The Price of War

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Abstract

We assemble a new data set spanning 150 years and 60 countries to study the economic impact of war. The economic costs of war are not confined to the war site, where output declines by approximately 30 percent and inflation increases persistently by 15 percentage points. There are strong spillovers to other countries as well—they depend on geographic distance. We rationalize these patterns in an international business cycle model: As war destroys the productive capacity of the war site, trade with nearby economies collapses, generating an endogenous supply-side contraction abroad. For very distant countries, output spillovers can turn positive.

JEL Classification: E50, F40, F50

Keywords: Interstate Wars, Disasters, Business Cycles, Spillovers, Geography, Distance, Supply Shocks, International Transmission

*We wish to dedicate this paper to Philippe Martin who discussed it at the Kiel-CEPR Geoeconomics Conference in Berlin before his untimely death in December 2023. Federle: Kiel Institute (email: jonathan.federle@ifw-kiel.de); Meier: Tudor Capital Europe LLP (email: Andre.Meier@alumni.eui.eu); Müller: Department of Economics, University of Tübingen, CEPR and CESifo (email: gernot.mueller@uni-tuebingen.de). Mutschler: Department of Economics, University of Tübingen, and Dynare Team (email: willi@mutschler.eu). Schularick: Kiel Institute, Sciences Po, and CEPR (email: moritz.schularick@sciencespo.fr). The views expressed in this paper are those of the authors and do not necessarily reflect the views of the institutions they are affiliated with. We thank our discussants Alessandra Bonfiglioli, Luca Dedola, Philippe Martin, and Ansgar Rannenberg, as well as Ralph Luetticke, Thierry Mayer, Timothy Meyer, Mathias Thoenig, and Christian Wolf for very helpful comments. Sven Eis, Kevin Klein, and Maximilian Reinhard provided excellent research assistance.

You may not be interested in war, but war is interested in you.
Leon Trotsky

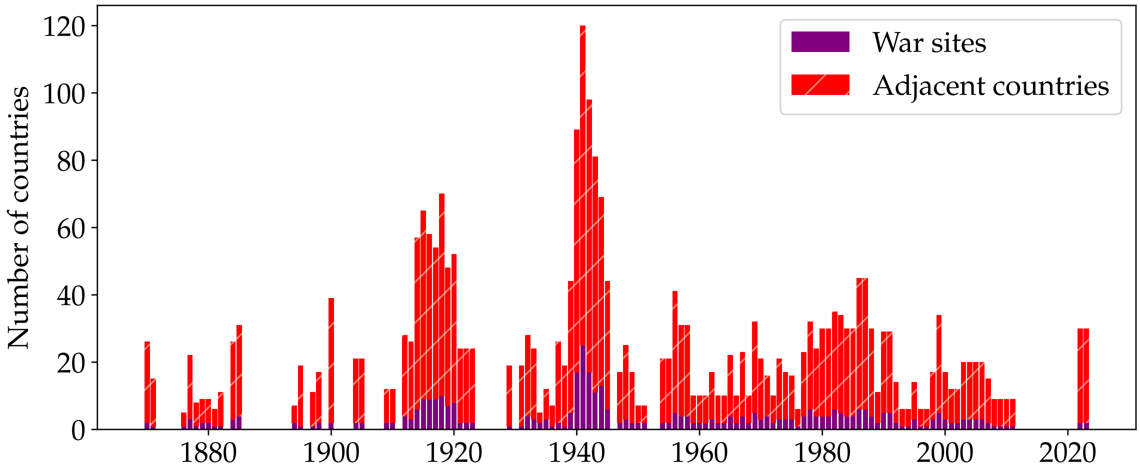
1 Introduction

The global political and economic landscape is undergoing profound changes. Geopolitical tensions are rising and rivalries between nations are breaking into the open. The process is fueled by a volatile blend of nationalism and shifts in power dynamics—the two most common reasons why nations go to war, as we discuss below. Wars cause death and destruction, disrupt trade, and wreak havoc on public finances. They also affect the economy at large: Many of the large economic disasters during the last century are related to wars on a country's own soil (Barro, 2006). However, as we show in this paper, the adverse economic impact of war is not confined to the war site. Other countries are paying a price for the war, too.

To establish this result, we put together a new data set that spans 150 years and observations for 60 countries. It contains information on wars, including the war sites, but also key macroeconomic indicators. We estimate local projections to quantify the impact of the average war in our sample. Our baseline focuses on large wars where the number of causalities exceeds 10k. In this case, output declines by more than 30 percent and inflation increases by 15 percentage points in the war-site economy. These effects materialize gradually over a horizon of 2-5 years after the start of the war. As we estimate economic spillovers to other countries, we condition on their geographic distance from the war site. Output in neighboring countries falls by more than 10 percent over 5 years, and inflation rises by 5 percentage points. Spillovers decline with geographic distance and the response of output can turn positive for very distant countries.

We rationalize these patterns in a multi-country business cycle model which accounts for distance by allowing for different levels of trade integration among countries. In the model, war simultaneously destroys productive capacity in the war site and triggers a military buildup. Such a buildup takes place elsewhere, too, but to a lesser extent. The calibrated model successfully replicates the key patterns in the data and offers a plausible account of how the economic impact of war spreads across the globe. A key insight is that the exogenous supply-side disruption in the war site endogenously generates a supply-side contraction abroad. In very distant countries its adverse effect on economic activity is overcompensated by higher demand due to increased military spending.

Figure 1: War sites and adjacent countries



Source: Correlates of War Project (Stinnett et al., 2002), classification based on 2016 borders.

Understanding the global economic repercussions of war is important because while war on a country's territory is a rare event, economies are frequently exposed to the negative spillovers from war in their neighborhood. Figure 1 illustrates this basic fact. It shows that in our sample, the frequency with which a country is a war site in a given year is very low at 1.4%. In contrast, the frequency with which a country is adjacent to a war site is much higher at 8.2%, and hence about twice as high as the (unconditional) frequency of financial crises (Schularick and Taylor, 2012). Exposure to war occurs almost at business cycle frequency but remains an understudied source of shocks in the international economy.

More in detail, our data set brings together data from the *Correlates of War* (COW) project and macroeconomic time-series data as assembled in the *Jorda-Schularick-Taylor Macrohistory Database* (Jordà, Schularick and Taylor, 2017), augmented in Funke, Schularick and Trebesch (2023). We add to these data, as we geolocate 176 actual war sites in our sample, based on granular battle-level data. Both, the classification of countries as war sites and the macroeconomic indicators are based on today's borders. We further distinguish between spillovers from the war site on belligerents and third countries, but the distinction does not turn out to be decisive. Although spillovers are somewhat stronger for countries that participate in the war ("belligerents") than for third countries, the overall pattern is similar for both.

While we consider the impact of war on a range of macroeconomic indicators, our focus is on GDP and inflation. GDP and inflation are not the only measures for the costs of war and its implications for human welfare. In particular, our analysis does not account for human losses. We also neglect specific economic dimensions, such as the fiscal burden of war. Last, because we lack sufficiently granular data, we cannot say to what extent the composition of GDP changes in wars and how private consumption is affected which is arguably a better measure of economic welfare than GDP. Our focus on GDP and inflation is warranted in order to study the business cycle impact of war, notably in countries that are not parties to the war.

We argue that the empirical patterns that we document support a causal interpretation. We narratively identify, in each individual case and based on a variety of sources, the *casus belli*, or the primary causes and motives behind a given war. The overwhelming majority of wars are linked to nationalist, ideological, or historical causes that are plausibly exogenous to the state of the business cycle.[1] Two exceptions confirm this rule: the Boxer uprising in 1900 and the Italo-Turkish War in 1911. In both cases, the sources available to us suggest that short-term economic conditions were decisive for the start of the war. Hence, we drop these wars from our sample. We also acknowledge that specific economic factors may play a role in the decision to go to war—for instance, disputes over natural resources or wars in the context of colonial expansion, as famously argued by Lenin (1917). Yet even then, these economic motivations appear largely orthogonal to the (short-term) business cycle, considering that they concern medium- to long-run objectives and that the outcome of war is typically uncertain. We see a parallel here with the tax changes for which Romer and Romer (2010) identify "more exogenous reasons".[2]

To provide a structural interpretation of our empirical results, we set up a state-of-the-art business cycle model of the global economy, building on earlier work by Gopinath et al. (2020) and Eichenbaum, Johannsen and Rebelo (2021). This setup allows us to study the impact of war in the war site, referred to as "Home". In terms of Foreign, we further distinguish "Nearby" and "Distant". These differ in their distance from Home, as captured by the degree of trade integration in steady state. In specifying the war shock, we draw on earlier work on rare disasters (Gourio, 2012). Specifically, we assume that the war shock

[1]The U.S. appear like a notable special case in this regard, as there is evidence that U.S. presidents have been more likely to deploy military force in times of "economic misery" (Ostrom and Job, 1986) and during recessions, provided they were up for reelection (Hess and Orphanides, 1995), notably in the post-WW2 period. What is special about the U.S. is that, despite the frequent involvement in wars during this period, the U.S. never itself turned into a war site.

[2]In our empirical specification, we interpret the *start* of the war as an exogenous event while acknowledging that *its duration* will likely depend on its economic impact. We also verify that "war shocks" are largely unanticipated by macroeconomic indicators and trace out their effects over time relative to a non-war baseline trend.

destroys a part of the capital stock and simultaneously induces a persistent decline of productivity in the war-site economy (Home)—and only there. At the same time, the war shock prompts an increase in military spending in Home and, to a lesser extent, in the other countries. To pin down parameter values, we match the impulse response functions that capture the effect of war on GDP and inflation using a Bayesian approach.[3]

The model provides a quantitatively successful account for the adjustment dynamics in both Home and Foreign. In the model, spillovers operate through trade and depend on the degree of pre-war trade integration. The war-site economy suffers from a large supply-side contraction (the capital stock is destroyed and productivity declines) which spills over to Nearby because, as Home goods become scarce and expensive, Nearby reduces imports from Home considerably. The use of intermediate goods, which feature a sizeable import component, cannot be maintained, and as a result, production in Nearby also declines. In addition, the capital stock in the nearby economy declines endogenously. The resulting supply-side contraction, both in the war-site and the nearby economy, accounts for the surge in inflation.

The adverse spillovers are weaker in Distant because there is much less trade with Home to begin with. In Distant, the overall effect may thus be dominated by the expansionary effect of increased military expenditure—accounting for the positive spillovers that we find for some of our empirical specifications. There is also a redirection of trade flows that stimulates economic activity in Distant, but this effect is modest. Overall, we find that the model offers a credible explanation for the war's impact on the war site and the spillovers to other countries. It not only offers additional insights into the transmission mechanism but also serves as a useful plausibility check for our empirical results, even from a quantitative point of view.

The paper is structured as follows. In the remainder of this section, we discuss the related literature and clarify the contribution of our paper. Section 2 details the construction of our data set, notably the specification of war sites, the classification of the casus belli, and a number of descriptive statistics. Section 3 discusses our empirical strategy and presents the main results. In Section 4, we outline and calibrate our business cycle model, assess its validity externally, and inspect the transmission mechanism. The final section offers a brief conclusion.

[3]As a technical contribution of this paper, we extend the method-of-moments toolbox in Dynare to now include formal (Frequentist or Bayesian) Impulse Response Matching capabilities as per Christiano, Trabandt and Walentin (2010). This feature is part of the 6.0 release of Dynare (Adjemian et al., 2022).

Related literature. Our paper relates to several strands of the literature. First, there is work on the economic impact of war on countries that are directly involved. Economic historians, in particular, have studied the inflationary impact and the economic damage caused by specific wars, as well as the human and economic costs of sustaining the war effort in the belligerent countries (e.g., Oliver, 1941; Harrison, 1998; Davis and Weinstein, 2002; Tooze, 2006). Interestingly, the literature has struggled to document an adverse effect of war on growth (Barro and Lee, 1994; Acemoglu, Johnson and Robinson, 2005).[4] The fact that GDP in the U.S. and U.K. expanded during both world wars has been attributed to the strong increase in military expenditures (Braun and McGrattan, 1993; Ilzetzki, 2022). Limiting his analysis to belligerent countries, Caplan (2002) distinguishes the growth effect of domestic and foreign wars, the latter being defined as wars that are fought abroad: domestic wars lower growth, while foreign wars are mildly expansionary. Likewise, Chupilkin and Kóczán (2022) document that wars on a country's territory reduce economic activity. Auray and Eyquem (2019) estimate a DSGE model on time series data for the two World Wars. What sets our paper apart from these papers is our focus on the macroeconomic spillovers of war.

In this regard, a second strand of the literature is relevant. It investigates the adverse impact of war on trade and production networks (Glick and Taylor, 2010; Qureshi, 2013; Couttenier, Monnet and Piemontese, 2022; Korovkin and Makarin, 2023). Our results are consistent with the findings of this literature, although our perspective is broader. Ex ante, we do not constrain spillovers to operate only via trade. Taking a complementary perspective, Martin, Mayer and Thoenig (2012) link the formation of trade agreements to the probability of conflict, while Konrad and Morath (2023) put the notion that the collateral damage of war is largest in frontline states—that is, states most at risk of becoming war sites—at the center of their theory of alliance formation.

Third, the role of geographic distance as a determinant of conflict spillovers has been highlighted in earlier work, though with a distinct focus on civil war and ethnic conflict (Murdoch and Sandler, 2002, 2004; Mueller, Rohner and Schönholzer, 2022).

Fourth, the market response to conflict, both expected and actual, has been analyzed in some detail, also with a view to the role of geographic distance

[4] There is consensus about the negative growth effects of conflict more generally (see, for instance, Novta and Pugacheva, 2021; de Groot et al., 2022), or for global and very large wars (Rasler and Thompson, 1985; Thies and Baum, 2020). Blomberg and Hess (2012) document that consumption drops strongly in response to small wars, whether initiated at home or abroad.

(Leigh, Wolfers and Zitzewitz, 2003; Guidolin and La Ferrara, 2007; Zussman, Zussman and Nielsen, 2008; Verdickt, 2020; Caldara and Iacoviello, 2022; Federle et al., 2022). Our analysis differs from these latter studies because we study the macroeconomic ramifications of actual wars.

Last, we build on earlier efforts to model rare disasters (including wars) already referenced above. In this regard, we share the open-economy perspective of Farhi and Gabaix (2016). In contrast to them, we bring to the fore what determines the economic spillovers of wars on countries that are not war sites but potentially exposed via close geographic proximity.

2 Data, identification, and basic facts

In this section, we introduce our data set and definitions. We also narratively classify the wars in our sample according to their *casus belli*. Finally, we present a number of descriptive statistics on how economic performance changes in the context of wars.

2.1 Data

Our sample covers annual observations for the period 1870–2022 for an unbalanced panel of 60 countries. The beginning of the sample period is constrained by the availability of comprehensive time-series data for macroeconomic outcomes. In the final year, the sample includes the start of the war in Ukraine.

To identify wars for our sample, we build on the *Correlates of War* (COW) project (Sarkees and Wayman, 2010). COW provides data on interstate wars for the period from 1816 to 2007. These wars are defined as "sustained combat involving regular armed forces on both sides and at least 1,000 battle-related fatalities among all of the system members involved". For the more recent years within our sample period, we note that there have been no interstate wars that meet this criterion between 2008 and the Russian invasion of Ukraine in 2022. We verify this using the database of the *Uppsala Conflict Data Program* (UCDP), see Gleditsch et al. (2002); Davies, Pettersson and Öberg (2022).[5]

Our analysis is centered around the notion of "war sites"; that is, countries that experience military action on their own soil. In what follows we therefore

[5]The definition of war according to UCDP is somewhat more restrictive: It classifies as wars all conflicts with at least 1,000 battle-related deaths in a given year, as opposed to deaths over the course of the entire war as in COW. We note, however, that all wars in the COW data set that lasted longer than a year also caused more than 1,000 battle-related deaths per year.

use "war" narrowly to refer to the military action in the war site. Moreover, our empirical analysis is premised on the hypothesis that war affects countries differently, depending on whether they are an actual war site or not; and, if not, depending on how geographically close they are to the war. We thus classify, in a first step, countries in their relation to the war as either "Home" or "Foreign": Home (Foreign) are countries where (no) war takes place. Note that Foreign includes both belligerent and non-belligerent countries. In the second step, we determine the geographic distance of Foreign from the war.

