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The economic consequences of war: Estimates using synthetic controls

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This paper investigates the short- and long run economic effects of wars drawing on a novel database of almost 400 wars over the past two centuries. We use a synthetic control method to examine both immediate disruptions due to wars and any long term scarring. We find that GDP per capita drops are driven by wars on territory, with GDP per capita even increasing relative to that of comparators for some wars off territory. Wars on territory result in a GDP per capita loss of over 7 percentage points relative to a synthetic control the year after the war ends. Civil wars have more persistent effects than interstate wars. Furthermore, our results suggest that a focus on flows, such as changes in value added generated each year, may significantly understate the lasting damage from wars. Even where income per capita recovers, there are lasting scars to labour forces and capital stocks.

In order to facilitate further research, the paper is accompanied by an interactive online annex providing economic variables and various counter-factual paths for over 100 wars included in our dataset.

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1. Introduction

This paper investigates the short- and long run economic effects of wars drawing on a large database of almost 400 wars over the past two centuries. The analysis is motivated by Russia's invasion of Ukraine in February 2022, however, it takes a broad view of the history of conflicts.

We use a synthetic control method to examine both immediate disruptions due to wars and any long term scarring, looking both at countries' GDP per capita and, more generally, any effects on economies' productive capacity: populations, capital stocks and total factor productivity.

Existing studies have typically examined such effects looking at much smaller subsamples of wars, using case studies, pre-trends or mostly cross-sectional regression-based analysis. We contribute to this literature by using a combination of other countries which did not experience wars to construct a synthetic control, which resembles the country at war before the conflict. We then compare the subsequent economic evolution of this 'counterfactual' country without a war to the actual experience of the country at war.

Our analysis is thus most closely related to Abadie and Gardeazabal (2003) who introduced the synthetic control method and applied it to estimate the effects of terrorist conflict in the Basque country, and Saxena and Cerra (2008), who documented the behaviour of output following civil wars as well as financial crises using impulse responses.

We construct a novel database covering almost two centuries of conflicts, which allows us to rely on a much larger sample than previous studies, including both civil and interstate wars and are able to distinguish between wars on and off territory, between winners and losers and parties initiating the war versus others.

We find that GDP per capita drops are driven by wars on territory, with GDP per capita even increasing relative to that of comparators for some wars off territory, explaining some of the mixed empirical findings of the existing literature. Wars on territory result in a GDP per capita loss of over 7 percentage points relative to a synthetic control the year after the war ends. Civil wars (which tend to be longer and are also more likely to remain unresolved) have more persistent effects than interstate wars. Losers and non-initiators also see significantly larger drops in GDP per capita than winners and initiators respectively.

We complement this analysis by also using a production function approach, looking at the effects of wars on economies' productive capacity: populations, capital stocks and total factor productivity. Our results here suggest that a focus on flows, such as changes in value added generated each year, may significantly understate the lasting damage from wars. Even where income per capita recovers, there are lasting scars to labour forces and capital stocks. While total factor productivity rebounds and recovers to its pre-war level about five years after the end of the war, populations and capital stocks of countries at war remain significantly smaller.

The paper focuses on average results across all country-wars for which balanced data is available.[1] The paper is, however, also accompanied by an interactive online annex (the Economies at War Atlas), which presents individual countries' GDP per capita, population, capital stock and total factor productivity relative to three counterfactual paths: a synthetic control, a simple average across economies when not at war and their own pre-trend.[2]

[1] As countries can participate in several wars and several countries participate in any given war, the unit of analysis in the following is a country-war.
[2] The online annex is available at:
https://public.tableau.com/app/profile/maxim.chupilkin/viz/EconomiesatWarAtlas/Menu

The paper is structured as follows: section 2 provides a brief overview of the empirical literature on the effects of wars, section 3 outlines the potential opposing effects of wars on the economy, section 4 presents the novel database and section 5 discusses our empirical approach, a synthetic control method. Section 6 presents the results of wars on GDP per capita, populations, capital stocks and total factor productivity, distinguishing between wars on and off territory, interstate and civil wars, winners versus losers and initiators versus attacked. Section 7 summarizes robustness tests, section 8 introduces the interactive online annex and section 9 concludes.

2. Literature review

There is a small but growing literature on the economic effects of wars. A number of studies have pointed to significant negative effects, driven by destruction of human and physical capital, disruptions to production processes and heightened uncertainty (Abadie and Gardeazabal 2003, Saxena and Cerra 2008, Cappelen, Gleditsch and Bjerkholt 1984, Thorp 1941). Some, including in the literature on the drivers of economic growth have found no meaningful effects of wars on growth (Acemoglu, Johnson and Robinson 2005, Barro and Lee 1994). Others, in turn, have pointed to positive effects on output, driven by increased military spending, higher utilization rates of labour and capital or increased total factor productivity (Deane 1975; Olson 2008; Organski and Kugler 1980).

Many of these studies have focused on specific countries or regions within countries (Abadie and Gardeazabal 2003, Harrison 1998; Broadberry and Harrison 2005). Some restricted analysis to only civil wars (Blattman and Miguel 2010; Collier 1999; Hoeffler and Reynal-Querol 2003) to ensure that a war occurs on the country's own territory (Cerra and Saxena 2008, p.439; Collier 1999, p. 168). The crucial difference between the growth experiences of countries that experienced wars on their territories and countries that actively participated in wars without war on their territory was already highlighted in Kuznets's comparison of post-WW2 economic growth in France, Germany, Japan and the USSR on the one hand and the United Kingdom and United States on the other (Kuznets 1964; 1971).

Studies of interstate wars have also typically relied on small samples, and often examined GDP losses relative to predictions based on country's own pre-trends, either shortly before the war, or based on the full time series (Organski and Kugler 1977; Wheeler 1980; Rasler and Thompson 1985).

Work on economic growth which included war variables in overall growth regressions mostly found insignificant effects (Acemoglu, Johnson, and Robinson 2005; Barro and Lee 1994), likely driven by data limitations and a high level of aggregation, mixing different types of wars, those both on and off territory and wars of different severity.

Our contributions to the literature are thus four-fold. First, we broaden the sample relative to existing studies to include all civil and interstate wars from 1816 to 2014 and are able to distinguish between wars taking place on and off territory, won, lost and unresolved wars, and consequences for initiators versus attacked. Second, we rely on synthetic controls to overcome difficulties with using pre-trends (with arbitrarily chosen lengths and given uncertainties surrounding trend estimates in emerging markets as highlighted by Aguiar and Gopinath 2007) or arbitrarily chosen comparators. Third, we hope to contribute to the existing literature on the longer-run effects of war on economic growth (Kang and Meernik 2005; Koubi 2005; Vonyó 2008) by complementing the analysis based on GDP per capita (a flow measure) with a production function approach, looking at stocks of population, capital and total factor productivity relative to a synthetic control. Fourth, in order to facilitate further research, our paper is accompanied by a publicly available database providing economic variables and various counterfactual paths for over 100 country-wars in our dataset.

