontent with Syrian government. Unlike elsewhere in the Middle East, the protests evolved and escalated into a massive armed conflict after the calls for the removal of Al Assad by Syrian opposition forces and the protestors were violently squashed. The war in Syria has been fought by several factions and quickly reached an international dimension. The Syrian Armed Forces under the government control have been supported by Iran, Russia and Hezbollah whilst the opposition-controlled Syrian Democratic Forces and Syrian National Army received the support from United States and Turkey. Without the loss of generality, Syrian civil war has been characterized as one of the most violent episodes of armed conflict in modern history leading to the most widespread displacement of population and unprecedented refugee crisis and paramount humanitarian costs. In tackling the costs of civil war, the question that has received much less attention concerns the counterfactual dynamics, namely, how would Syrian economy, institutions and society have developed in the hypothetical absence of the armed conflict.

In this paper, we examine the causal effect of civil war on Syrian economy, human development and institutional quality by estimating the missing set of counterfactual scenarios using the synthetic control method. Our period of investigation begins in 1996 and ends in 2021, which allows us to exploit a reasonable pre-war outcomes' dynamic to track and reproduce the Syria's economic and institutional development through a convex combination of attributes of countries without armed conflict in donor pool of 66 nations. Through the attributes of countries that resemble the latent characteristics of Syria prior to the civil war but have not undergone armed internal conflicts, we are able to estimate the gaps in trajectories of economic growth, human development and institutional quality to plausibly estimate the underlying effect of war.

Our results uncover large and deleterious negative effect of civil war on Syrian economy and society. A broad array of synthetic control estimates invariably suggests

that the civil war has caused a large but temporary deviation of economic growth trajectory from its synthetic counterfactual. That said, the civil war has produced a sharp drop in GDP per capita until 2014 that appears to be statistically significant. After 2014, Syrian economy gradually caught up its counterfactual trajectory until the onset of COVID19 pandemic whilst the effect of war on per capita GDP down to the present day has narrowed down substantially. Although a more elaborate analysis would hinge on the specific mechanism at work, the humanitarian and military aid by China, and, to a much lesser extent, Iran and Russia may be an important mechanism behind the rapid post-war recovery.

On the contrary, the effect of civil war on human development is particularly devastating. The evidence based on the series of synthetic control specifications indicates pervasive drops human development capability that is further reinforced by massive decrease in life expectancy, a large increase in infant mortality and a huge drop in population density relative to Syria's synthetic control group. In real terms, our estimates imply that the civil war in Syria has led to more than 4,500 cumulative additional infant deaths for the duration of the war until 2019 which is both unprecedentedly large and also appears to be statistically significant at the conventional levels. Our estimates also uncover some tacit insights into the path of institutional development after the war. In this respect, we show that Syria's institutional quality has deteriorated rampantly towards a more exclusionary, rent-seeking oriented and distortionary institutional environment. Down to the present day, the civil war appears to have caused a large-scale deterioration of the freedom of the expression and pluralism, debilitation of political stability, escalation of political violence against the non-regime forces, rampant drops in government effectiveness and widespread weakening of the rule of law and control of corruption. The estimated institutional quality, economic growth and human development effects appear to be statistically significant and very large. The estimates indicate a rapid recovery of Syrian economy after the first 3 years of the war coupled with deep losses of human development potential and pervasively more extractive institutional environment tilted in favour of the existing political and business elites that mutually undermines the long-term growth and development potential.

The future research on the effect of Syrian civil war should go a step further. One potentially interesting avenue of research hinges on the subnational effects of civil war by differentiating between regime-controlled areas and the areas under the control of opposition or ISIS insurgency guerrillas, urban and non-urban areas, major and minor cities among several other dimensions. This may better unravel the heterogeneity of the effects of civil war in greater detail which would greatly improve our understanding the short-term and possible long-term consequences of armed conflicts such as the civil war in Syria.

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