The COW project does not provide information on where a given war took place. In order to identify war sites, we consult additional sources and determine the geographical location of the military action. Again, we proceed in two steps. First, we disaggregate wars to the battle level based on information in the warfare encyclopedia by Clodfelter (2017). As a result, we are able to identify 525 different battles for which we code the geolocation.[6] Using the same sources, we obtain—for each battle—estimates for the number of casualties. Casualties include the number of dead, missing, or wounded people as well as prisoners of war captured in the respective battles. The largest battle in our sample is the Battle of Wuhan in China during the Sino-Japanese War, which is associated with more than 2 million casualties. Other well-known battles, such as the Battle of Stalingrad and the Siege of Leningrad, with a total of 500k and 485k casualties, respectively, also rank among the bloodiest in our sample.

Second, we aggregate casualties to the country level, which is the unit of our analysis.[7] In aggregating to the country level, we follow the approach of Conte et al. (2022) and code according to the country definitions provided by the CIA World Factbook. That is, we rely on today's borders so that we can study the macroeconomic outcomes associated with a war in either Home or in Foreign in a geographically consistent manner. To illustrate the issue, consider the Italian-Turkish War in 1911 as an example. It was fought between the Ottoman Empire and Italy but major warfare predominantly took place in modern-day Libya rather than in Turkey or Italy. Since our macroeconomic indicators consistently refer to modern-day national borders, we code Libya as the Home economy of the war and modern-day Italy and Turkey as Foreign.

We further cross-check our war-site coding by consulting GPT-4. As a large language model, it is trained on huge corpora of texts, including historical

[6] In some instances, the available information is less granular than what we would ideally like to have. For instance, an important battle in WW2 is the "Eastern front".

[7] In case a battle field extends over the territory of several countries we assign the casualties in equal shares to all countries.

accounts of wars. We leverage this fact and systematically consult the GPT-4 API to identify the countries in which major battles took place and compare the outcomes with our own coding.[8] The Pearson correlation with our coding is 0.68 and highly significant (p-value < 0.001). In total, GPT-4 identifies 73 countries as war sites that we have not previously identified among the 158 countries in our coding. Because large language models tend to hallucinate, we systematically search for corroborating evidence on these countries and are able to find some documentation of actual fighting in 18 of the proposed additional war sites. We include these countries in our war site coding, see Table A.1 for an overview of these countries. For the period 1870–2022 we end up with 176 country-year observations for when a war starts on a country's soil (Home) and 2,786 corresponding observations for Foreign.[9]

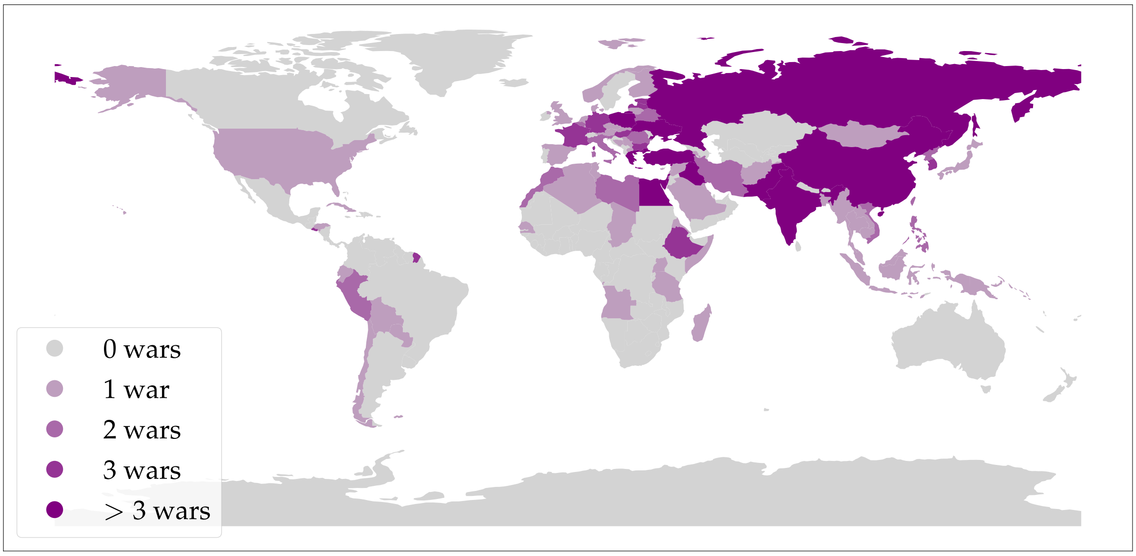
We obtain time-series data for output and inflation from the *Macrohistory* database, which covers 18 advanced countries starting in 1870 (Jordà, Schularick and Taylor, 2017). This database, in turn, is constructed from a number of sources, including Bolt and van Zanden (2014) and others that typically make adjustments for changing borders so that the data refer to current borders; see, for instance, Maddison (1995). We complement the *Macrohistory* database with time series for additional countries from various sources (Funke, Schularick and Trebesch, 2023; World Bank, 2022) which, in turn, build on Ursùa and Barro (2010) and Bolt et al. (2018). These sources provide us with data for GDP in per capita terms. For our analysis, we compute an aggregate output measure to account for changes in the population during wars. For this purpose, we rely on population data for the territories that define countries today (Bolt and van Zanden, 2014).[10] The same sources provide us with a measure of consumer price inflation that we winsorize at the 99% and 1% levels. We further obtain data on total factor productivity, labor, and capital stock from the Long-Term Productivity Database (Bergeaud, Cette and Lecat, 2016). Data on military expenditures and employment in the military are provided by the COW project (Singer et al., 1972; Singer, 1988),

[8]For each war, we ask GPT-4 "*Which countries suffered major battles on their own territory during the war '*' which started in *? Consider modern-day borders. Specifically, even if a state did not exist at the time of the war, refer to it by its current name within today's borders. For example, if there was a war in 1870 within modern-day Libya, please refer to it as having taken place in Libya instead of referring to it as the Ottoman Empire. It is crucial that you only provide the ISO-3 codes of the countries and nothing else, as your response is being parsed as a CSV.*" Parameters of GPT-4 requests were: temperature (0), max_tokens (256), top_p (1), frequency_penalty (0), presence_penalty (0).

[9]In principle, each war in Home should correspond to a war in Foreign for each of the other countries in the sample. However, there are years in which several foreign wars start, which are aggregated into a single war event.

[10]Although Bolt and van Zanden (2014) mostly refer to 1998 boundaries, these have only changed to a small extent since (Schvitz et al., 2022).

Figure 2: War sites (1870-2022)



Note: Colors indicate number of wars that took place on a country's soil for the period 1870–2022. Sample comprises all and not only large wars.

and data on unemployment are sourced from Gabriel (2023). Lastly, we source bilateral trade data from Barbieri, Keshk and Pollins (2009) and Barbieri and Keshk (2016).

The map in Figure 2 shows the geographical distribution of the war sites in our sample: the darker a country is shaded, the more often it has experienced a war on its own soil. We observe war sites to be distributed across the world, with some clustering in Europe, the Middle East, and Asia. The U.S. also experienced combat on its own soil, but only once: During World War II there were several battles on the Aleutian Islands, a group of islands belonging to Alaska, as well as the Japanese attack on Pearl Harbor. The Aleutian Islands example illustrates that military action will not, in all cases, cause meaningful economic effects. In our baseline, we thus focus on war sites where the fighting was most severe. Specifically, we set the threshold to 10k casualties and refer to the resulting sample as "large war sites" in what follows. The U.S. example does not meet this criterion.

Table 1 provides summary statistics for progressively more severe wars. The top line refers to all 176 wars, with an average duration of war of 2.6 years. The average number of casualties for this sample is 184k. In terms of macroeconomic time series, this full sample includes data for 66 observations for the start of a war in Home and 2,786 observations for Foreign. In the second row we report the figures for large wars (casualties $\geq$ 10k), which we use as our baseline sample

Table 1: Categories of war sites

	Casualties		Length		Wars	Macro time-series for...	
Severity	Min	Mean	Mean	Median	Total	Home	Foreign
All sites	46	184,357	2.6	2.0	176	66	2,786
Large sites	10,000	334,920	3.3	2.0	96	38	1,798
Major sites	105,525	658,323	4.4	4.0	46	21	1,026

Note: Table shows different war-site samples according to casualty thresholds. Min casualties denotes war site with lowest number of casualties in sample. Length denotes duration in years for wars in our sample. Home (Foreign) are observations for when a war starts in the war site (abroad), provided macro time series are available. Large sites restrict sample to those sites with casualties $\geq$ 10k, major sites to those with casualties $\geq$ 100k.

and for which we provide details in Table A.2 in the appendix.[11] The average number of casualties is as high as 335k in this sample, and the average length of the war extends to over three years. Importantly, this sample still comprises 96 wars, although we note that country-year observations for macro time series are only available for a subset of these, as the rightmost panel of the table reports. The last line of the table reports statistics for the major wars in our sample (casualties $\geq$ 100k), for which we also report results in our robustness analysis.

Lastly, in our formal analysis below, we relate the spillover effects of war on Foreign to its geographic distance from the war. Following Mayer and Zignago (2011), it is defined as the distance in kilometers between the most populated cities across these two countries, again in terms of today's borders. The greatest distance between two economies in our sample is 19,930 km, which corresponds to the distance between Bolivia and Taiwan during the 1932 Chaco war. During war times, the mean distance from war, measured in relation to the closest war site, is 6,691 kilometers.

2.2 The casus belli: a narrative classification

In the empirical analysis below, we seek to identify the macroeconomic effect of wars at a business cycle frequency. For this purpose, we assume that wars are largely exogenous to the business cycle. A similar assumption is typically invoked for military spending in the literature on the fiscal transmission mechanism (see, for instance, Barro and Redlick, 2011; Ramey, 2011; Miyamoto, Nguyen and Sheremirov, 2019). It is also consistent with theories in political science which discuss the causes of war in terms of power struggle or power transition (for

[11]Recall that our casualty measure for war sites is compiled based on specific battles and, therefore, likely understates the actual number of casualties.

Table 2: Reasons for going to war

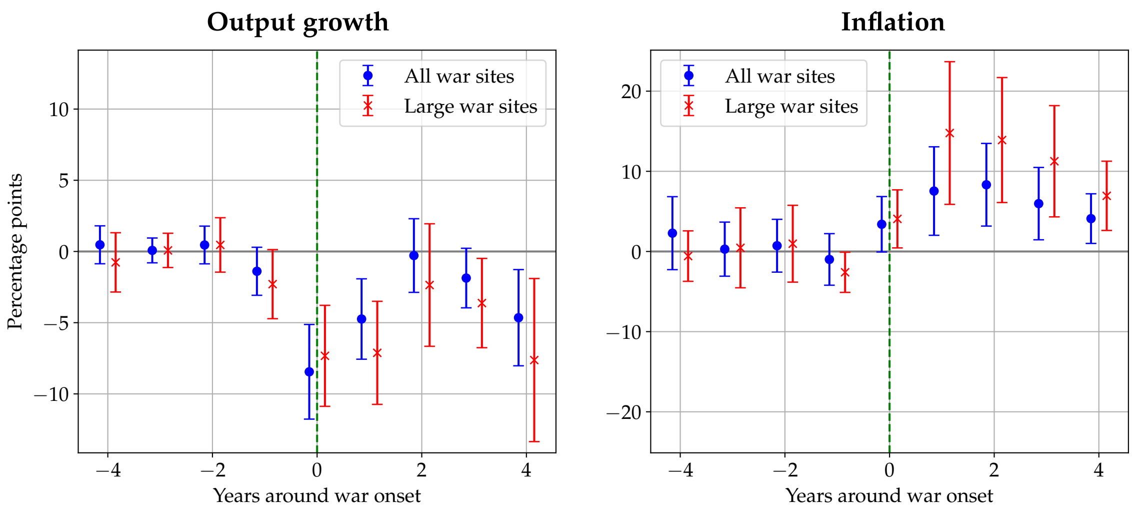
Reason	Explanation	# Wars
Nationalism	Creation of own sovereign state, wars for independence, imperialism	46
Power Transition or Security Dilemma	A rising power challenges a dominant one. Classic examples of the security dilemma in action are situations, where measures taken by one country to increase its security lead others to feel less secure and to take countermeasures, resulting in increased tensions that can lead to war.	33
Religion or Ideology	Deep-rooted disagreements over religious beliefs or ideologies (e.g., communism)	23
Border Clashes	Unclear borders or intensifying border clashes	15
Economic, Long-Run	States might go to war to gain control over trade routes, markets, or valuable resources; economic rivalry and protectionism	10
Domestic Politics	Leaders may use foreign war to distract from domestic political issues or to rally their population around a common cause	8
Revenge/Retribution	Wars can be initiated in response to perceived wrongs or to regain lost honor, even if there's no tangible gain to be had	3
Economic, Short-Run	The economy is in a severe recession (e.g., unemployment is high)	2

Note: Some wars have multiple causes, which is why sum of war reasons in table exceeds total number of wars in our sample. Reasons were identified using various sources; see Table D.1.

instance, Organski and Kugler, 1980; Lebow, 2010). The business cycle does not feature in these accounts. However, there is evidence for the U.S., specifically that U.S. presidents have been more likely to deploy military force in times of "economic misery" (Ostrom and Job, 1986) and during recessions provided they were up for reelection (Hess and Orphanides, 1995), notably in the post-WW2 period. For the purposes of our exercise, however, we may disregard this evidence because the U.S. never became a war site during this period. Still, we need to consider the possibility of short-term cyclical considerations driving decisions to go to war and investigate how representative the apparent U.S. evidence may be. To this end, we use narrative records to classify the apparent *casus belli* for the wars in our full sample.

For the classification of wars, we base our categories on the warfare encyclopedias by Clodfelter (2017) and Sarkees and Wayman (2010), while also cross-referencing numerous other sources for verification. A detailed overview of the different sources used for the casus belli identification is provided in Table D.1 in the Appendix. Countries go to war for a variety of reasons, and we do not restrict them to be mutually exclusive. As we try to determine the reasons

Figure 3: Economic performance in war sites around start of war



Note: Sample period 1870–2022. Average output growth and inflation in the war site around the start war (in the war site), measured in percentage point deviations from country means.

for going to war, our reading of the historical records results in an average of two main reasons per war. These may include, inter alia, nationalism, ideological differences, or power transitions. Table 2 lists the results of our classification based on eight distinct categories. In the right-most column, we report the number of wars which fall into each category.

Nationalism and power transitions rank among the top reasons for going to war. Importantly, although we find that countries also pursued economic objectives in several wars, these pertain mostly to long-run outcomes, such as gaining control over trade routes or securing natural resources. Such long-run objectives should be largely orthogonal to the business cycle, as has been similarly argued in the influential study on the effects of tax shocks by Romer and Romer (2010). In our sample, we identify only two wars in which short-term economic factors seem to have played a key role. These are the Boxer Rebellion of 1900 and the Italo-Turkish War of 1911. In the first case, religion and nationalism were key aspects, but so were adverse economic conditions. Likewise, in the second case, nationalism or, more specifically, colonialism was key. However, dire economic conditions in Italy, as reflected in mass emigration in the decade prior to the war, were arguably also conducive to the war. Hence, we drop both of these wars from our sample.

2.3 Economic performance of war sites around war

In the next section, we formally analyze the macroeconomic consequences of war. To set the stage for our analysis, Figure 3 shows the average economic performance in war sites in an eight-year window centered around the start of the war in the war site. In the left panel, we display output growth, measured in differences relative to a country's average, distinguishing between the full sample (blue) and the sample of large wars (red). We find that output growth falls short of the average by 7-8 percentage points in the year the war starts. In the following years, there is still a significant growth shortfall, and more persistently so in the case of large wars. Prior to the war, output growth is not systematically lower. We show results for inflation in the right panel of the same figure. And again, there is no systematic deviation from average inflation prior to the start of the war. Once the war starts, inflation is systematically higher. Hence, we conclude this section by noting that the data in Figure 3 does not point to sizeable anticipation effects, consistent with Ferguson (2008). Taking a financial markets' perspective he illustrates the difficulties of investors to anticipate (the economic impact) of the world wars.

3 The macroeconomic consequences of war

In this section, we establish and contrast the effects of war in Home and Foreign. We first introduce our empirical framework and then present the results for a number of specifications.