3. Mechanisms

Economies can undergo significant economic reorientation during wars (see Rasler and Thompson 1985; Van Raemdonck and Diehi 1989 for reviews). For instance, military spending reached 40 percent of GDP in the United Kingdom and the United States during the World Wars, while military employment accounted for up to 10 percent of the population.[3] While military production, increased utilization rates and higher productivity could boost GDP (Deane 1975, Organski and Kugler 1980; 1977; Olson 2008), wars, in particular those fought on the country's territory, can also result in significant disruptions to economic activity, heightened uncertainty and increased fiscal burdens (Thorp 1941; Cappelen, Gleditsch, and Bjerkholt 1984).

Beyond affecting flows (such as value added produced annually), wars can also have long-lasting effects on populations, reflecting casualties, outflows of refugees and fewer births. For instance, 10 years after the end of the First World War, the populations of France, Germany and the United Kingdom were smaller than in 1913, while the populations of Denmark, the Netherlands and Spain exceeded their pre-war levels by 13-24 percent. Wars also destroy human capital (Justoni 2011). Years of schooling stagnate or decline during wars, while they continue to accumulate in comparators without wars.[4] Ichino and Winter-Ebmer (2004) showed that Austrian and German individuals who were 10 years old during the Second World War received less education than comparable individuals from non-war countries, such as Switzerland and Sweden. As a result, these individuals also experienced a sizable earnings loss up to 40 years after the war, pointing to long-lasting effects from the war.

Wars can also significantly reduce capital stocks as existing capital is destroyed during wars or taken out of the country, while investments in new capital may remain subdued. For instance, Mozambique's railways lost more than 90 percent of the rolling stock during the 1977 civil war (Brück 2001, p. 64). Capital stocks in the United States did not recover until 20 years after the 1861 civil war, with agricultural investment in affected areas remaining suppressed for almost 60 years (Feigenbaum, Lee and Mezzanotti 2019). After the Second World War, the capital stocks of France, Germany and Italy were 20-40 percent lower than in 1939 and returned to their pre-war trend only 20-25 years later (Alvarez-Cuadrado 2008).

Total factor productivity (TFP) may drop during wars as established production processes are disrupted. However, it could also increase and even offset declines in populations and capital stocks. This could be the case if technologies created for military purposes are successfully converted to civilian uses (past examples include the internet, nuclear power or aircraft manufacturing; Ruttan 2006, Gross and Sampat 2020), public investments in military research and development crowd in private investments (Moretti, Steinwender and Van Reenen 2019, Antolin-Diaz and Surico 2022; see also Deleidi and Mazzucato 2021) or firms 'learn by necessity', that is improve production methods to make up for less available labour and capital (for example, between 1941 and 1944 the man-hours required to produce a Liberty cargo ship in the United States fell by 55 percent; Ilzetski 2020, Rapping 1965).

The following analysis examines such potentially opposing effects empirically by extending the analysis looking at GDP per capita to a production function approach, examining potential changes to populations, capital stocks and total factor productivity.

[3] Based on the Correlates of War National Material Capabilities database.
[4] Based on the Lee-Lee (2016); Barro-Lee (2018) and UNDP HDR (2018) database.

4. Data

We construct a novel database building on information on war episodes from the Correlates of War database and combining this with macroeconomic variables from the Maddison tables and the Penn World Tables.

The paper follows the Correlates of War database's definition of wars as sustained combat, involving organized armed forces, resulting in a minimum of 1,000 battle-related deaths per year, excluding civilian fatalities. This database covers over 700 wars over the period 1816-2014, providing information on the parties at war, the start and end dates of the war, whether the war was civil or interstate, which side is generally agreed to have won the war, which side attacked first, and whether the war was resolved (Sarkees 2007, Sarkees and Wayman 2010).

We manually code for each war whether it took place on a country's territory. All civil wars are treated as taking place on territory; interstate wars are coded manually. In order to isolate the effect of a major war happening on a country's territory from military activity, which does not significantly disrupt the economy we rely on evidence of substantial battles being fought on the country's territory and do not include minor attacks, border skirmishes or attacks only targeted at military infrastructure as on territory. With that, still over 70 percent of observations in our overall sample involve a war on a country's territory. Among interstate wars in the sample, 44 percent are on territory. Wars off territory include, for instance, participation in the World Wars by countries such as Australia and the United States, participation in foreign interventions such as the Kosovo war and the war in Iraq by the United States and several European countries and invasions with subsequent occupations such as the Turkey-Cyprus war of 1974.

We complement this using historical GDP per capita from the Maddison tables (1816 onwards) and information on populations, capital stocks and total factor productivity from the Penn World Tables (1950 onwards).

For GDP per capita, our full (balanced) panel covering a period from five years before the war to five years after the war has 222 (133) country-wars. Of these, around half are interstate. For population, the full (balanced) panel has 207 (135) country-wars. Given data limitations, samples are somewhat smaller for capital stocks, covering 96 (59) country-wars, and total factor productivity, 57 (41) country-wars. As could be expected given data limitations, the balanced panel has a somewhat higher share of interstate wars, advanced economies and shorter wars than the full panel, though differences are not statistically significant. If anything, effects estimated in the following are thus likely to be underestimates of the damage from wars.

Wars often reoccur. Only around 23 percent of wars are followed by at least 25 years of peace. Strikingly, 58 percent of civil wars are followed by another war in the next 6 years.[5] For the following analysis we focus on wars not preceded or followed by other wars within a 5-year window.

5. Empirical approach

Synthetic control methods were originally proposed by Abadie and Gardeazabal (2003), estimating the economic effects of terrorist conflict in the Basque Country, and Abadie, Diamond and Hainmueller (2010), examining the effects of aggregate interventions for policy analysis. They have since become widely applied in empirical research.

[5] Repeat wars are also more likely after won wars (44 percent of won country-wars are followed by another war in the next 6 years versus 35 percent for lost country-wars; 17 versus 27 percent are followed by at least 25 years of peace), likely reflecting stronger economies.

Synthetic controls are well suited to situations where no single unit alone may provide a good comparison (Abadie 2021) and where the series examined are not too volatile (Abadie and Vives-i-Bastida 2022).

They can have important advantages relative to comparative case studies, regression or time series analysis or when aiming to estimate the effects of aggregate interventions affecting a small number of large units.

While a drawback of comparative case studies is that the selection of the comparison units is not formalized, the synthetic control methodology formalizes the selection of the comparison units using a data driven procedure (Abadie 2021). Synthetic controls may also allow for more flexibility than regression analysis (King and Zeng 2006), restrict weights to be between zero and one and make explicit the contribution of each comparison unit to the counterfactual of interest (Abadie, Diamond and Hainmueller, 2015).

Time series analysis may be confounded by the presence of other shocks to the outcome of interest, and the arbitrary choice of a particular pre-trend time period. As documented by Aguiar and Gopinath (2007), in emerging markets the business cycle itself constitutes the trend, further complicating analysis based on countries' own GDP paths preceding wars. Synthetic controls compare outcomes to a counterfactual based on other economies selected on pre-defined criteria. They also implicitly take year fixed effects into account by comparing economies at war to countries not at war in the same year.

The following analysis examines how economic outcomes (GDP per capita, populations, capital stocks and total factor productivity) evolve in countries at war, relative to what would be expected in the absence of war based on a synthetic comparator: a counterfactual path based on economies that are similar to the economy at war but did not experience armed conflict during the relevant period.

We use a combination of other countries not at war to construct a synthetic control country, which resembles relevant economic characteristics of the country at war before the start of the conflict in terms of their pre-war GDP per capita at purchasing power parity (PPP), population and pre-war growth of the variable of interest. The subsequent economic evolution of this 'counterfactual' country without a war is then compared to the actual experience of the country at war.

More formally, we observe $j = 1, \dots, J+1$ aggregate units (in this case countries), for $t = 1, \dots, T$ periods. The first unit ($j = 1$) experiences a war (the 'treatment') at time $t = T_0 + 1$ with $T_0 + 1 \leq T$. The remaining countries do not experience a war (no 'treatment'). We aim to estimate the effect of the war on GDP per capita, population size, capital stocks and total factor productivity during the war and post-war periods, $T_0 + 1, \dots T$.

The effects of the war are examined using a model of potential outcomes (Rubin, 1974). Y_{jt}^N denotes the potential outcome observed for unit $j \in \{1, \dots J+1\}$ and time $t = \{1, \dots T\}$ in the absence of a war. Y_{1t}^I denotes the potential outcome observed for the country at war (the 'treated' unit) at time $t = T_0 + 1, \dots T$ under the 'intervention' (war). $T_0 + 1$ refers to the first year of the war, T to the fifth year after the end of the war. For each unit and time period, Y_{jt} is the observed outcome. Therefore, observed outcomes for untreated units, $j = 2, \dots, J+1$, are equal to Y_{jt}^N. For the treated unit, the observed outcome is equal to Y_{1t}^N for $t = 1, \dots, T_o$ and equal to Y_{1t}^I for $t = T_0 + 1, \dots, T$. The object of interest is the treatment effect on the treated unit, that is the impact of the war on the country experiencing the war,

$$\tau_t = Y_{1t}^I - Y_{1t}^N$$

for $t = T_0 + 1, \ldots, T$. A synthetic control estimator of Y_{1t}^N is a weighted average of the outcomes of the 'donor pool' of J untreated units (economies at peace),

$$\hat{Y}_{1t}^N = \sum_{j=2}^{J+1} W_j Y_{jt}$$

where $W_2, \ldots W_{J+1}$ are non-negative and sum to one. The weights $W_2, \ldots W_{J+1}$ represent the contribution of each untreated observation to the estimate of the counterfactual of interest, $\hat{Y}_{1t}^N$.

Weights are chosen to approximate the path of the country at war in the five years prior to the start of the war. The procedure relies on the statistical package developed by Abadie, Diamond and Hainmueller (2011). The predictor variables are average GDP per capita and average population in the five years before the start of the war and the growth of the variable of interest (such as GDP per capita, population etc.) in each of the three years prior to the start of the war. These predictor variables allow a synthetic control to be constructed from countries that are both similar in size and have similar growth paths prior to the start of the war as the country of interest. We explore alternative predictor variables in the robustness section.

The goal of the synthetic control is to approximate the trajectory that would have been observed for Y_{1t} and $t > T_0$ in the absence of the war. The synthetic control method thus selects the set of weights such that the resulting synthetic control resembles the affected unit before the intervention along the values of variables $X_{11,\ldots} X_{k1}$ (Abadie 2021).

A synthetic control estimator of τ_{1t} is equal to the difference between the outcome values for the treated units (economies at war) and the outcome values for the synthetic control,

$$\hat{\tau}_t = Y_{1t} - \sum_{j=2}^{J+1} W_j Y_{jt}$$

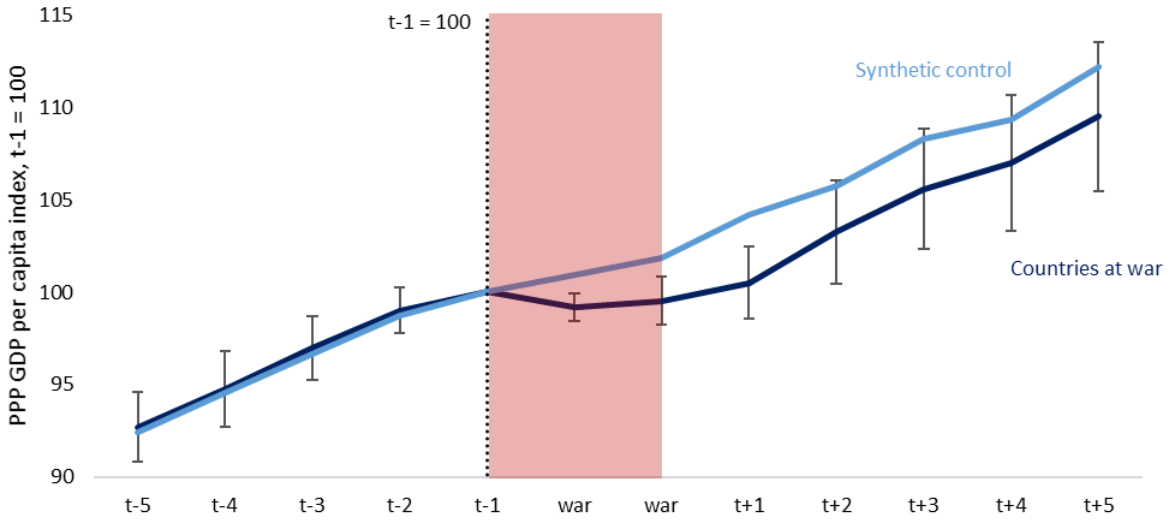
The median war in the dataset lasted a year, while the average war length was 2.4 years, driven by some very long (mostly civil) wars. In the following figures, wars of varying length are collapsed into two typical war years by computing the average growth rate during the first and second halves of the war and treating it as the growth rate of the first and second years of the 'typical' war.[6] A robustness test examines an alternative approach of relying on cumulative GDP changes over the duration of the war (rather than averages across its two halves). Averages are preferred as the baseline as cumulative drops would increase the importance of very long wars with large cumulative GDP changes and hence overstate the effects of a war relative to the 'average' experience.

[6] If the number of years is odd, the growth rate of the median year is included in the calculation of both the first and second halves.