3.1 Empirical framework

We take a business cycle perspective and focus mostly on how war affects output and inflation. In terms of identification, we rely on the notion—established via narrative analysis—that the wars in our sample are exogenous to the business cycle, see Section 2.2 above. Importantly, we seek to identify the effect of the *start* of the war and how this effect plays out over time. In this context, we think of the onset of war as a *shock* to the economy. Recall from Section 2.3 that there is indeed little evidence that wars are anticipated via early moves in either growth or inflation. By focusing on the dynamic effects of (or impulse responses to) the initial war shock, we do not rule out possible feedback effects from the macroeconomic consequences of the war to the ability of the warring parties to mobilize the necessary resources to keep the war going. Similarly, we do not rule out that war alters long-term economic prospects. Our identification strategy only requires the start of war to be exogenous to the business cycle of the war-site economy.[12]

Linear specification Based on these considerations, we estimate a set of local projections as in Jordà (2005) to trace out the macroeconomic effects of war over time. Formally, using i to index countries and h the number of years since the start of the war in year t, we let $x_{i,t+h}$ denote the response of a generic outcome variable to the war and estimate the following "linear specification":

$$x_{i,t+h} - x_{i,t-1} = \alpha_{i,h} + \gamma_h Home_{i,t} + \psi_h Foreign_{i,t} + \zeta_h Controls_{i,t} + u_{i,t+h} \,. \quad (3.1)$$

Here $\alpha_{i,h}$ captures country fixed effects. $Home_{i,t}$ and $Foreign_{i,t}$ are dummy variables that assume a value of one if the domestic economy or (at least) one foreign economy is turned into a war site in year t, respectively. We assign a value of one in the year in which the war starts and zero later. $Home_{i,t}$ and $Foreign_{i,t}$ are not mutually exclusive because several wars may take place at the same time: A country may become a war site and, at the same time, be exposed to spillovers from another war: Our specification does not rule out this possibility but merely imposes the domestic effects and the spillovers from foreign wars to be additively separable. However, we set $Foreign_{i,t}$ to zero whenever a country is itself a war site in the *same war* at any point in time.[13]

Specification (3.1) allows us to capture the dynamic effects of a war that starts in period t. The parameters γ_h and ψ_h provide an estimate for the effect in Home and Foreign in year h after the start of the *average* large war in our sample. Note also that our specification is agnostic about the duration of the war: It recovers the average effect over time of a war which starts in year t, that is from year t to year $t + h$. The set of controls includes four lags of both the dependent variable and the regressors, while $u_{i,t+h}$ denotes the error term. The dependent variable is specified in differences relative to the pre-war level to account for the possibility that wars have permanent effects on the outcome variables (Stock and Watson, 2018). We find our results are robust if, instead, we exclude this possibility.

[12]This assumption does not conflict with the evidence put forward by Ostrom and Job (1986) and Hess and Orphanides (1995) for the U.S. since it has never been a war site in the post-WW2 period on which their evidence is based upon.

[13]In this way, we seek to distinguish sharply between the war-site economy and the other countries exposed to a given war. As a practical matter, however, results do not change much if we allow countries to be simultaneously exposed to a domestic war and to the spillovers from other war sites of the same war. Results are available on request.

Baseline specification While the distinction between Home and Foreign is central to our analysis, so too is the notion that the economic spillovers on Foreign may vary in its distance from the war site. To account for this possibility, we depart from the linear model (3.1) and allow spillovers to differ depending on the distance from the war site in a non-linear way. In what follows we put forward the following smooth-transition model as our "baseline specification":

$$x_{i,t+h} - x_{i,t-1} = \alpha_{i,h} + \zeta_h Controls_{i,t} + \gamma_h Home_{i,t} + \psi_{D,h} F(i,t) Foreign_{i,t} + \psi_{N,h} \left[1 - F(i,t)\right] Foreign_{i,t} + u_{i,t+h} \,. \quad (3.2)$$

Here the response of the outcome variable may differ at each horizon h across regimes "D" (Distant) and "N" (Nearby), with the ψ-coefficients indexed accordingly. Observations are assigned to these regimes based on the transition function $F(i,t)$. As in Born, Müller and Pfeifer (2020) we use an in-sample criterion to determine this function. Specifically, for each country-year observation, we determine the relative distance to the foreign war site in logs, such that:

$$0 \leq F(i,t) = \frac{\ln(1 + d_{i,t})}{\ln(1 + d^{\max})} \leq 1. \quad (3.3)$$

Here $d_{i,t}$ is the distance of the geographically closest war site to country i, measured in thousand kilometers, while $d^{\max}$ is the largest distance between any pair of Home and Foreign in our sample.

Size-distance specification Wars differ in many dimensions and our baseline specification does not attempt to account for these. Rather, it provides estimates for the effects of the average war in the sample in order to highlight the role of geographic distance for the economic spillovers of war. Still, the economic size of the war site is bound to have a first-order effect on these spillovers, too. If, all else equal, a war site is small, we expect smaller spillovers than in case it is a large economy. Given this argument, we also consider a variation to our baseline specification in which we replace the dummy variable in (3.2) with the economic weight of the war site as a quantitative shock measure. Specifically, we set

$$Foreign_{i,t} = \sum_{j \in J_{i,t}} \frac{GDP_{j,t-1}}{GDP_{world,t-1}}, \quad (3.4)$$

where $J_{i,t}$ is the set of all countries that become war sites of a foreign war in year t.[14] $Foreign_{i,t}$ then captures the aggregate pre-war share in world GDP of the countries that turn into war sites in year t. We adjust our distance measure accordingly and define it as the GDP-weighted average distance from all foreign war-site economies in year t:

$$F(i,t) = \sum_{j \in J_t} \frac{GDP_{j,t-1}}{\sum_{k \in J_t} GDP_{k,t-1}} \left[\frac{\ln(1+d_{i,j})}{\ln(1+d^{\max})} \right], \tag{3.5}$$

where $d_{i,j}$ is the distance between country i and war site j. Below we refer to this variant of the baseline as the "size-distance specification".

Trade-distance specification In our analysis, we allow economic spillovers of war to depend on geographic distance. Ultimately, we think of these spillovers as reflecting the extent of economic integration across countries, very much in the spirit of the gravity equation (Head and Mayer, 2014). To assess this hypothesis, we replace, in a second variation of our baseline specification (3.2), the transition function with a measure of economic integration based on the relative importance of trading partners, as measured by imports. Specifically, we replace the transition function (3.3) with a measure of "trade-distance":

$$0 \leq F(i,t) = 1 - \sum_{j \in J_t} \frac{imports_{j \to i,t-1}}{imports_{i,t-1}} \leq 1. \tag{3.6}$$

Here $imports_{j \to i,t-1}$ are imports of country i from war site j in the year prior to the war. We scale these with the total imports of country i and sum over all war sites.[15] At its maximum value of 1, $F(i,t)$ indicates that there is virtually no trade with the war site, just like $F(i,t) = 1$ reflects a maximum distance in the baseline.[16]

[14] A foreign war, from country i's perspective, is a war in which country i never becomes a war site itself.

[15] Relative importance of trading partners is winsorized at the 99% level to account for varying coverage over time and across country-pairs.

[16] We show the cumulative distribution functions for the three different transition functions in Figure A.1 in the appendix. Both the baseline specification and the size specification are approximately uniformly distributed. For the distribution of trade distance, we find that only a few countries exhibit very high trade exposure to the war site.

3.2 Results

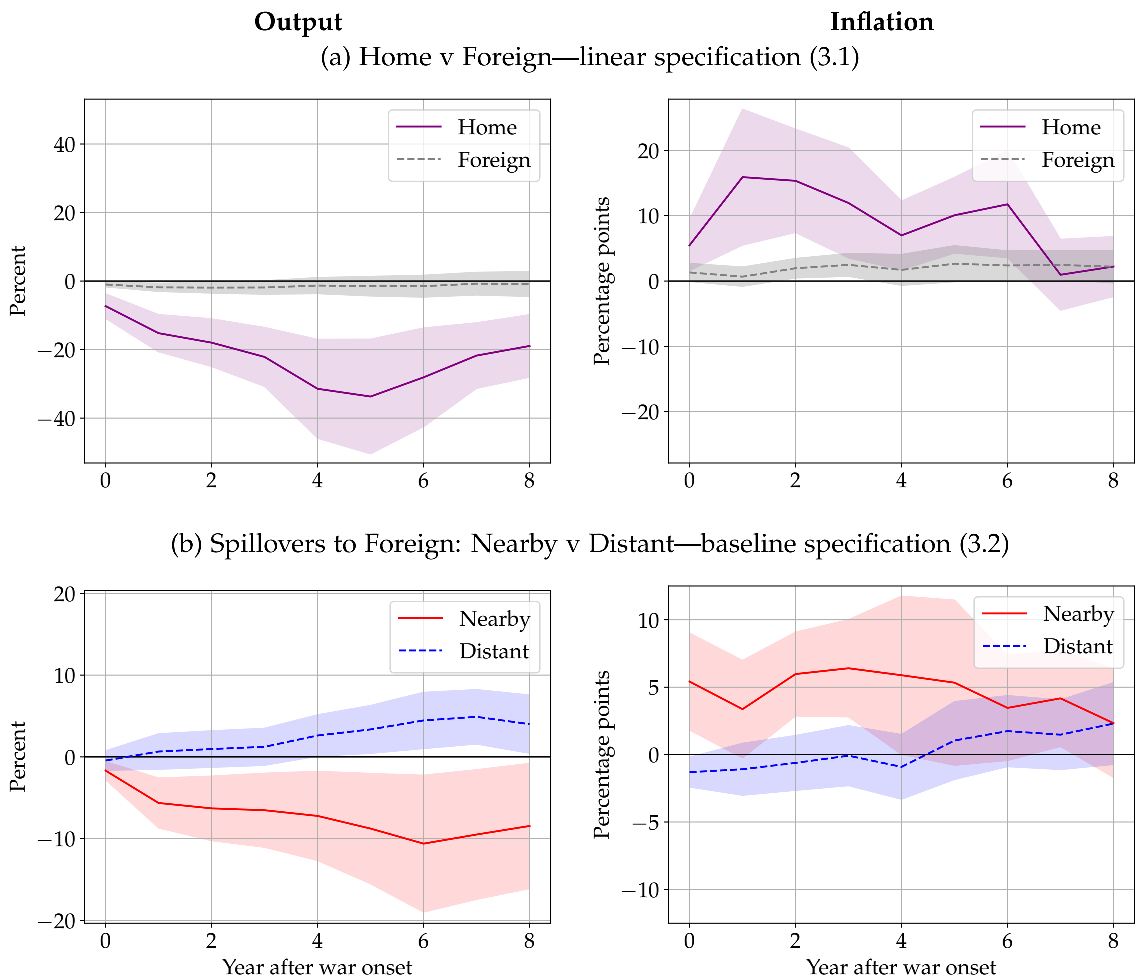
We now turn to our main results. They are based on our sample of annual observations for the period 1870–2022. In what follows we consider only large war sites, that is, war sites where casualties exceed 10k; results for alternative specifications are reported in Section 3.5. We estimate the responses of two outcome variables, $x_{i,t}$, in Home and Foreign: the log of real GDP, after the removal of a linear country-specific time trend prior to the estimation, and inflation, measured in terms of consumer price indices.

Figure 4 shows the estimated impulse responses, tracing the macroeconomic consequences of war over time, beginning with the start of the war ($h = 0$). In each panel, the horizontal axis measures time in years. In the left panels, we measure the percentage deviation of (detrended) output from its pre-war level against the vertical axis. In the right panels, we measure the effect of war on inflation in percentage-point deviations from the pre-war inflation rate norm. In the top panels, we show results for the linear specification (3.1). The solid purple line shows the response for Home, and the dashed black line the estimated spillovers to Foreign. Here, and in what follows, shaded areas indicate 90% confidence intervals, computed using standard errors that are robust with respect to heteroskedasticity as well as serial and cross-sectional correlation (Driscoll and Kraay, 1998).

We observe that the adverse effect in Home is particularly strong and gets stronger over time, reaching a maximum effect some five years after impact. At this point, the war has reduced output in Home by about 30 percent. What's more, the subsequent recovery is rather slow. In year $h = 8$, output is still reduced by about 20 percent, and even after 16 years the recovery is incomplete, as Figure C.2 in the appendix shows. This is also noteworthy in light of the fact that the mean (median) duration of large wars is 3.3 (2) years. Clearly, based on our estimates, we cannot rule out that war has a permanent effect in Home. Turning to the top-right panel of Figure 4, we also observe a strong inflationary impact: Inflation increases for several years following the start of the war, exceeding its pre-war rate by up to 15 percentage points. It converges back to the pre-war norm only after six to seven years.

The top panels of the figure also show that, *on average*, there are virtually no spillovers to Foreign. The dashed black line is no different from zero, not for output (left) and barely for inflation (right). However, this average effect masks sizeable heterogeneity across countries. To see this, consider the bottom panels of Figure 4, which show results for the baseline specification (3.2), allowing the

Figure 4: The macroeconomic impact of war



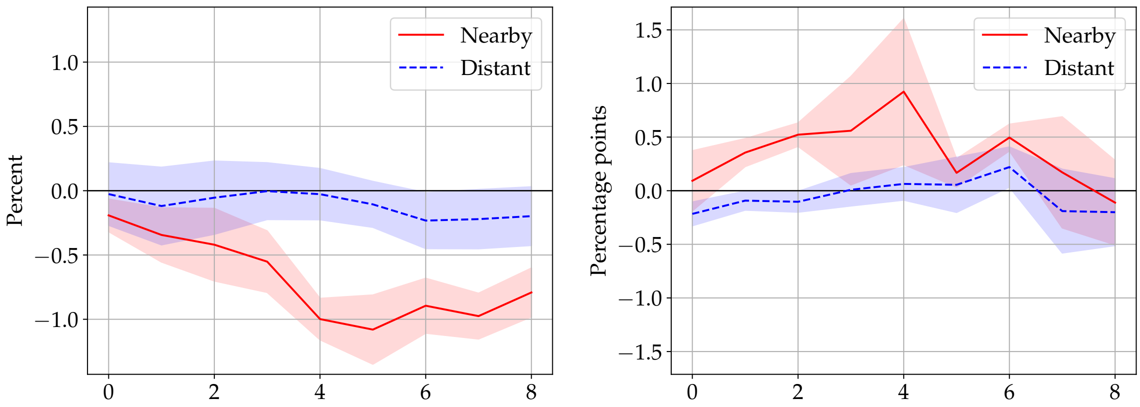
Note: Results based on large wars, sample period 1870–2022. Left panels show deviation of (detrended) output from pre-war level, right panels show deviation of inflation from pre-war rate. Shaded areas indicate 90% confidence bands.

spillovers of war to vary with the distance of Foreign from the war site. In the panels, the solid red line corresponds to regime N, showing the spillovers to foreign countries that are direct neighbors to the war. Technically, we define this case as representing zero distance between a war site and a foreign country ($F(i,t) = 0$). The dashed blue line, in turn, corresponds to regime D, representing the spillovers to a distant country, meaning the maximum possible distance from the war site in our sample ($F(i,t) = 1$). The difference across these scenarios is stark and it bears noting that actual effects fit somewhere in between these two limiting cases. Output declines on impact and persistently so in nearby economies. Five years after the onset of war, output is reduced by some 10 percent compared to the pre-war level. At the same time, inflation increases

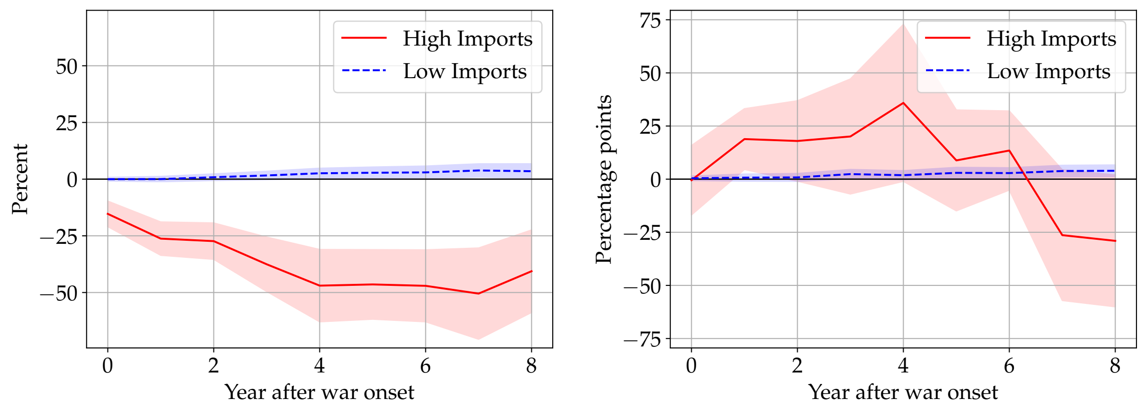
Figure 5: Alternative shock and distance measures

Output **Inflation**

(a) Size-distance specification (3.5): war-site normalized to 1% of world GDP



(b) Trade-distance specification (3.6)



Note: Results based on large wars, sample period 1870–2022. Left panels show deviation of (detrended) output from its pre-war level, right panels show deviation of inflation from pre-war rate. Shaded areas indicate 90% confidence bands.

considerably, matching the shape of the impulse response in Home. Roughly speaking, we find that the output loss and the inflation increase in Nearby are about one-third of what we find for Home. For Distant, an altogether different pattern of spillovers emerges: output rises moderately and in a statistically significant manner, while inflation does not respond significantly.

Figure 5 shows the results for alternative specifications. Both panels are organized in the same way as the bottom panel of Figure 4 and show the spillovers of war to Foreign—distinguishing again the effects in Nearby and Distant. In the top panel (a) we show results for the size-distance specification. Specifically, in the estimation we now account for the economic size of the war site, using the measure given in equation (3.4) and the GDP-weighted distance measure as specified in equation (3.5). We then normalize the size of the war shock to be equal to one percent of world GDP. The results show the same pattern as those shown in Figure 4 above, except that we no longer observe positive output spillovers to distant countries. Note also that the average size of war sites in our sample is about 6 percent of world GDP. Accordingly, if we multiply the responses in the top panel of Figure 5 with a factor of 6, we obtain results that are in the same ballpark as those for the baseline. Any remaining discrepancies are likely to reflect differences in the sample.[17]

In the bottom panels of Figure 5 we show results that are based on trade distance as specified by equation (3.6), rather than geographic distance. Again, we obtain the familiar pattern. Spillovers are large in Nearby ("High imports"), as indicated by the solid red line. Note that in this case, the nearby scenario is quite extreme: it assumes that a country imports only from the war site. Perhaps unsurprisingly, spillovers are massive. In the opposite case where there are no imports from the war site at all—the hypothetical scenario indicated by the dashed blue line—the output spillovers are positive, as in our baseline specification above. Likewise, we observe very large inflation spillovers in the nearby scenario, and only small ones if the war is very distant in terms of trade relations.

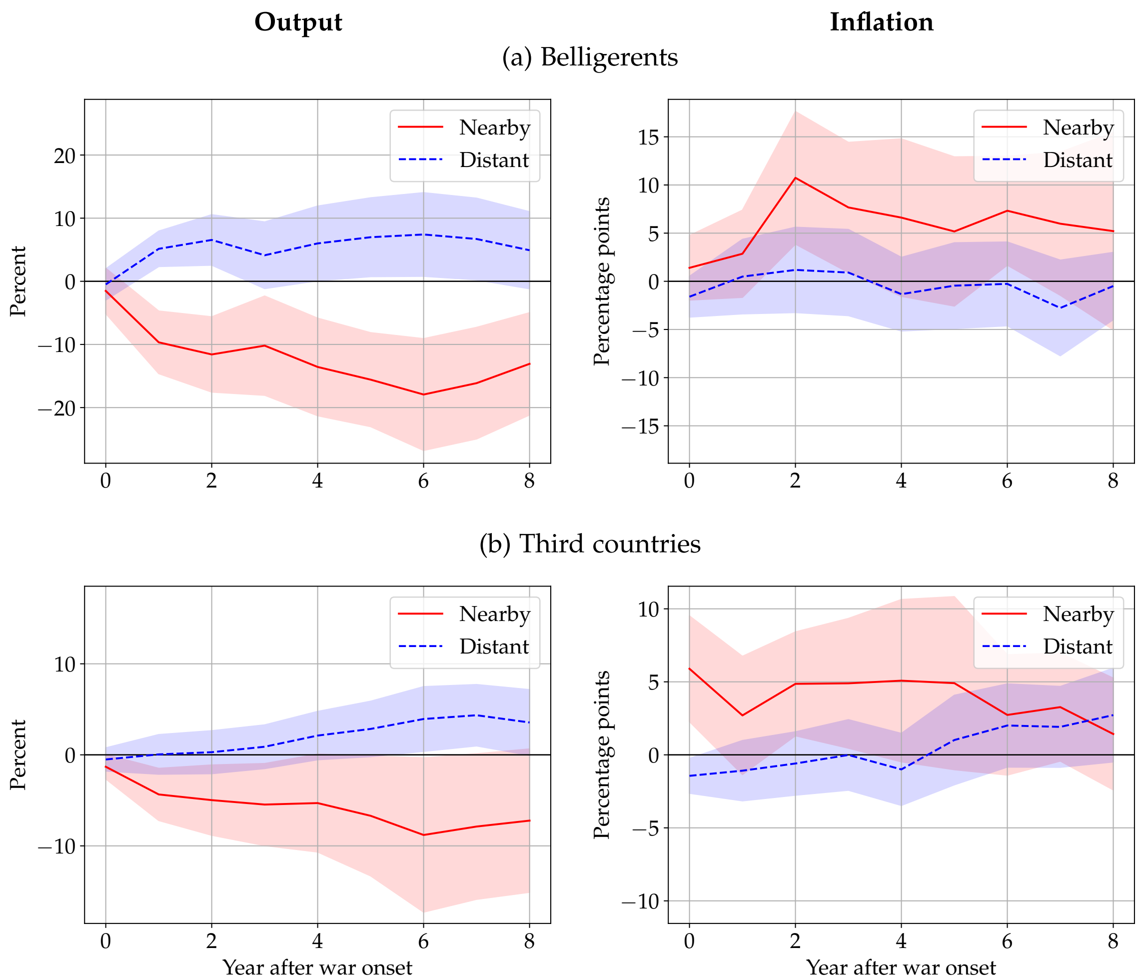
3.3 Belligerents

The estimates reported so far focus on geography, size and/or trade exposure as a key determinant of the spillovers from the war site. When it comes to Foreign, they do not distinguish between belligerent countries and third countries that are not parties to the war. We now assess whether this distinction matters for how spillovers play out and split the sample accordingly: Of the 1,798 country-year observations that capture foreign countries' exposure to war sites, 152 qualify as belligerent according to CoW. We revisit the unconditional projections and find that results are almost identical for belligerents and third countries, and thus in each case comparable to what we show for Foreign in panel (a) of Figure 4 above: For the average foreign country—belligerent or not—there is not much of an effect on inflation and output, see Figure B.1 in the appendix.[18]

[17]The size-distance specification is more demanding in that it requires information on the economic size of the war site, which the baseline does not. As a result, our sample shrinks to 961 country-year observations for Foreign.

[18]In disentangling these effects we replace the Foreign dummy in equations (3.1) and (3.2) with two new dummies indicating whether the countries are belligerents or third parties in relation to a war which started in a given year, respectively.

Figure 6: Belligerents v third countries



Note: Results based on large wars, sample period 1870–2022. Left panels show deviation of (detrended) output from pre-war level, right panels show deviation of inflation from pre-war rate. Shaded areas indicate 90% confidence bands.

We also estimate a version of our baseline specification (3.2) while allowing the effects of distance to differ for belligerents and third countries. Figure 6 shows the results for output and inflation for both country groups. The figure shows that the effects for belligerents (top) are stronger than for third countries (bottom), but the general pattern is very similar. For both country groups, we find negative output spillovers in Nearby and mildly positive output spillovers in Distant (left column), matching the evidence for the whole sample, see again panel (b) of Figure 4 above. In sum, the first-order effect of geography dominates, with a change of sign in the spillovers as we move from Nearby to Distant. Similarly, the pattern of the inflation response, shown in the right column of the figure, is somewhat amplified as we zoom in on the belligerents, but does not change fundamentally. An implication of this finding is that participation in the war as such does not explain the spillovers from the war site. Instead, it amplifies the primary effect related to proximity.

3.4 Further evidence

We now present evidence on the adjustment of additional outcome variables in an effort to shed some light on the transmission mechanism and guide our modeling efforts in Section 4.[19] To economize on space we only discuss the results of this and the next subsection and show figures in Appendices B and C.

We begin by looking at government expenditures which have been shown to increase strongly during wars (Barro, 1987; Ramey, 2011). Given the context of our analysis, we simply estimate specifications (3.1) and (3.2) but consider military expenditures, measured in percentage points of pre-war GDP, as the outcome variable.[20] We find that during the average large war, military spending increases by about 10 percentage points, with a maximum effect four years from the start of the war. Importantly, military spending increases not only in the war site, but also in Nearby (by approximately 2 percentage points) and even in Distant, although in this case the effect is more delayed and less pronounced. The results remain fairly similar once we distinguish between belligerents and third countries, although—quite plausibly—the effects for belligerents again look stronger and somewhat less delayed.

Consistent with the increase in military spending during wars, we find that the fraction of the population employed in the military increases significantly. Again, the effect is strongest for the war sites, where the share of people employed in the military increases by 2 percentage points, measured in terms of the pre-war population. In nearby countries, it increases by about 1 percentage point. There is no significant response in distant countries. We further find unemployment to briefly rise by close to 2 percentage points on impact in the war site, before decreasing persistently below the pre-war level thereafter. Unemployment in Nearby and Distant is hardly affected. In terms of total population, we find a moderate impact of wars, which also takes more time to materialize. The

[19] Since the outcome variables are gathered from different sources, their availability differs from that in our baseline sample. Thus, the samples used for the estimations vary from those in our baseline.

[20] We obtain measures of military expenditures from the COW database, which relies on country codes referencing historical borders and states. These have been translated manually to ISO codes referring to countries in today's borders, which may result in minor inconsistencies within the data and in comparison to the main analysis above.

population of the war site shrinks somewhat, with a maximum effect of about 3 percent seven years after the start of the war. The effects in Foreign are not significant, neither in Nearby nor in Distant. These population changes may point to migration flows, though their average magnitude suggests they are unlikely to be a key driver of the economic spillovers we observe in the data. That said, a more systematic analysis of migration flows in the context of wars, based on more granular data than we have available, could be an important avenue for future research.

Another salient feature of war sites is physical destruction. Accordingly, we measure the response of the capital stock to the onset of large wars. This response is very strong and persistent for war sites, where the capital stock declines by some 20 percent within the eight years following the start of a war. There is also evidence for spillovers along this dimension: in Nearby, the capital stock declines by more than 5 percent. This suggests that the decline of the capital stock not only reflects physical destruction but also an endogenous response to changes in the economy during war times, an issue we take up in our model analysis below. To inform this analysis further, we also estimate the response of total factor productivity. We find that TFP in Home responds strongly and quickly to the war. After two years, it is down by some 20 percent. This effect lasts for more than four years into the war. Only afterward do we observe some recovery. For nearby countries, there is also a decline, but the effect is only marginally significant. This pattern is consistent with the notion that a shift of employment to the military sector lowers the productive capacity of the economy, as substantiated in the classic study of Ramey and Shapiro (1998). They put forward a neoclasscial two-sector model to study military buildups and provide estimates for specific episodes in the U.S. post-WW2 period. They find that labor productivity declines in response to the build-up (which, in their model analysis, reflects that capital in the civilian sector becomes idle) and provide supporting evidence based on data for the manufacturing sector.

3.5 Robustness

We explore the robustness of our findings along a number of dimensions. First, we consider several additional specifications to assess how the economic effects of war play out over time. In our baseline, the start of the war is defined as the year when military action starts in the war site. Yet depending on how the war unfolds the start of the war in the war site may be anticipated to some extent.

To address this issue, we consider an alternative specification, where we define the start of the war as the year when the war as such starts—even though there might not yet be military action in the war site itself. For this specification, we find similar results as for the baseline, except that it takes longer for the full effect to materialize.

Next using again the definition of war as in the baseline, we consider longer horizons and document that even 16 years after the onset, the adverse effects of war have not been completely reversed in Home. We also verify that results are robust to expressing the dependent variables in levels (rather than in changes relative to the pre-war period). The resulting projections differ only marginally from our baseline results. Lastly, we conduct a series of tests where we condition the sample of war sites on the duration of the wars. This involves producing two separate sets of projections: one for a sample of wars with a duration below or equal to the median duration of wars in the entire sample, corresponding to two years or less; and one for the sample of wars that last more than two years. Across both sets, we observe that our results do not change significantly. Even short wars with a duration of at most two years have a sizeable effect on output and inflation similar to what we find for the baseline, and the effect is still manifest some eight years after the beginning of the (short) war.

Third, we explore to what extent our results are driven by the two largest wars in our sample, World Wars I and II. We do so by estimating our baseline specification on a sample from which we drop the World Wars. Unsurprisingly, we find that the impact of war is weaker compared to the baseline, but the overall pattern is very much the same. We conclude that the World Wars help to identify the economic impact of war, as one would have expected, but the apparent empirical pattern does not hinge on them. Likewise, we verify that the distinct effects in distant countries are not driven by the U.S. For this purpose, we exclude the U.S. from our panel and re-estimate our baseline projection for nearby and distant countries. We find that results are virtually unchanged.

Fourth, we re-estimate our specification now including all wars and not only large wars, for which casualties exceed 10k. The estimated effects are smaller, which confirms that the size of military conflict matters, but they still mirror the findings from our baseline: Wars are associated with a considerable shortfall in output and excess inflation in Home. Both effects spill over to nearby countries.In a similar vein, we re-estimate our baseline specification for the sample of major war sites with more than 100k casualties. The results are consistent with the notion of greater material destruction leading to more pronounced economic effects.

In light of these results, we also examine more systematically how a war's severity—as reflected in our casualties measure—shapes its economic spillovers. Thus, we estimate a variant of specification (3.2) which differs from the baseline in several aspects. First, we expand our sample to include all wars, without any restrictions regarding the number of casualties. Second, we consider only spillover effects on countries located within 5,000 km of the war site and redefine variable $Foreign_{i,t}$ to take on the value of 1 in this case only. Third, we modify the transition function in the following way: $F(i,t) = casualties_{i,t}/casualties^{\max}$. Here $casualties_{i,t}$ is the sum of casualties per war site for which country i is nearby (less than 5,000 km away) in year t and $casualties^{\max}$ is the maximum exposure in terms of war severity in the sample. Thus, the transition function takes on the value of 0 if there is no war going on in the neighborhood of country i and the value of 1 for the country that was exposed to the most battle deaths in its neighborhood throughout the whole sample. We find the severity of wars to be a significant determinant of spillovers to nearby countries. Notably, the effects for the "low severity" group are negligible for both output and inflation. At the other end of the spectrum, we find the spillovers of the most severe wars to be very large. Countries located in the neighborhood of such a severe war see their output declining by some 40 percent relative to trend, while inflation rises by about 20 percentage points for an extended period.

4 Structural interpretation

We now employ an international business cycle model to offer a structural interpretation of the evidence. The model features three countries—*Home*, *Nearby*, and *Distant*—as well as a *Rest of the World*. In this way we can simultaneously account for differences in the degree of trade integration among countries—their distance—as well as their size, both key aspects for the economic spillovers of wars according to our empirical analysis. In terms of features, our model synthesizes recent work by Eichenbaum, Johannsen and Rebelo (2021) and Gopinath et al. (2020) to account for the use of both intermediate goods and capital in production as well as nominal and real rigidities, familiar from empirically successful accounts of the international business cycle.[21]

[21]Our model simulations use adaptable code in Dynare's macro-preprocessing language, allowing users to switch between different pricing regimes (DCP, PCP, LCP as in Georgiadis and Schumann (2021)), modify aggregation technologies, adjust the number of countries (including two- and three-country versions) and add or remove model features. It thus provides a robust

We devise a war-shock scenario building on earlier work on rare disasters (Gourio, 2012). Specifically, we assume that there is a "war shock" in Home which destroys a fraction of the capital stock and lowers total factor productivity. Additionally, the war shock induces an increase of government spending, reflecting military buildups in the war site but also, to a different extent, elsewhere. We show that, under these assumptions, the model is able to provide a quantitatively successful account of the economic impact of the war—not only in the war site but also in foreign countries. Trade integration proves to be key for the economic spillovers of war as stressed by Martin, Mayer and Thoenig (2008). However, we pivot the focus toward the role that trade relationships have on the transmission of war shocks, rather than the impact of trade on the likelihood of war. In what follows, we first outline the model structure and our calibration strategy, which relies on matching impulse response functions. We then use the model to inspect the mechanism through which a war shock affects the global economy.