6. Results

The existing literature has pointed to significant heterogeneity in the effects of wars on GDP per capita, often depending on the sample used. On average, based on a balanced panel of 133 country-wars including both wars on and off territory, civil and interstate wars, we find that GDP per capita of countries at war drops by up to 3.7 percentage points relative to their synthetic controls in the first year after the end of the war (Figure 1). While the average does not recover even five years after the end of the war, the difference between the country at war and its synthetic control becomes statistically insignificant two years after the end of the war.

Figure 1. Average economic effects of wars



Notes: $t-1$ refers to one year before the start of the war. 90 percent confidence intervals shown.

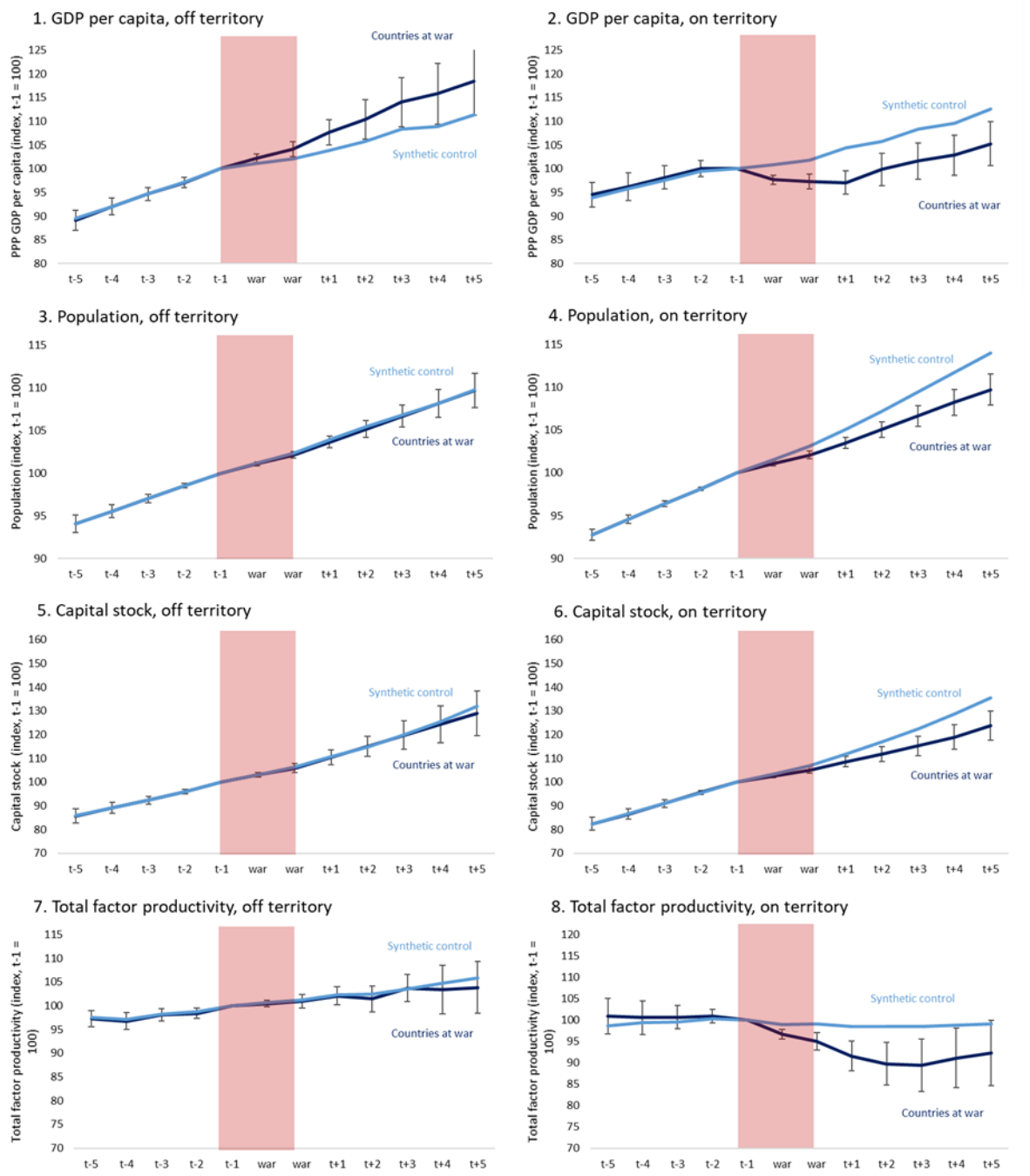
6.1 Wars on versus off territory

Figure 2 shows the evolution of GDP per capita in countries at war relative to a synthetic comparator without a war, distinguishing between wars that took place on a country's territory versus those that did not. Strikingly, while wars on territory result in a GDP per capita loss of over 7 percentage points relative to a synthetic control the year after the war ends, countries engaged in wars not on their territory may even outperform a synthetic comparator, though effects are only weakly significant reflecting the wide variety of experiences (Figure 2, panels 1 and 2). Such positive effects may reflect large increases in military spending and investment with spillovers to activity in related sectors, increased utilization rates of labour and/or capital or in some cases higher productivity.

Consistent with these GDP per capita patterns, populations, capital stocks and total factor productivity all decline relative to synthetic controls for wars on territory (Figure 2, even panels), while differences between countries at war and synthetic controls are not significant for wars not on territory (Figure 2, odd panels). The boost to GDP per capita for wars not on territory could be driven by differences in factor utilization (such as changes in employment, hours worked and capital utilization, not captured here due to data constraints).

The following analysis (Figures 3-5) differentiates between the effects of interstate and civil wars, winners versus losers and initiators versus non-initiators, throughout restricting the samples to wars on territory.