4.1 Model outline

We keep the exposition brief, using index $j \in \{H, N, D, R\}$ to denote countries, and relegate all derivations to a full model documentation available in the replication files. The size of the world economy is normalized to unity, $\sum_j n_j = 1$, where $n_j = |\mathcal{N}_j|$ represents the proportion of both the population as well as firms residing in each country j, distributed over distinct masses $\mathcal{N}_j$ on the unit interval. Countries are isomorphic and differ in three key aspects only: their size (in terms of population), their trade integration, and the way in which they are exposed to the war shock.

Within each country, a generic household $h \in \mathcal{N}_j$ chooses consumption, supplies labor, invests in physical capital and trades financial assets. At an international level, we restrict financial trade to a non-contingent bond issued in the Rest of the World's currency. Within countries, by contrast, financial markets are complete such that household heterogeneity due to sticky wages is largely immaterial (Erceg, Henderson and Levin, 2000). In what follows, uppercase letters represent individual choices made by households or firms, while lowercase letters denote variables in per-capita terms.

The expected lifetime utility of household h depends on consumption $C_{j,t}(h)$

and flexible tool for analyzing a wide range of international economic scenarios. The original models of Eichenbaum, Johannsen and Rebelo (2021) and Gopinath et al. (2020) are nested and can be accessed as special cases.

and labor $L^s_{j,t}(h)$:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{1}{1-\sigma^C} \left(C_{j,t}(h) - \phi^C c_{j,t-1} \right)^{1-\sigma^C} - \frac{\chi^L}{1+\sigma^L} (L^s_{j,t}(h))^{1+\sigma^L} \right\},$$

where β is the discount factor, σ^C represents the inverse of the intertemporal elasticity of substitution, σ^L the inverse of the Frisch elasticity of labor supply, and χ^L is a parameter that normalizes hours worked in steady state. The parameter ϕ^C measures the degree of external habits, governed by the previous period's per-capita consumption, defined as $c_{j,t-1} = 1/n_j \int_{\mathcal{N}_j} C_{j,t-1}(h)dh$. Households own an internationally immobile capital stock, $k_{j,t}$, which evolves according to:

$$k_{j,t} = \left((1-\delta^K) k_{j,t-1} + \left(1 - \frac{\phi^K}{2} \left(\frac{i_{j,t}}{i_{j,t-1}} - 1 \right)^2 \right) i_{j,t} \right) e^{-\Delta^K_j \omega_t}.$$

Here, δ^K denotes the rate of capital depreciation, $i_{j,t}$ represents investment, and ϕ^K parameterizes investment-adjustment costs.ω_t is the war shock, which—akin to the rare disaster in Gourio (2012)—destroys a fraction $\Delta^K_H > 0$ of the capital stock in Home. Letting η_t denote the innovation to the war-shock process that takes a value of one at the onset of war, the war shock follows an AR(2) process with persistence parameters ρ^ω_1 and ρ^ω_2:

$$\omega_t = \rho^\omega_1 \omega_{t-1} + \rho^\omega_2 \omega_{t-2} + \eta_t.$$

Recall that households trade a full set of state-contingent securities domestically. They are in zero net supply and, hence, we omit these, as we state period budget constraint in real per-capita terms:

$$\begin{aligned} & c_{j,t} + i_{j,t} + \mathcal{E}^r_{Rj,t} b_{Rj,t} + \frac{\phi^B}{2} \left(\mathcal{E}^r_{Rj,t} b_{Rj,t} \right)^2 + \tau_{j,t} \\ & \quad = \frac{1}{n_j} \int_{\mathcal{N}_j} \frac{W_{j,t}(h) L^s_{j,t}(h)}{P_{j,t}} dh + r^K_{j,t} k_{j,t-1} + \mathcal{E}^r_{Rj,t} \frac{R_{R,t-1}}{\Pi_{R,t}} b_{Rj,t-1} + \sum_i div_{ji,t}. \end{aligned}$$

Here $P_{j,t}$ is the price index for final goods and $\Pi_{j,t} = P_{j,t}/P_{j,t-1}$ is inflation. $\mathcal{E}^r_{Rj,t} = \mathcal{E}^n_{Rj,t} P_{R,t}/P_{j,t}$ is the real exchange rate, where the nominal exchange rate, $\mathcal{E}^n_{Rj,t}$, is defined as the price of currency R expressed in units of currency j. $b_{Rj,t}$ denotes the holdings of the international bond, expressed in real per capita terms of country j. It yields a gross nominal interest rate of $R_{R,t}$. ϕ^B parameterizes bond carrying cost. This reflects, albeit in a stylized manner, financial frictions as in García-Cicco, Pancrazi and Uribe (2010) and—more technically—ensures a stationary solution (Schmitt-Grohé and Uribe, 2003). $r^K_{j,t}$ is the rental rate of capital that is leased to firms. Furthermore, households receive income from dividends, symbolized by $div_{ji,t}$, and $\tau_{j,t}$ represents taxes.

Households provide differentiated labor types that are aggregated into homogeneous labor services. Like capital, these services are not traded across borders. The demand for labor types is given by: $L^d_{j,t}(h) = (W_{j,t}(h)/W_{j,t})^{-\epsilon^W} l_{j,t}$, where $l_{j,t}$ are labor services in per-capita terms and $\epsilon^W > 1$ measures the elasticity of substitution between distinct labor types. $W_{j,t}$ is the aggregate wage index and $W_{j,t}(h)$ is the wage of household h which is adjusted infrequently: In each period, a randomly selected fraction of households $1 - \theta^W$ may adjust its wage.

Households consume final goods which are also used for investment and government spending as well as an intermediate input in production. Formally, the final good $y_{j,t}$ is an aggregate, composed of bundles of domestically produced goods, $y_{jj,t}$, and imported goods, $y_{ij,t}$, where $i \neq j$ specifies the country of production:

$$y_{j,t} = \left(\gamma_{jj}^{\frac{1}{\sigma}} (y_{jj,t})^{\frac{\sigma-1}{\sigma}} + \sum_{i \neq j} \gamma_{ij}^{\frac{1}{\sigma}} \left(\varphi_{ij,t} y_{ij,t} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}.$$

Here, σ is the elasticity of substitution in the terms of trade, while the term

$$\varphi_{ij,t} = 1 - \frac{\phi^{IM}_{ij}}{2} \left(\frac{y_{ij,t}/y_{jj,t}}{y_{ij,t-1}/y_{jj,t-1}} - 1 \right)^2$$

captures adjustment costs that effectively reduce the price elasticity of imports in the short run. γ_{ij} is the weight of country-i goods used in the production of final goods in country j and determines the degree of trade integration in steady state. We set $\gamma_{ij} = \gamma_{ji}$ and $\gamma_{jj} = 1 - \sum_{i \neq j} \gamma_{ij}$ such that trade is balanced in steady-state (for which we assume relative prices to be unity). We parameterize these weights according to $\gamma_{ij} = \Omega_{ij}\, n_i$, where the "home bias" parameter $0 < \Omega_{ij} \leq 1$ controls the degree of trade integration beyond economic size n_i. In the limiting case where $\Omega_{ij} = 1$, imports from country i simply reflect its size in the world economy. By varying home bias we may—in the spirit of gravity—account for other factors that determine trade integration, in particular geographic distance (Head and Mayer, 2014).

The term $y_{ji,t}$ represents an aggregate of country-specific varieties, which are produced under monopolistic competition. We assume that prices are sticky à la

Calvo: In each period a randomly selected fraction of firms $1 - \theta^P$ is permitted to reset its price. We assume producer currency pricing such that a generic producer m in country j faces the demand functions $Y^d_{ji,t}(m) = (\mathcal{E}^n_{ji,t} P_{ji,t}(m)/P_{ji,t})^{-\epsilon^P} \frac{n_i}{n_j} y_{ji,t}$. Here, $P_{ji,t}(m)$ is a firm's price, expressed in its currency j, for goods sold to country i. $P_{ji,t}$ is the producer price index in country i and ϵ^P denotes the elasticity of substitution between varieties. Production of varieties adjusts to meet demand at posted prices from all four destinations and is Cobb-Douglas:

$$\sum_i Y^d_{ji,t}(m) = A_{j,t}(X^d_{j,t}(m))^{\alpha^X} \left((K^d_{j,t}(m))^{\alpha^K} (L^d_{j,t}(m))^{1-\alpha^K} \right)^{1-\alpha^X},$$

where $X^d_{j,t}(m)$, $K^d_{j,t}(m)$, and $L^d_{j,t}(m)$ represent the amounts of intermediate inputs, capital, and labor employed by firm m in country j. The parameters α^X and α^K determine the corresponding factor shares and $A_{j,t}$ denotes total factor productivity (TFP), which follows an AR(1) with persistence parameter ρ^A and changes in response to the war:

$$\log(A_{j,t}) = \rho^A \log(A_{j,t}) - \Delta^A_j \omega_t.$$

Importantly, we assume that the war shock impacts TFP only in the Home country, $\Delta^A_H > 0$, a conservative assumption in light of the evidence in Figure B.7.

Bond market clearing requires that $\sum_j n_j b_{Rj,t} = 0$ for the internationally traded bond. Market clearing for final goods implies:

$$y_{j,t} = c_{j,t} + i_{j,t} + x_{j,t} + \frac{\phi^B}{2}\left(\mathcal{E}^r_{Rj,t} b_{Rj,t}\right)^2 + \frac{P_{jj,t}}{P_{j,t}} g_{j,t},$$

where $g_{j,t}$ is real government spending, which is funded through lump-sum taxes and composed of domestically produced varieties only. We assume that government spending increases during the war because of military buildups. Using variables without time-subscript to refer to steady-state values, we assume an AR(1) process for government spending which responds to the war shock according to parameter $\Delta^G_j \geq 0$:

$$\frac{g_{j,t}}{gdp_j} = (1 - \rho^G_j)\left(\frac{g_j}{gdp_j}\right) + \rho^G_j \left(\frac{g_{j,t-1}}{gdp_j}\right) + \Delta^G_j \, \omega_t.$$

Here $gdp_{j,t}$ is per-capita GDP, measured in value-added terms, that is, by subtracting intermediate inputs from total output. Monetary policy adjusts interest rates according to a simple feedback rule:

$$\frac{R_{j,t}}{R_j} = \left(\frac{R_{j,t-1}}{R_j}\right)^{\rho_j^R} \left(\left(\frac{\Pi_{j,t}}{\Pi_j}\right)^{\psi_j^\Pi} \left(\frac{gdp_{j,t}}{gdp_j}\right)^{\psi_j^{gdp}}\right)^{1-\rho_j^R},$$

where ψ_j^Π and ψ_j^{gdp} are feedback parameters, ρ_j^R captures interest-rate smoothing. Exchange rates adjust freely to clear the foreign exchange market.

4.2 Model calibration and validation

We solve the model based on a first-order perturbation and compute the impulse response to the onset of war, η_t. To calibrate the model, and in particular, the war-shock scenario, we target the empirical response functions of GDP and inflation in Home, Nearby and Distant, as shown in the four panels of Figure 4 above. Specifically, we pin down key parameters by matching these impulse response functions. The other parameters are fixed at conventional values prior to the matching exercise.

We validate the calibrated model by confronting its predictions for the responses of the capital stock, total factor productivity and military expenditures with their empirical counterparts. Alternatively, we may target the latter variables to calibrate the model and use its prediction for output and inflation for evaluation purposes. Yet, since these variables are arguably less prone to measurement problems, we consider them more suitable calibration targets. Nevertheless, it is important to verify that the model is in the right ballpark when it comes to the underlying driving process, as we show below.

Fixed parameters. Parameter values are identical across countries, except when noted otherwise. A period in the model represents one year, with the time-discount factor β set to $1/1.04$. The cost of holding international bonds is governed by $\phi^B = 0.001$, while capital depreciation occurs at a rate of $\delta^K = 0.1$, and the investment adjustment-cost coefficient ϕ^K is fixed at 4. Elasticities of substitution both for labor types (ϵ^W) and product varieties (ϵ^P) are uniformly set to 11. Risk aversion σ^C is equal to 2 and the inverse Frisch elasticity σ^L is set to 1, while the habit parameter ϕ^C is fixed at 0.75. χ^L is determined to normalize labor supply in steady-state to 1. The same normalization applies to the targeted gross inflation rate, $\bar{\Pi}_j = 1$. θ^P and θ^W are both set to 0.15, such that wages and prices are reset approximately after 1.2 years, on average.[22] We set α^X to 0.45 and α^K to 0.40 (Bouakez, Rachedi and Santoro, 2023) and the trade-price elasticity σ to 0.9 (Corsetti, Dedola and Leduc, 2008; Heathcote and Perri, 2002). Import adjustment costs between Home, Nearby, and Distant are uniformly set to 10 in line with Eichenbaum, Johannsen and Rebelo (2021).

For the steady state we assume that trade is balanced and all relative prices as well as exchange rates are equal to unity. In terms of size, Home is calibrated to represent 6 percent of the world economy, which corresponds to the average size of war sites in our sample. We assume that Nearby and Distant each account likewise for 6 percent of the world economy, with the remaining 82 percent represented by the Rest of the World. In our sample, the degree of openness varies considerably across countries and over time. We set the share of imports to 25 percent of GDP in steady-state: $1 - \gamma_{jj} = 0.25(1 - \alpha^X(\epsilon^P - 1)/\epsilon^P)$ for $j \neq R$. *Home* and *Nearby* are fully integrated with each other, $\Omega_{HN} = \Omega_{NH} = 1$, whereas trade with *Distant* is almost irrelevant, $\Omega_{DH} = \Omega_{HD} = \Omega_{DN} = \Omega_{ND} = 0.01$. The assumptions of symmetry and balanced trade pin down the parameters in the Rest of the World. Lastly, we set the level of government spending to 20% of GDP in steady state.

IRF matching. We determine the key parameters by matching impulse response functions based on a Bayesian procedure, as suggested by Christiano, Trabandt and Walentin (2010). In this way, we treat the empirical impulse responses as data and select parameters to ensure that the model's impulse responses closely mirror their empirical counterparts. Specifically, we target the responses of GDP and inflation in Home, Nearby and Distant from years 0 to 8. In line with standard practices, we employ a diagonal weighting matrix, with the diagonal elements set to the inverse of the squared standard error of the respective empirical impulse response, see Meier and Müller (2006) for an early discussion.

Table 3 reports our priors and the parameters that are selected by the matching procedure. We start from the premise that the war shock affects all margins in a sizeable and persistent way. For parameters controlling the impact effects

[22]Given recent estimates by, for instance, Hazell et al. (2022), this is a moderate degree of nominal stickiness, consistent with the notion that nominal wages, in particular, have become less flexible over time only (Chernyshoff, Jacks and Taylor, 2009). Note also that concerns about counterfactual predictions of the basic New Keynesian model pertain to the markup response to demand shocks (Nekarda and Ramey, 2020). Instead, our war-shock scenario is first and foremost a supply shock. And, indeed, we find that a version of the model without nominal rigidities is also able to capture key aspects of the adjustment to the war shock; results are available in the replication package.

Table 3: War-shock scenario—priors and posteriors

	Prior				Posterior			
	Distribution	Mean	Stdev	Bounds	Mode	Mean	5%	95%
ρ_I^ω	Beta	0.500	0.100	[0; 0.99]	0.6389	0.6529	0.5350	0.7672
ρ_{II}^ω	Beta	0.500	0.100	[0; 0.99]	0.6901	0.6531	0.5375	0.7709
Δ_H^K	InvGamma	0.025	0.100	[0; 0.10]	0.0201	0.0303	0.0059	0.0645
Δ_H^A	InvGamma	0.020	0.100	[0; 0.10]	0.0748	0.0847	0.0730	0.0994
ρ_H^A	Beta	0.500	0.100	[0; 0.99]	0.6461	0.5902	0.4649	0.7281
Δ_H^G	InvGamma	0.035	0.100	[0; 1.00]	0.0143	0.0161	0.0086	0.0237
Δ^G	InvGamma	0.001	0.100	[0; 1.00]	0.0001	0.0078	0.0002	0.0161
ρ_H^G	Beta	0.600	0.100	[0; 0.99]	0.5758	0.5111	0.4171	0.5999
ρ^G	Beta	0.600	0.100	[0; 0.99]	0.5843	0.5371	0.4620	0.6000
ρ_H^R	Beta	0.500	0.100	[0; 0.99]	0.7652	0.7125	0.6032	0.8138
ρ^R	Beta	0.500	0.100	[0; 0.99]	0.4518	0.4800	0.3213	0.6336
ψ_H^Π	Normal	2.000	0.100	[1.01; 4]	2.1356	2.0441	1.8995	2.2005
ψ^Π	Normal	2.000	0.100	[1.01; 4]	1.8884	1.9435	1.7824	2.0976
ψ_H^{gdp}	Normal	0.500	0.100	[0; 0.75]	0.3888	0.6009	0.4893	0.7368
ψ^{gdp}	Normal	0.500	0.100	[0; 0.75]	0.6145	0.5967	0.4568	0.7500

Note: IRF matching based on Slice sampler with 24,000 draws (50% of draws as burn-in).

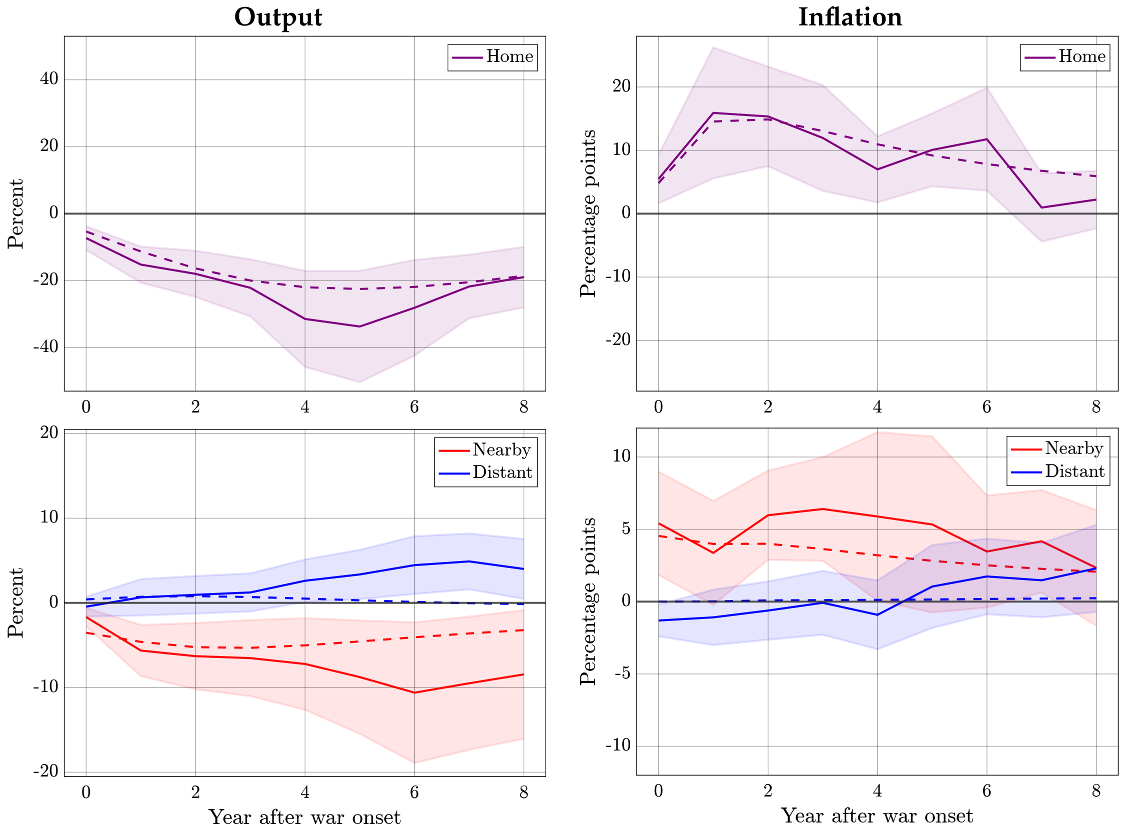
of the war shock on the capital stock, total factor productivity and military expenditures, we assume an Inverse Gamma prior (InvGamma). Persistence parameters, in turn, follow a Beta prior distribution while the priors for the monetary policy parameters are normally distributed. Regarding the incidence of shocks, we posit that capital destruction and productivity disturbances happen in Home only, $\Delta_H^K > 0$ and $\Delta_H^A > 0$. We hypothesize that military spending increases not only in Home, $\Delta_H^G > 0$, but also globally, with increases outside the war site assumed to be symmetric and equal to $\Delta_N^G = \Delta_D^G = \Delta_R^G = \Delta^G > 0$. Our prior mean reflects the view that Home increases its spending much more than the other countries, but we set the same prior for the persistence parameters, where again $\rho_N^G = \rho_D^G = \rho_R^G = \rho^G$. Likewise, for monetary policy we assume response coefficients in Home to differ from those everywhere else, where we assume identical coefficients. Instead of directly estimating the coefficients ρ_1^ω and ρ_2^ω of the second-order autoregressive process which governs the dynamics of the war shock, we estimate the roots ρ_I^ω and ρ_{II}^ω of the process (Born, Peter and Pfeifer, 2013; Bayer, Born and Luetticke, 2023). These are related according to $\rho_1^\omega = \rho_I^\omega + \rho_{II}^\omega$ and $\rho_2^\omega = -\rho_I^\omega \cdot \rho_{II}^\omega$. By imposing the Beta prior distribution with a mean of 0.5, we ensure the stability of this process. All prior standard deviations are set equally to 0.2 and the prior is numerically truncated to ensure that parameters remain within economically plausible bounds.

Initially, a slice sampler is used to generate 4,800 draws across 24 parallel chains. The covariance matrix from these draws is then utilized to scale the stepping out procedure of a subsequent, so-called *rotated* Slice sampler, generating 24,000 draws also spread across 24 parallel chains, allocating half of these samples for burn-in.[23] We report posterior estimates in the right panel of Table 3. We observe updates to the prior distributions for almost all parameters and the highest posterior density (HPD) intervals contain economic plausible values. The estimated persistence of the war shock is adjusted upwards, with both roots being around 0.65. The initial exogenous destruction of the capital stock is approximately 3% on impact; yet because of the persistence of the war shock, combined with an endogenous reduction in investment, this leads to a much larger reduction in the capital stock over time of up to 42% after 8 years (as shown in Figure 8 below). The estimated drop in productivity in Home is substantial, at more than 8% on impact. Military spending in the war site is estimated to increase more strongly than in Foreign, with an initial rise of 1.6 percentage points relative to pre-war GDP in Home, compared to less than 0.8 percentage points in the other countries (for which we impose symmetry). The persistence parameters ρ_H^G and ρ^G are estimated within plausible ranges. However, the HPD intervals for the government spending process are somewhat broad, indicating minimal updating from the prior. We find similar weak identification for the estimates of the monetary policy parameters, even though the posterior mean aligns with conventional estimates in the literature (reflecting our prior).

The dashed lines in Figure 7 show the impulse response functions predicted by the model at the posterior mean. We contrast them to their empirical counterparts (solid lines), reproduced from Figure 4 above. These responses have been used as calibration targets and hence—perhaps unsurprisingly—the model predictions align well with the data, notably for the war site (Home). Still, we emphasize that the model is able to generate spillovers to Nearby which are quantitatively well in line with the evidence. The model also predicts positive output spillovers to Distant, but these are somewhat smaller than in the data and at the lower bound of the significance bands. We note, however, that the extent and even

[23] For a comprehensive assessment: convergence diagnostics, trace plots, and relative inefficiency factors are provided in the supplementary Dynare replication codes. These also include additional estimation results using the standard Random-Walk Metropolis-Hastings algorithm (RW-MH) with 24 million draws, where the posterior mode from the rotated Slice serves as the initial guess for an optimization-based search to accurately find the posterior mode. It's noteworthy that the posterior distributions from RW-MH closely match those from the rotated Slice sampler, where the latter typically yields Markov chains with much lower autocorrelation and doesn't require a cumbersome and time-consuming mode-finding step. Note that we contributed our (user-friendly) IRF matching toolbox as a feature of Dynare from version 6.0 onwards.

Figure 7: The macroeconomic impact of war—model v data (targeted)



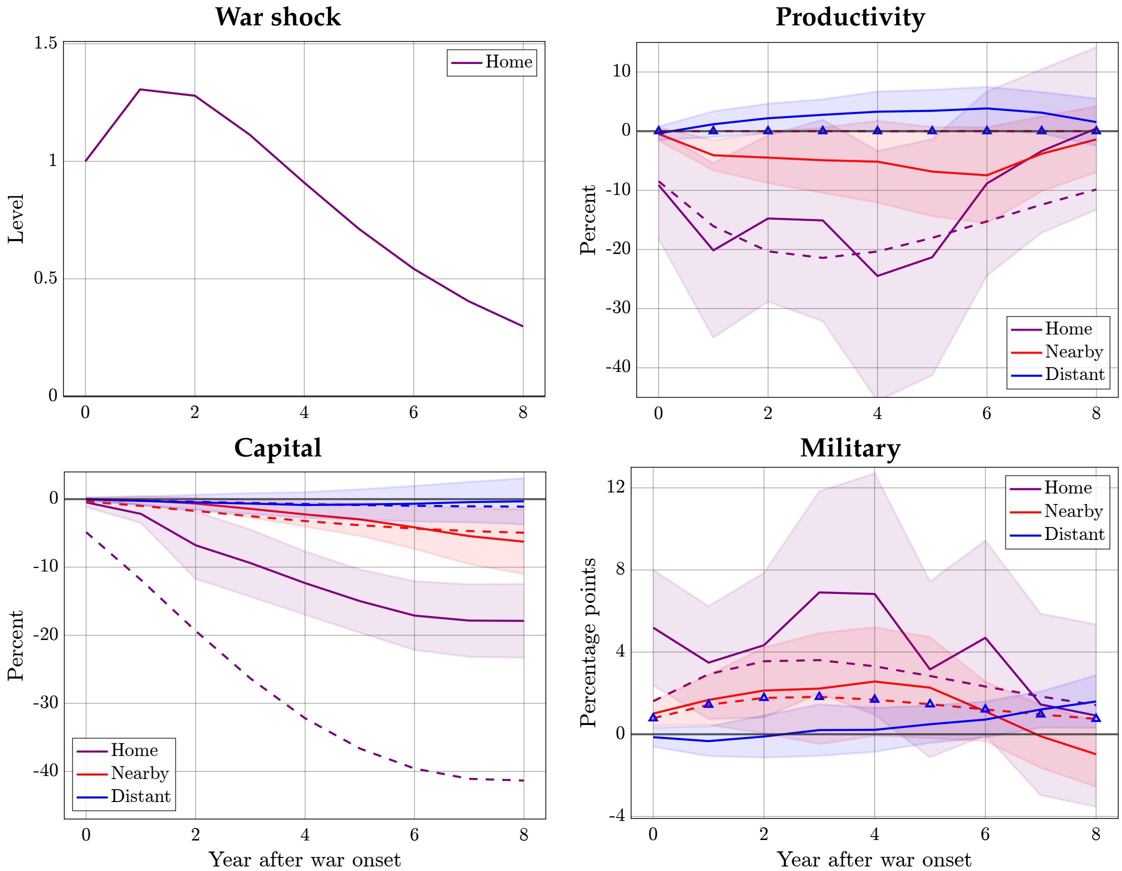
Note: Dashed lines show adjustment to war shock according to calibrated model (posterior mean). Solid lines and shaded areas reproduced from Figure 4 above. Vertical axis measures deviation from pre-war (steady-state) level.

the sign of output spillovers to Distant varies across empirical specifications, see Figure 5 above.[24] In terms of inflation spillovers, the model is both qualitatively and quantitatively in line with the evidence.

Model validation. We now assess the performance of the model based on evidence that has not been used in the matching procedure. Here we focus on the key features of the war shock itself, which is shown in the first panel of Figure 8. It exhibits a hump-shaped pattern and has no observable counterpart. Yet in the remaining panels of the same figure we show the dynamics of productivity (TFP) and the capital stock, as predicted by the model (dashed lines) alongside the empirical estimates (solid lines) reproduced from Figures B.6 and B.7. We also compare the model prediction for the change in government spending to

[24] Key parameters shaping the spillover effects are the trade elasticity (σ) and the risk aversion (σ^C). We illustrate the robustness of our results for different combinations of σ and σ^C in the replication package.

Figure 8: The macroeconomic impact of war—model validation



Note: Dashed lines and triangles show adjustment of model economy. Solid line and shaded area corresponds to Figures B.2, B.6, and B.7. Vertical axis measures deviation from pre-war (steady-state) level. Military expenditures as a ratio of pre-war (steady-state) GDP.

the empirical response of military expenditures (shown in Figure B.2), assuming that the change of government spending predicted by the model reflects changes in military spending only.[25]

Focusing on the top-right panel, we observe the implied dynamics of total factor productivity. In the model we only allow TFP in Home to respond to the war shock, even though there is some evidence that TFP also drops in Nearby. This effect is only marginally significant, however, and we are particularly interested in the spillovers from the war site to the other countries that arise endogenously in the model. Remarkably, the decline of productivity in Home, as implied by our model, aligns rather well with its empirical counterpart, even though it has not been targeted in the calibration. The model predicts a persistent TFP reduction of approximately 20 percent. Even eight years following the war's

[25]Recall that the estimated responses used for validation are based on a more restricted sample of countries due to limitations in data availability.

onset, TFP remains about 10 percent reduced compared to its pre-war level.

In the bottom-left panel, we zoom in on the dynamics of the capital stock which can adjust endogenously in Home, Nearby, and Distant. Two observations are key. First, the reduction of the capital stock in the war-site economy is not only a consequence of direct, exogenous damage; instead it continues to decline over time, reflecting endogenous investment decisions which, in turn, are driven by the decline of total factor productivity. Some 8 years after the start of the war, the capital stock is reduced by roughly 40 percent of its pre-war level. This overstates the decline apparent from the estimated impulse response, but we note that quantifying the actual change of the capital stock in the war sites during conflicts is fraught with measurement problems, a widely acknowledged issue in the literature (Braun and McGrattan, 1993; Cook, 2002; Ohanian, 1997). The capital stock starts to recover, both in the model and according to the estimated response after about 8 years. Second, the model also predicts a decline in the capital stock in Nearby, even though there is neither physical destruction nor a decline of productivity. Hence, in Nearby the decline of the capital stock reflects only the endogenous investment response and aligns remarkably well with the data (again not targeted). We do not observe a comparable effect in the distant economy, neither in the data nor in the model.

Finally, the bottom-right panel shows the change of military expenditures, measured in terms of pre-war GDP. For Home we observe an increase of military expenditures which is in the ballpark of the empirical responses, if somewhat weaker: at the peak, military spending rises by some 7 percentage points of pre-war GDP in the data and by roughly 4 percentage points according to the model. In the other countries, the simulation constrains the response of military expenditures to be identical in order to limit the degrees of freedom as we match impulse responses. We find that the increase is considerably weaker than in Home, as observed in the data. Still, there is a non-trivial increase of military spending by approximately 2 percentage points of pre-war GDP on average, quite similar to what our empirical estimates imply for Nearby on impact and for Distant after 6 years.

Overall, given that the model has been calibrated without taking the empirical responses shown in Figure 8 into account, we consider the performance of the model along these dimensions as satisfactory and conclude that the model offers an empirically successful account of the macroeconomic impact of war on the global economy. Hence, we use it to gain further insights into the international transmission of the war shock.