Figure 2. Wars off versus on territory



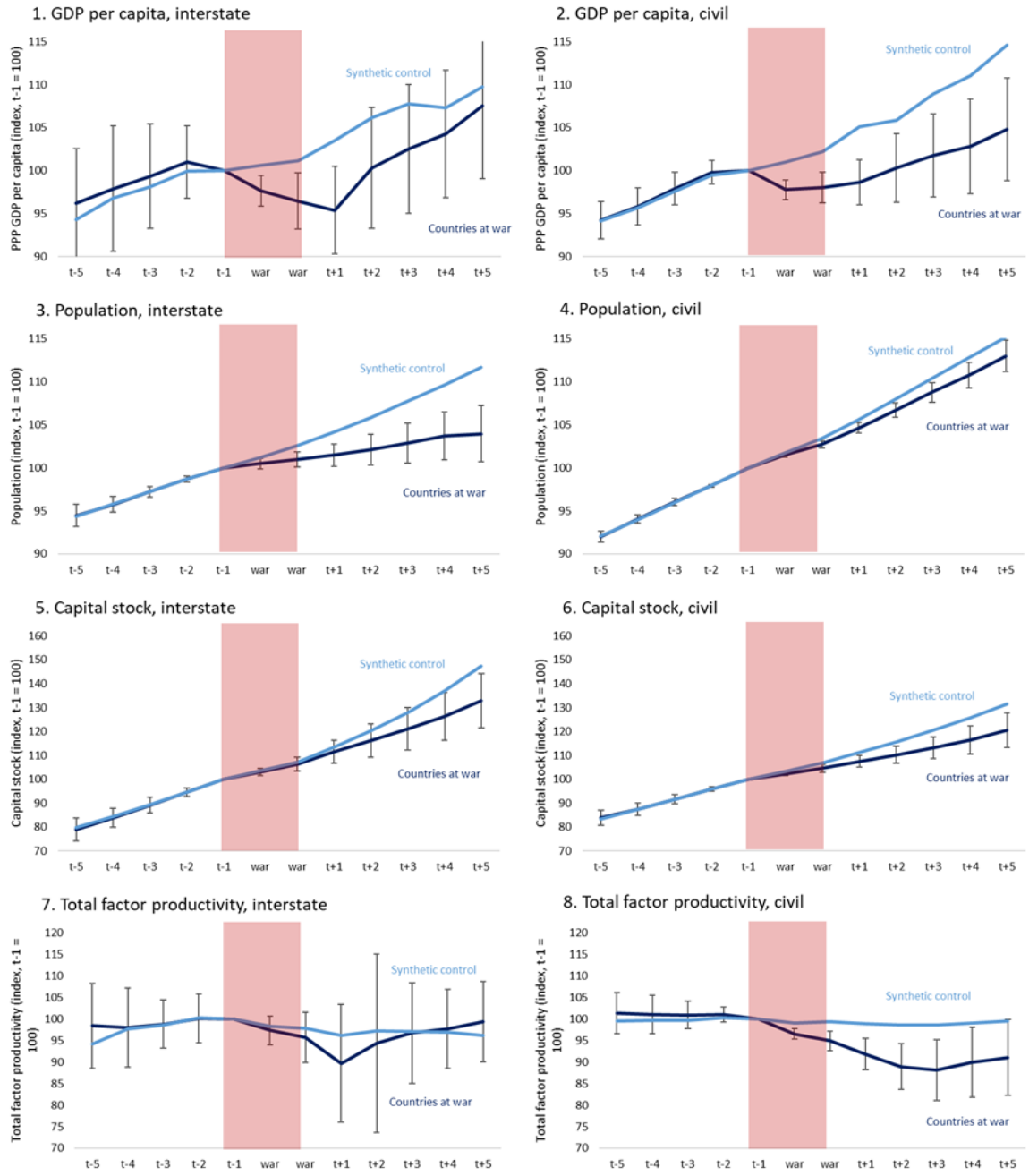
Notes: All civil wars are regarded as taking place on a country's own territory. Interstate wars are coded as taking place on territory if there were substantial battles within the country's own borders (excluding minor attacks, border disputes and attacks only targeting military infrastructure). GDP per capital, population, capital stock and total factor productivity are estimated here on the largest possible samples for each variable and may thus include different sets of country-wars (see the robustness section for estimates on the same smaller sample across all variables). Due to data constraints focus is on populations rather than labour forces and utilization rates cannot be included – factors shown here may thus not add up to overall GDP.

6.2 Interstate versus civil wars

GDP per capita drops are more persistent during and after civil wars than interstate wars (Figure 3). GDP per capita lags behind that of synthetic comparators by around 10 versus 2 percentage points respectively 5 years after the end of the war, with the effect remaining statistically significant for civil

wars even 5 years after the end of the war (Figure 3, panels 1 and 2). The difference is driven by a drop in total factor productivity after civil wars (panels 7 and 8), while population and capital fall during both civil and interstate wars, and the difference between interstate and civil wars is not statistically significant at the 5 percent level (panels 3-6).

Figure 3. Interstate versus civil wars



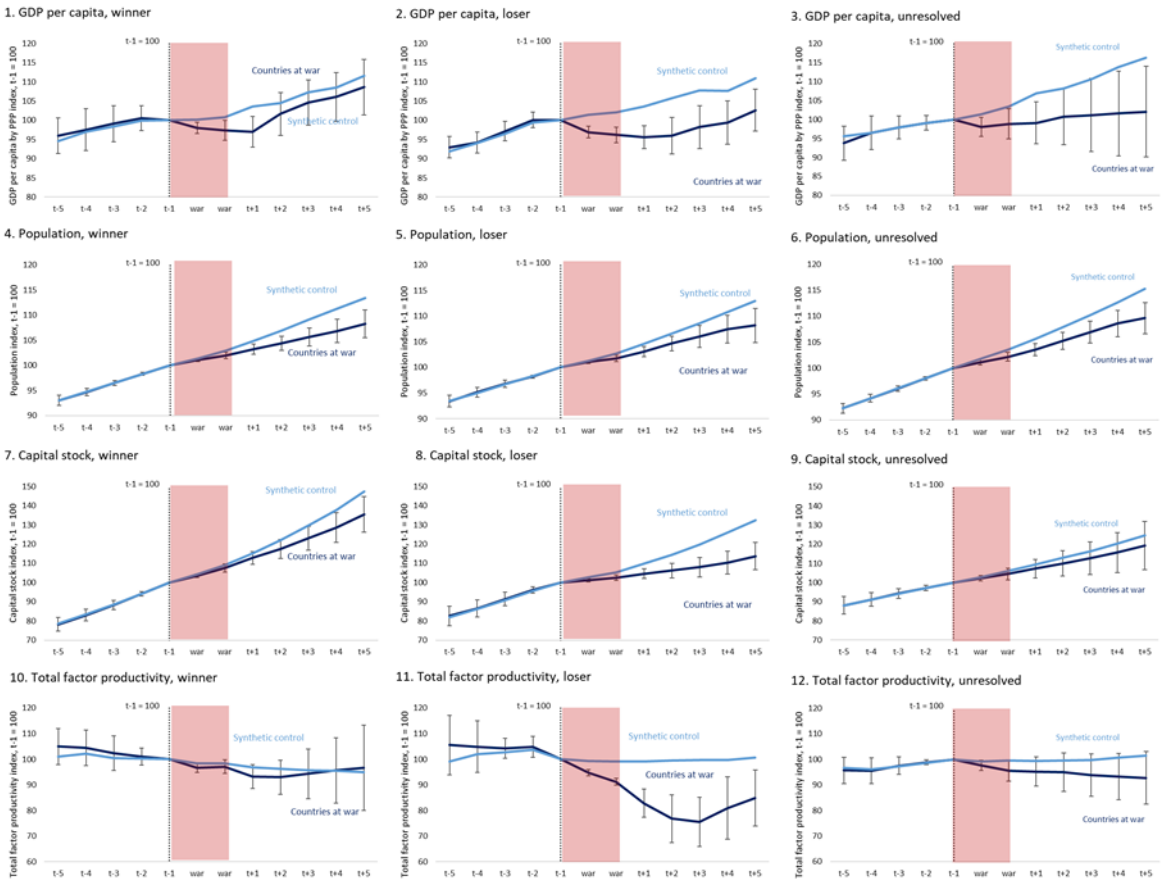
Notes: Includes only wars on territory. Interstate/civil wars follow the Correlates of War database: interstate wars refer to wars between states, civil wars refer to all intra-state wars including between a state and a group within its borders and intercommunal wars.