4.3 Inspecting the mechanism

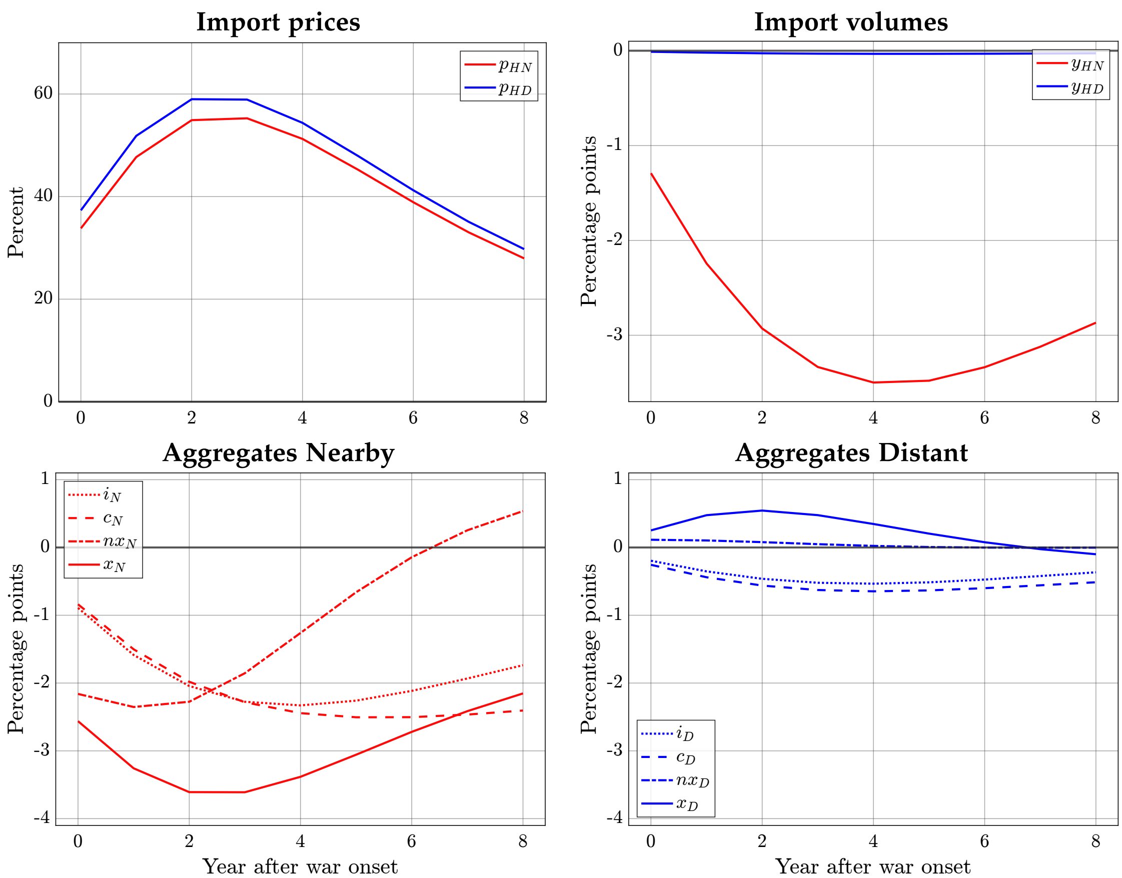
As a first step toward this end, we show the response of selected variables in Figure 9, contrasting the adjustment in Nearby and Distant. The upper-left panel shows the prices of imports from the war site—they increases massively, reflecting the adverse supply shock which war represents for Home. As a result, imports from the war site (upper-right panel) drop by more than 3 percentage points of GDP in Nearby as it trades a lot with Home. Instead, the effect is quantitatively negligible in Distant because it does not trade much with Home in the first place. Hence, the model endogenously predicts a decline in trade flows during wars. This pattern is consistent with, but does not require us to model reduced market access observed by Martin, Mayer and Thoenig (2008).

The same figure shows the response of key macro aggregates in the bottom panels—again, contrasting the adjustment in Nearby (left) and in Distant (right). In Nearby, consumption and investment drop, as does the use of intermediate goods in production because these are final goods which feature a substantial part of Home-goods as import content. Since imports from Home become so scarce the level of final-good production can no longer be maintained which, in turn, is reflected in a decline of all aggregates. The decline of intermediates lowers the production in Nearby such that net exports drop despite the decline of domestic absorption. Finally, the decline of investment lowers productive capacity, accounting for the decline of the capital stock in Nearby (see Figure 8). In sum, the adverse supply shock in the war site causes a supply-side contraction in Nearby, even though there is neither a destruction of physical capital nor a shock to productivity.

In Distant the adjustment pattern is quite different. Note first that the effects are generally much smaller because Distant is less exposed to the war. Moreover, there is an increased use of intermediate inputs, reflecting an (moderate) expansion of production as economic activity in the war site and in Nearby falters. Net exports (nx_D) increase due to a redirection of trade flows, although this effect is not enough to offset the decline in consumption and investment.

Finally, to synthesize the results of our model simulations, Figure 10 decomposes the overall effect of the war shock on output and inflation into the contributions of its different features. Specifically, we compute the average annual change in output and inflation over the projection horizon in Home, Nearby, and Distant. In each panel, the grey area represents the contribution of capital destruction, an event that occurs exclusively in Home but endogenously affects output and inflation also abroad. The contribution of the TFP decline,

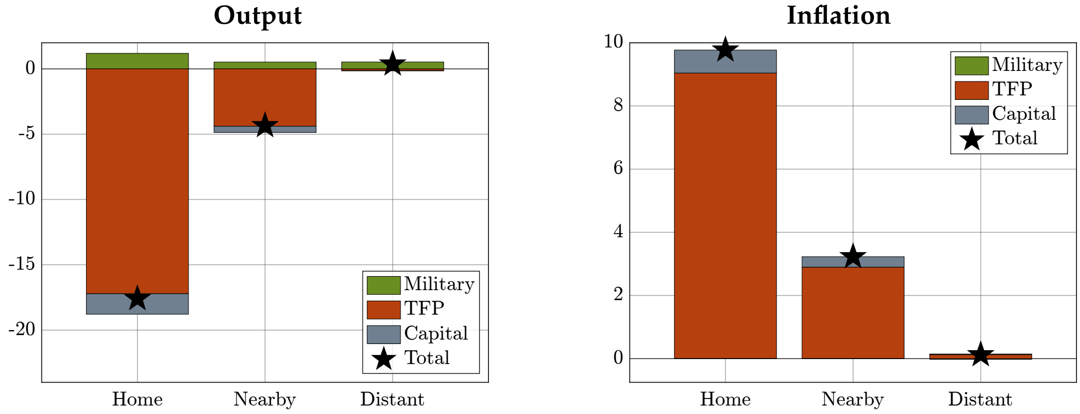
Figure 9: The economic spillovers of the war shock



Note: Adjustment of selected variables to the war shock in Nearby and Distant according to the model, relative to (pre-war) GDP. Import prices as deviation from (pre-war) steady state.

also unique to Home, is represented by the red area. Finally, the contribution of increased military expenditures is marked by the green area. The cumulative effect of these three factors is indicated by a star. Three aspects are worth noting. First, the TFP contraction in Home is key in driving the effects on output and inflation, not only in Home but also in Nearby, reinforcing the view that war is first and foremost an adverse supply shock that spills over from Home to its trading partners. Second, while the capital destruction significantly impacts Home, its quantitative effect on Nearby is more subdued. Third, military expenditures have an expansionary effect on output in all three countries, though this effect is relatively minor in Home and Nearby. In Distant, however, this—combined with a positive contribution of net exports—explains the endogenous increase in GDP. Lastly, we note that the increased military spending has virtually no impact on inflation because it is largely back-loaded.

Figure 10: Decomposition of average effects



Note: Average effect of war channels is computed by averaging IRFs over projection horizon.

5 Conclusion

Which countries pay the price of war? Our analysis addresses this question by focusing on the economic costs of war in terms of business cycle effects. We find that these economic costs are not only massive in the war-site economy itself but also spill over to a significant extent to countries that are geographically close to the war site. What matters less is whether countries are involved as parties to the war or not. In this sense, the price of war is largely paid by those countries that happen to be located in its proximity. They suffer lower output and higher inflation than would have been the case without the war.

We rationalize this result in a state-of-the-art model of the global economy. In the model, we do not distinguish between belligerent countries and third countries. Instead, we model the war shock in the war site and let countries differ in their degree of trade integration with the war site. In this way, we are able to account for the time series evidence. In a nutshell, as the war destroys the productive capacity in the war-site economy, exports to nearby economies falter. This, in turn, induces a scarcity of intermediate inputs and induces a decline of the capital stock in the nearby country—even in the absence of any physical destruction of capital. These dynamics accounts for the output and price effects that we observed in the data.

The main takeaway of our study is that the adverse impact of war is not limited to the war site. There are clear and significant spillovers from the war, notably for economies closer to the war site. These spillovers lower output while putting upward pressure on prices. As such, they represent an adverse supply shock and give rise to a difficult trade-off for stabilization policy. What's worse, in contrast to supply shocks of the garden-variety type, the supply contraction induced by war tends to be more persistent. This implies, among other things, that monetary policymakers will generally not be in a position to "look through" the supply shock.

References

Acemoglu, Daron, Simon Johnson, and James Robinson. 2005. "The Rise of Europe: Atlantic Trade, Institutional Change, and Economic Growth." *American Economic Review*, 95(3): 546–579.

Adjemian, Stéphane, Houtan Bastani, Michel Juillard, Fréderic Karamé, Ferhat Mihoubi, Willi Mutschler, Johannes Pfeifer, Marco Ratto, Sébastien Villemot, and Normann Rion. 2022. "Dynare: Reference Manual Version 5." CEPREMAP 72.

Auray, Stéphane, and Aurélien Eyquem. 2019. "Episodes of War and Peace in an Estimated Open Economy Model." *Journal of Economic Dynamics and Control*, 105: 203–249.

Barbieri, Katherine, and Omar Keshk. 2016. "Correlates of war project trade data set codebook." *Codebook Version*, 4.

Barbieri, Katherine, Omar Keshk, and Brian M. Pollins. 2009. "Trading data: Evaluating our assumptions and coding rules." *Conflict Management and Peace Science*, 26(5): 471–491.

Barro, Robert J. 1987. "Government Spending, Interest Rates, Prices, and Budget Deficits in the United Kingdom, 1701–1918." *Journal of Monetary Economics*, 20(2): 221–247.

Barro, Robert J. 2006. "Rare Disasters and Asset Markets in the Twentieth Century." *Quarterly Journal of Economics*, 121(3): 823–866.

Barro, Robert J., and Charles J. Redlick. 2011. "Macroeconomic Effects From Government Purchases and Taxes." *The Quarterly Journal of Economics*, 126(1): 51–102.

Barro, Robert J., and Jong-Wha Lee. 1994. "Sources of Economic Growth." *Carnegie-Rochester Conference Series on Public Policy*, 40: 1–46.

Bayer, Christian, Benjamin Born, and Ralph Luetticke. 2023. "The Liquidity Channel of Fiscal Policy." *Journal of Monetary Economics*, 134: 86–117.

Bergeaud, Antonin, Gilbert Cette, and Rémy Lecat. 2016. "Productivity trends in advanced countries between 1890 and 2012." *Review of Income and Wealth*, 62(3): 420–444.

Blomberg, S. Brock, and Gregory D. Hess. 2012. "18 The Economic Welfare Cost of Conflict: An Empirical Assessment." In *The Oxford Handbook of the Economics of Peace and Conflict*. Oxford University Press.

Bolt, Jutta, and Jan Luiten van Zanden. 2014. "The Maddison Project: collaborative research on historical national accounts." *The Economic History Review*, 67(3): 627–651.

Bolt, Jutta, Robert Inklaar, Herman De Jong, and Jan Luiten Van Zanden. 2018. "Rebasing 'Maddison': New Income Comparisons and the Shape of Long-Run Economic Development." University of Groningen 174.

Born, Benjamin, Alexandra Peter, and Johannes Pfeifer. 2013. "Fiscal News and Macroeconomic Volatility." *Journal of Economic Dynamics and Control*, 37(12): 2582–2601.

Born, Benjamin, Gernot J. Müller, and Johannes Pfeifer. 2020. "Does Austerity Pay Off?" *The Review of Economics and Statistics*, 102(2): 323–338.

Bouakez, Hafedh, Omar Rachedi, and Emiliano Santoro. 2023. "The Government Spending Multiplier in a Multisector Economy." *American Economic Journal: Macroeconomics*, 15(1): 209–239.

Braun, R. Anton, and Ellen R. McGrattan. 1993. "The Macroeconomics of War and Peace." *NBER Macroeconomics Annual*, 8: 197–247.

Caldara, Dario, and Matteo Iacoviello. 2022. "Measuring Geopolitical Risk." *American Economic Review*, 112(4): 1194–1225.

Caplan, Bryan. 2002. "How does war shock the economy?" *Journal of International Money and Finance*, 21(2): 145–162.

Chernyshoff, Natalia, David S. Jacks, and Alan M. Taylor. 2009. "Stuck on gold: Real exchange rate volatility and the rise and fall of the gold standard, 1875–1939." *Journal of International Economics*, 77(2): 195–205.

Christiano, Lawrence J., Mathias Trabandt, and Karl Walentin. 2010. "DSGE Models for Monetary Policy Analysis." In *Handbook of Monetary Economics*. Vol. 3, , ed. Benjamin M. Friedman and Michael Woodford, 285–367. Elsevier.

Chupilkin, Maxim, and Zsóka Kóczán. 2022. "The Economic Consequences of War: Estimates Using Synthetic Controls." European Bank for Reconstruction and Development Working Paper 271.

Clodfelter, Micheal. 2017. *Warfare and Armed Conflicts: A Statistical Encyclopedia of Casualty and Other Figures, 1492-2015.* . Fourth edition ed., Jefferson, North Carolina:McFarland & Company, Inc., Publishers.

Conte, Maddalena, Pierre Cotterlaz, Thierry Mayer, et al. 2022. *The CEPII gravity database.* CEPII.

Cook, David. 2002. "World War II and Convergence." *Review of Economics and Statistics*, 84(1): 131–138.

Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc. 2008. "High Exchange-Rate Volatility and Low Pass-Through." *Journal of Monetary Economics*, 55(6): 1113–1128.

Couttenier, Mathieu, Nathalie Monnet, and Lavinia Piemontese. 2022. "The Economic Costs of Conflict: A Production Network Approach." Centre for Economic Policy Research CEPR Discussion Papers 16984.

Davies, Shawn, Therése Pettersson, and Magnus Öberg. 2022. "Organized Violence 1989–2021 and Drone Warfare." *Journal of Peace Research*, 59(4): 593–610.

Davis, Donald R, and David E Weinstein. 2002. "Bones, Bombs, and Break Points: The Geography of Economic Activity." *American Economic Review*, 92(5): 1269–1289.

de Groot, Olaf J, Carlos Bozzoli, Anousheh Alamir, and Tilman Brück. 2022. "The Global Economic Burden of Violent Conflict." *Journal of Peace Research*, 59(2): 259–276.

Driscoll, John C., and Aart C. Kraay. 1998. "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data." *Review of Economics and Statistics*, 80(4): 549–560.

Eichenbaum, M. S., B. K. Johannsen, and S. T. Rebelo. 2021. "Monetary Policy and the Predictability of Nominal Exchange Rates." *The Review of Economic Studies*, 88(1): 192–228.

Erceg, Christopher J., Dale W. Henderson, and Andrew T. Levin. 2000. "Optimal Monetary Policy with Staggered Wage and Price Contracts." *Journal of Monetary Economics*, 46(2): 281–313.

Farhi, Emmanuel, and Xavier Gabaix. 2016. "Rare Disasters and Exchange Rates." *The Quarterly Journal of Economics*, 131(1): 1–52.

Federle, Jonathan, André Meier, Gernot Müller, and Victor Sehn. 2022. "Proximity to War: The Stock Market Response to the Russian Invasion of Ukraine." Centre for Economic Policy Research CEPR Discussion Papers 17185.

Ferguson, Niall. 2008. "Earning from History? Financial Markets and the Approach of World Wars." *Brookings Papers on Economic Activity*, 2008: 431–477.

Funke, Manuel, Moritz Schularick, and Christoph Trebesch. 2023. "Populist Leaders and the Economy." *American Economic Review*, 113(12): 3249–88.

Gabriel, Ricardo Duque. 2023. "Monetary policy and the wage inflation-unemployment tradeoff." *European Economic Review*, 159: 104565.