6.3 Winners versus losers

GDP per capita drops are typically larger for losers of wars and after unresolved conflicts than for winners (Figure 4, panels 1 and 2). For lost *civil* wars (defined as the government losing to the rebels,

as, for instance in Libya in 2011 or in Rwanda in 1994), GDP per capita declines by up to 17 percentage points relative to a synthetic control after the war, while for winners the effect is shorter lived and only up to 5 percentage points the year after the war ends. While for *interstate* wars the magnitudes of declines are similar for winners and losers (around 7 percentage points relative to a synthetic control), they are only statistically significantly different at the 5 percent level for losers. Both capital and total factor productivity declines are more pronounced for losers than for winners (Figure 4, panels 7-8 and 10-11). Unresolved wars – conflicts that end in a stalemate, where fighting ceases without a satisfactory agreement or morphs into continued low-intensity conflict – also see much larger and more lasting GDP per capita losses than observed for winners (panel 3).

Figure 4. Winners, losers and unresolved wars

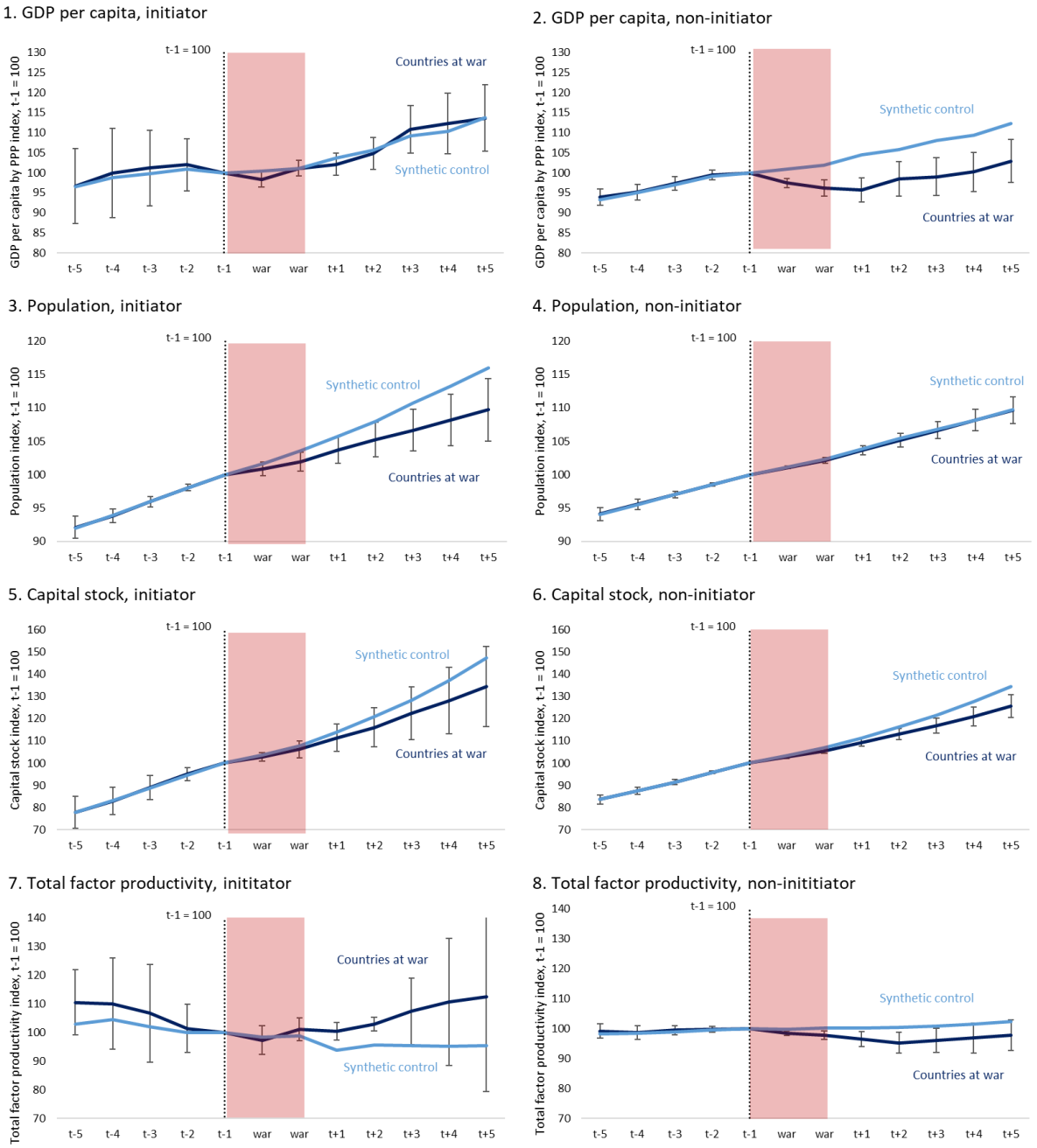


Notes: Includes only wars on territory, both civil and interstate. Winner/loser/unresolved follows the Correlates of War database on which side is generally agreed to have won the war based on a consensus of historians. Unresolved wars refer to conflicts that end in a stalemate, where fighting ceases without a satisfactory agreement or morphs into continued low-intensity conflict.

6.4 Initiators versus attacked

Initiators (referring to the party, which started the war based on the consensus of historians on whose battalions made the first attack) see smaller drops in GDP per capita than non-initiators (Figure 5, panels 1 and 2). This may be driven by a selection effect where economically weaker countries avoid paths to war (Shea and Poast 2018). This pattern holds for both interstate and civil wars and is driven by larger drops in capital stocks and total factor productivity (Figure 5, panels 5-8).

Figure 5. Initiators versus non-initiators



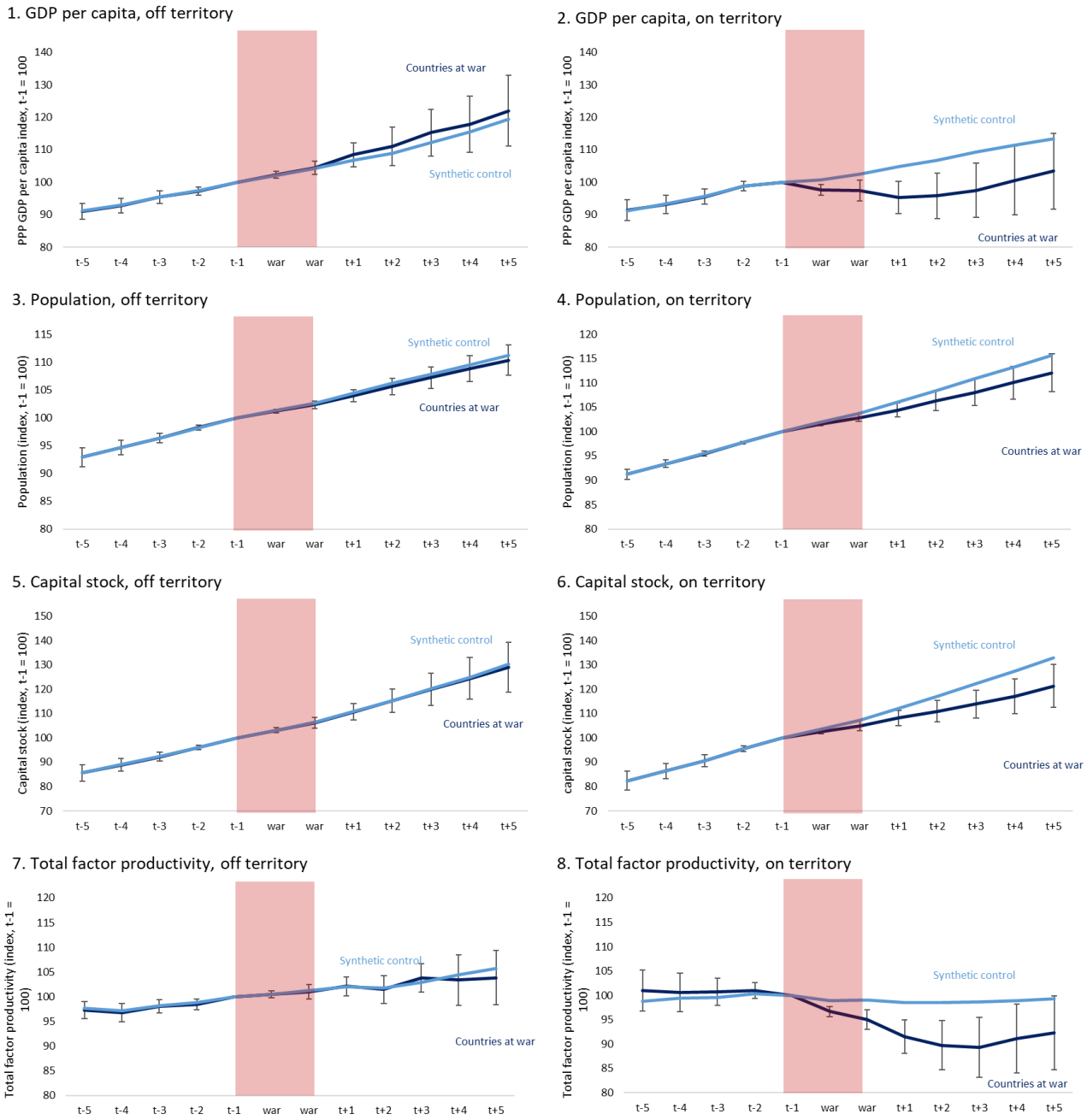
Notes: Includes only wars on territory, both civil and interstate. Initiators follows the Correlates of War database and refers to the party, which started the war based on the consensus of historians on whose battalions made the first attack.

7. Robustness

Our results are robust to using cumulative growth rates instead of average growth rates when compressing all war years into a 'typical' first and second half of the average war. Relying on cumulative growth rates points to larger war effects—as expected given the influence of some long wars with large drops. The effect of the war five years after its end is 5.5 percentage points more negative for wars on territory and 7.7 percentage points more positive for wars off territory relative to the estimates under the baseline using average growth rates.

The results are also robust to leaving out one country at a time from the set of comparator economies. They are broadly unchanged when relying on a different set of similarity variables, such as including only a subset of those used in the baseline specifications (pre-war GDP per capita, population and the variable of interest's own pre-war growth), adding inflation, investment-to-GDP, government debt-to-GDP, manufacturing value added as a share of total value added, years of schooling and geographic regions, as well as using different pre-war time periods over which the variables are compared (3 or 10 years instead of 5 years in the baseline). While the above results are estimated on the largest possible samples of country-wars for each variable, results are robust to focusing on a smaller subsample for which all variables are available (Figure 6).

Figure 6. Wars off versus on territory, subsample results



Notes: All variables are estimated on the sample of 21 country-wars on territory and 19 country-wars off territory for which a balanced panel of all four variables is available.

We also examine the robustness of our results to using the new synthetic difference-in-difference estimator introduced by Arkhangelsky et al. (2021). Like synthetic controls, this method re-weighs and matches pre-war trends to weaken the reliance on parallel trend type assumptions. Like difference-in-differences estimators, it is invariant to unit-level shifts and allows for valid large-panel inference. Relative to the synthetic control estimator, it includes unit and time fixed effects when determining the weights. Our results remain very similar to those presented in the baseline: effects are more negative for wars on territory, for losers and unresolved wars and for non-initiators. These differences are statistically significant.

This synthetic difference in difference approach also allows us to examine the share of country-wars with persistent effects five years after the end of the war. Table 1 presents the share of countries with significant negative effects on the *level* of GDP per capita five years after the end of the war. As before, persistent negative effects are more common after wars on territory, for lost and unresolved wars and these differences are statistically significant. While, unlike in the baseline specifications, here countries involved in interstate wars appear to be significantly more likely to experience persistent negative effects than those with civil wars, this disparity could be explained by volatile economic growth in countries with civil wars even before the war.

This approach can also be extended to examine any persistent negative effects on GDP per capita *growth*—thus examining not only whether the level of GDP per capita is significantly below that of synthetic comparators five years after the war, but whether there may have been a structural break affecting even growth rates as a result of the war. Here too, wars on territory and unresolved wars are more likely to be followed by slower growth relative to synthetic controls than wars off territory and won wars. These differences are statistically significant.

Strikingly, while more than 20 percent of countries that experienced a war on their territory, lost a war or participated in an unresolved conflict do not recover to the GDP per capita *level* of their synthetic comparators five years after the war, 8-14 percent experience a persistent negative effect even in terms of their GDP per capita *growth*.

Table 1. Synthetic difference in difference estimates for GDP per capita and GDP per capita growth

	All wars	Off territory	On territory	Interstate	Civil	Winner	Loser	Unresolved	Initiator	Non-initiator
Level	16.2	3.1	21.7	9.6	23.4	7.3	27.4	23.2	13.2	17.5
Growth	8.6	3.1	10.8	5.2	12.1	5.5	8.1	14.3	5.9	9.7
Sample size	*222*	*65*	*157*	*115*	*107*	*109*	*62*	*56*	*68*	*154*

Notes: The table shows the share of negative effects significant at 10 percent level for each category. Each treatment effect is based on the pre- versus post-war difference-in-difference between the start of the war and five years after the end of the war between countries at war and their synthetic controls. Standard errors are calculated based on 100 placebo repetitions.

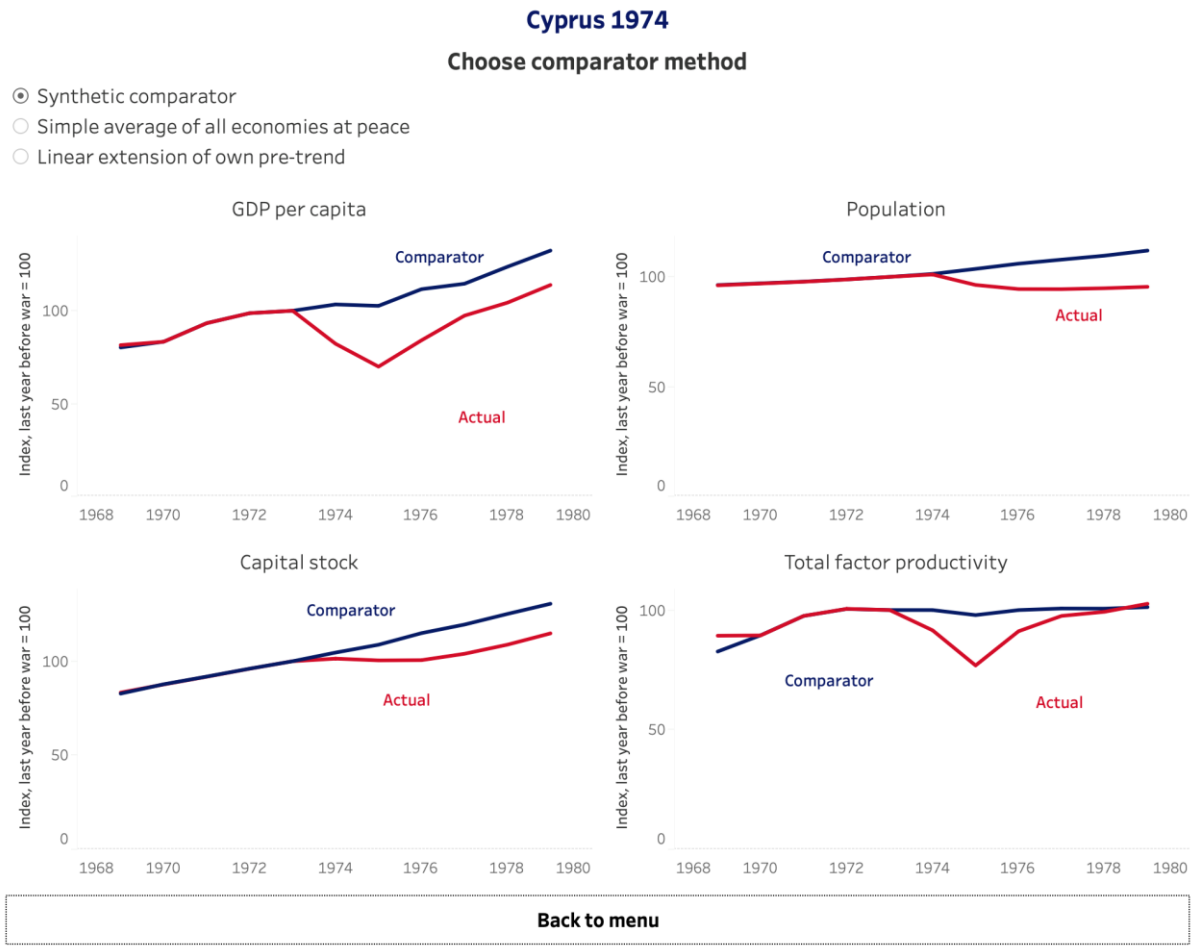
8. Economies at War Atlas

In order to facilitate further research, and in the spirit of other interactive online atlases (such as Chetty et al (2022) and Hausmann et al. (2014)), our paper is accompanied by a publicly available database providing economic variables and various counterfactual paths for over 100 country-wars in our dataset.[7] This Economies at War Atlas illustrates the paths of GDP per capita, population, capital stock and total factor productivity. For each variable of interest, it also provides three comparator methods:

[7] The Economies at War Atlas is available at:
https://public.tableau.com/app/profile/maxim.chupilkin/viz/EconomiesatWarAtlas/Menu

the synthetic comparator used in this paper, the variable's expected evolution based on the country's own pre-trend and a simple average across all economies at peace in a given year (Figure 7).

Figure 7. Example of the online Economies at War Atlas



Besides providing easily accessible information, the Atlas also illustrates the benefits of the synthetic comparator approach relative to other methods. For instance, for wars preceded by economic crises, such as the wars in Armenia and Azerbaijan, a simple comparison with all countries at peace would overestimate the negative effects of the war (by comparing the country at war with economically much stronger comparators), while a comparison with its own pre-trend would likely provide an underestimate of the 'true' effect (by comparing it to its already weak pre-war state).

The Atlas also hopes to increase transparency and mitigate concerns that the results reported in the paper may be driven by outliers. The Atlas illustrates that for the large majority of country-wars our synthetic comparator matched the variable's own pre-trend before war closely, with divergence starting at the time of the war.

9. Conclusions

Our analysis indicates that GDP per capita drops are driven by wars on territory, with such wars resulting in a GDP per capita loss of over 7 percentage points relative to a synthetic control the year after the war ends. Conflict studies have focused heavily on highly devastating episodes, such as the Second World War, however, these do not appear to be representative of the 'typical conflict' (Hendrix 2017). While the most damaging conflicts saw GDP per capita drop by 40 to 70 percent, most wars were significantly shorter and less damaging. Based on the distribution of almost 400 wars spanning

almost two centuries, projections as of September 2022 would already put the expected contraction in GDP per capita in Ukraine among the deepest 10-20 percent in the history of modern wars.

Restricting the sample to wars on territory, we find that civil wars have more persistent effects than interstate wars, losers and non-initiators see larger drops in GDP per capita and more scarring in terms of their factors of production than winners and initiators respectively.

Our analysis also suggests that focus on flows, such as changes in value added generated each year may significantly understate the lasting damage from wars. Total factor productivity rebounds in about 5 years after the end of the war. However, the populations of economies at war are significantly smaller (around 4 percent) than a synthetic comparator even 5 years after the end of the war, which did not experience conflict—reflecting casualties, outflows of refugees and fewer births. Capital stocks are also around 9 percent smaller than in a synthetic comparator 5 years after the end of the war.

We hope that the Economies at War Atlas can facilitate and point to avenues for further research. For instance, enhancing our understanding of the drivers of the observed heterogeneity in country experiences or the mechanisms behind economic recoveries.

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