García-Cicco, Javier, Roberto Pancrazi, and Martín Uribe. 2010. "Real Business Cycles in Emerging Countries?" *American Economic Review*, 100(5): 2510–2531.

Georgiadis, Georgios, and Ben Schumann. 2021. "Dominant-Currency Pricing and the Global Output Spillovers from US Dollar Appreciation." *Journal of International Economics*, 133: 1–16.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Eriksson, Margareta Sollenberg, and Håvard Strand. 2002. "Armed Conflict 1946-2001: A New Dataset." *Journal of Peace Research*, 39(5): 615–637.

Glick, Reuven, and Alan M Taylor. 2010. "Collateral Damage: Trade Disruption and the Economic Impact of War." *Review of Economics and Statistics*, 92(1): 102–127.

Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller. 2020. "Dominant Currency Paradigm." *American Economic Review*, 110(3): 677–719.

Gourio, François. 2012. "Disaster Risk and Business Cycles." *American Economic Review*, 102(6): 2734–66.

Guidolin, Massimo, and Eliana La Ferrara. 2007. "Diamonds Are Forever, Wars Are Not: Is Conflict Bad for Private Firms?" *American Economic Review*, 97(5): 1978–1993.

Harrison, Mark. 1998. "The Economics of World War II: An Overview." In *The Economics of World War II*. . 1 ed., , ed. Mark Harrison, 1–42. Cambridge University Press.

Hazell, Jonathon, Juan Herreño, Emi Nakamura, and Jón Steinsson. 2022. "The Slope of the Phillips Curve: Evidence from U.S. States." *The Quarterly Journal of Economics*, 137(3): 1299–1344.

Head, Keith, and Thierry Mayer. 2014. "Gravity Equations: Workhorse,Toolkit, and Cookbook." In *Handbook of International Economics*. Vol. 4, 131–195. Elsevier.

Heathcote, Jonathan, and Fabrizio Perri. 2002. "Financial Autarky and International Business Cycles." *Journal of Monetary Economics*, 49(3): 601–627.

Hess, Gregory D., and Athanasios Orphanides. 1995. "War Politics: An Economic, Rational-Voter Framework." *The American Economic Review*, 85(4): 828–846.

Ilzetzki, Ethan. 2022. "Learning by necessity: Government demand, capacity constraints, and productivity growth." Working Paper.

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review*, 95(1): 161–182.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor. 2017. "Macrofinancial History and the New Business Cycle Facts." *NBER Macroeconomics Annual*, 31(1): 213–263.

Konrad, Kai, and Florian Morath. 2023. "Alliance Formation in Regional Space: Shifting the Battlefront Between Competing Powers." Max Planck Institute for Tax Law and Public Finance Working Paper 2023 – 15.

Korovkin, Vasily, and Alexey Makarin. 2023. "Conflict and Intergroup Trade: Evidence from the 2014 Russia-Ukraine Crisis." *American Economic Review*, 113(1): 34–70.

Lebow, Richard Ned. 2010. *Why Nations Fight: Past and Future Motives for War*. . 1 ed., Cambridge University Press.

Leigh, Andrew, Justin Wolfers, and Eric Zitzewitz. 2003. "What Do Financial Markets Think of War in Iraq?" National Bureau of Economic Research w9587, Cambridge, MA.

Lenin, Vladimir Ilyich. 1917. *Imperialism, the Highest Stage of Capitalism.* Varga & Mendelsohn.

Maddison, Angus. 1995. "Monitoring the world economy."

Martin, Philippe, Thierry Mayer, and Mathias Thoenig. 2008. "Make Trade Not War?" *Review of Economic Studies*, 75(3): 865–900.

Martin, Philippe, Thierry Mayer, and Mathias Thoenig. 2012. "The Geography of Conflicts and Regional Trade Agreements." *American Economic Journal: Macroeconomics*, 4(4): 1–35.

Mayer, Thierry, and Soledad Zignago. 2011. "Notes on CEPII's Distances Measures: The GeoDist Database." CEPII research center Working Papers 2011-25.

Meier, André, and Gernot J Müller. 2006. "Fleshing out the Monetary Transmission Mechanism: Output Composition and the Role of Financial Frictions." *Journal of Money, Credit, and Banking*, 38(8): 2099–2133.

Miyamoto, Wataru, Thuy Lan Nguyen, and Viacheslav Sheremirov. 2019. "The Effects of Government Spending on Real Exchange Rates: Evidence from Military Spending Panel Data." *Journal of International Economics*, 116: 144–157.

Mueller, Hannes, Dominic Rohner, and David Schönholzer. 2022. "Ethnic Violence Across Space." *The Economic Journal*, 132(642): 709–740.

Murdoch, James C., and Todd Sandler. 2002. "Economic Growth, Civil Wars, and Spatial Spillovers." *Journal of Conflict Resolution*, 46(1): 91–110.

Murdoch, James C., and Todd Sandler. 2004. "Civil Wars and Economic Growth: Spatial Dispersion." *American Journal of Political Science*, 48(1): 138–151.

Nekarda, Christopher, J., and Valerie A. Ramey. 2020. "The Cyclical Behavior of the Price-Cost Markup." *Journal of Money, Credit and Banking*, 52(S2): 319–353.

Novta, Natalija, and Evgenia Pugacheva. 2021. "The Macroeconomic Costs of Conflict." *Journal of Macroeconomics*, 68: 103286.

Ohanian, Lee E. 1997. "The Macroeconomic Effects of War Finance in the United States: World War II and the Korean War." *The American Economic Review*, 87(1): 23–40.

Oliver, Henry. 1941. "War and Inflation since 1790 in Engand, France, Germany, and the United States." *The American Economic Review*, 30(5): 344–351.

Organski, A. F. K., and Jacek Kugler. 1980. *The War Ledger.* Chicago:University of Chicago Press.

Ostrom, Charles W., and Brian L. Job. 1986. "The President and the Political Use of Force." *The American Political Science Review*, 80(2): 541–566.

Qureshi, Mahvash Saeed. 2013. "Trade and Thy Neighbor's War." *Journal of Development Economics*, 105: 178–195.

Ramey, Valerie A. 2011. "Identifying Government Spending Shocks: It's All in the Timing." *The Quarterly Journal of Economics*, 126(1): 1–50.

Ramey, Valerie A., and Matthew D. Shapiro. 1998. "Costly Capital Reallocation and the Effects of Government Spending." *Carnegie-Rochester Conference Series on Public Policy*, 48: 145–194.

Rasler, Karen, and William R. Thompson. 1985. "War and the Economic Growth of Major Powers." *American Journal of Political Science*, 29(3): 513.

Romer, Christina D, and David H Romer. 2010. "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks." *American Economic Review*, 100(3): 763–801.

Sarkees, Meredith Reid, and Frank Whelon Wayman. 2010. *Resort to War: 1816-2007. Correlates of War Series*, Washington, D.C:CQ Press.

Schmitt-Grohé, Stephanie, and Martín Uribe. 2003. "Closing Small Open Economy Models." *Journal of International Economics*, 61(1): 163–185.

Schularick, Moritz, and Alan M Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008." *American Economic Review*, 102(2): 1029–1061.

Schvitz, Guy, Luc Girardin, Seraina Rüegger, Nils B Weidmann, Lars-Erik Cederman, and Kristian Skrede Gleditsch. 2022. "Mapping the international system, 1886-2019: the CShapes

2.0 dataset." *Journal of Conflict Resolution*, 66(1): 144–161.

Singer, J David. 1988. "Reconstructing the correlates of war dataset on material capabilities of states, 1816–1985." *International Interactions*, 14(2): 115–132.

Singer, J David, Stuart Bremer, John Stuckey, et al. 1972. "Capability distribution, uncertainty, and major power war, 1820-1965." *Peace, war, and numbers*, 19(48): 9.

Stinnett, Douglas M., Jaroslav Tir, Paul F. Diehl, Philip Schafer, and Charles Gochman. 2002. "The Correlates of War (Cow) Project Direct Contiguity Data, Version 3.0." *Conflict Management and Peace Science*, 19(2): 59–67.

Stock, James H., and Mark W. Watson. 2018. "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments." *The Economic Journal*, 128(610): 917–948.

Thies, Clifford F., and Christopher F. Baum. 2020. "The Effect of War on Economic Growth." *The Cato Journal*, 40(1): 199–212.

Tooze, J. Adam. 2006. *The Wages of Destruction: The Making and Breaking of the Nazi Economy.* London:Allen Lane.

Ursùa, Jose F., and Robert J. Barro. 2010. "Barro-Ursùa Macroeconomic Data."

Verdickt, Gertjan. 2020. "The Effect of War Risk on Managerial and Investor Behavior: Evidence from the Brussels Stock Exchange in the Pre-1914 Era." *The Journal of Economic History*, 80(3): 629–669.

World Bank. 2022. "GDP per Capita (Constant 2015 US$)."

Zussman, Asaf, Noam Zussman, and Morten Ørregaard Nielsen. 2008. "Asset Market Perspectives on the Israeli - Palestinian Conflict." *Economica*, 75: 84–115.

Online Appendix to The Price of War

(Not for Publication)

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Willi Mutschler, and Moritz Schularick

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A Additional descriptive statistics

Table A.1: War sites identified via GPT-4

War	Site	Total Casualties	Start Date
World War II	Estonia	489,459	1944
World War I	Turkey	392,856	1915
Russo-Polish	Poland	207,040	1920
World War II	Luxembourg	195,000	1940
World War I	Romania	184,560	1916
World War II	Slovakia	36,820	1944
World War I	Latvia	29,200	1917
World War I	Greece	10,745	1918
World War II	Austria	9,000	1945
Chaco	Bolivia	8,302	1932
World War II	Czechia	7,400	1942
Boxer Rebellion	China	4,508	1900
World War I	China	2,911	1914
World War I	Estonia	1,411	1917
World War II	Slovenia	130	1942
World War I	Lithuania	N/A	1914
Bangladesh	India	N/A	1971
Second Russo-Turkish	Romania	N/A	1877

Note: Table shows war sites that have been identified after cross-checking with GPT-4 and additional sources. For some sites, we could not come up with credible sources for the casualties incurred (outlined as N/A). We assume that these poorly documented battles are likely small in terms of casualties.

Table A.2: War Site Overview

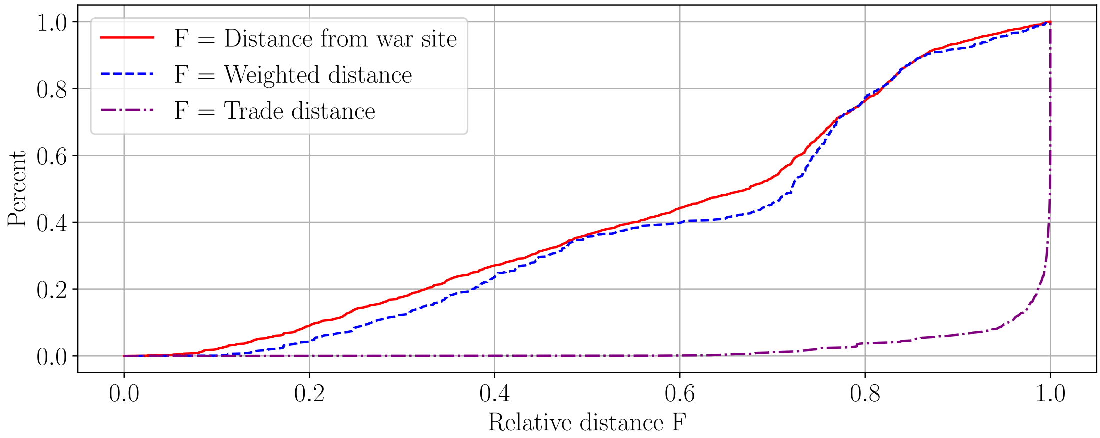
War	Site	Total Casualties	Start Date
World War I	France	4,027,517	1914
Third Sino-Japanese	China	3,531,359	1937
World War II	Russia	2,288,675	1941
Vietnam War, Phase 2	Vietnam	2,006,561	1957
World War I	Ukraine	1,891,000	1914
World War II	Poland	1,864,645	1939
World War I	Belgium	1,162,039	1914
World War II	Belarus	1,030,815	1941
World War II	Germany	982,127	1941
World War I	Italy	951,812	1915
World War II	Japan	868,392	1944
World War I	Poland	640,500	1914
World War I	Slovenia	562,452	1915
World War II	Estonia	489,459	1939
World War II	Ukraine	440,807	1941
World War II	France	424,849	1940
Russo-Japanese	China	419,098	1904
World War II	Philippines	402,157	1941
World War I	Turkey	392,856	1914
World War II	Romania	369,188	1941
World War II	Hungary	369,082	1941
Conquest of Ethiopia	Ethiopia	349,601	1935
World War II	Indonesia	339,039	1941
World War I	Germany	303,000	1914
Vietnamese-Cambodian	Cambodia	280,300	1977
Franco-Prussian	France	266,224	1870
Korean	Korea, Republic of	262,037	1950
World War II	Italy	251,693	1943
Second Laotian, Phase 2	Lao, People's DR	250,000	1959
World War II	Greece	240,824	1940
Iran-Iraq	Iraq	224,526	1980
Russo-Polish	Poland	207,040	1919
Gulf War	Iraq	200,000	1990
World War II	Luxembourg	195,000	1939
Korean	North Korea	191,536	1950
World War I	Romania	184,560	1914
Invasion of Iraq	Iraq	177,113	2003

World War II	Belgium	173,010	1940
Second Greco-Turkish	Turkey	162,652	1920
Russo-Ukrainian	Ukraine	150,000	2022
Invasion of Afghanistan	Afghanistan	150,000	2001
World War II	United Kingdom	134,237	1940
World War I	Belarus	132,000	1916
World War II	Myanmar	125,843	1941
Second Russo-Turkish	Bulgaria	111,700	1877
First Balkan	Turkey	105,525	1912
World War II	China	94,857	1945
Chaco	Paraguay	94,581	1932
Chaco	Bolivia	94,581	1932
World War II	Libya	90,090	1940
Russo-Finnish	Finland	89,604	1939
Second Greco-Turkish	Greece	89,500	1920
Iran-Iraq	Iran, Islamic Republic	77,293	1980
World War II	Egypt	70,924	1940
War over Lebanon	Lebanon	70,821	1982
Badme Border	Eritrea	70,500	1998
Badme Border	Ethiopia	69,500	1998
War over Angola	Angola	63,315	1975
Second Sino-Japanese	China	60,000	1931
World War I	Israel	45,324	1917
Second Balkan	Bulgaria	44,500	1913
World War I	Iraq	42,722	1915
Yom Kippur War	Egypt	40,223	1973
World War II	India	38,350	1941
World War II	Slovakia	36,820	1939
World War II	Malaysia	36,177	1941
Bosnian Independence	Bosnia and Herzegovina	34,617	1992
First Balkan	Bulgaria	30,273	1912
Hungarian Adversaries	Hungary	29,807	1918
Six Day War	Israel	29,594	1967
World War I	Latvia	29,200	1914
Soviet Invasion of Hungary	Hungary	25,013	1956
World War II	Papua New Guinea	24,311	1942
World War II	Palau	24,063	1944
World War II	Solomon Islands	21,723	1942
War of the Pacific	Peru	19,876	1879
War of Attrition	Egypt	18,548	1969

First Balkan	North Macedonia	16,594	1912
World War II	Netherlands	16,556	1944
Gulf War	Israel	16,532	1990
Gulf War	Kuwait	16,532	1990
Gulf War	Saudi Arabia	16,532	1990
World War II	Hong Kong	14,879	1941
World War I	Palestine, State of	14,869	1917
Sinai War	Egypt	14,656	1956
World War II	Norway	14,450	1940
Nomonhan	China	13,480	1939
Nomonhan	Mongolia	13,480	1939
Nomonhan	Russia	13,480	1939
World War II	Syrian Arab Republic	13,429	1941
Bangladesh	Pakistan	12,777	1971
Bangladesh	Bangladesh	12,777	1971
Latvian Liberation	Latvia	10,971	1918
World War I	Greece	10,745	1914
Second Ogaden War, Phase 2	Ethiopia	10,000	1977
Second Ogaden War, Phase 2	Somalia	10,000	1977

Note: Table provides an overview over all large wars in our sample. Name corresponds to the war names given in the Correlates of War Project (Sarkees and Wayman, 2010).

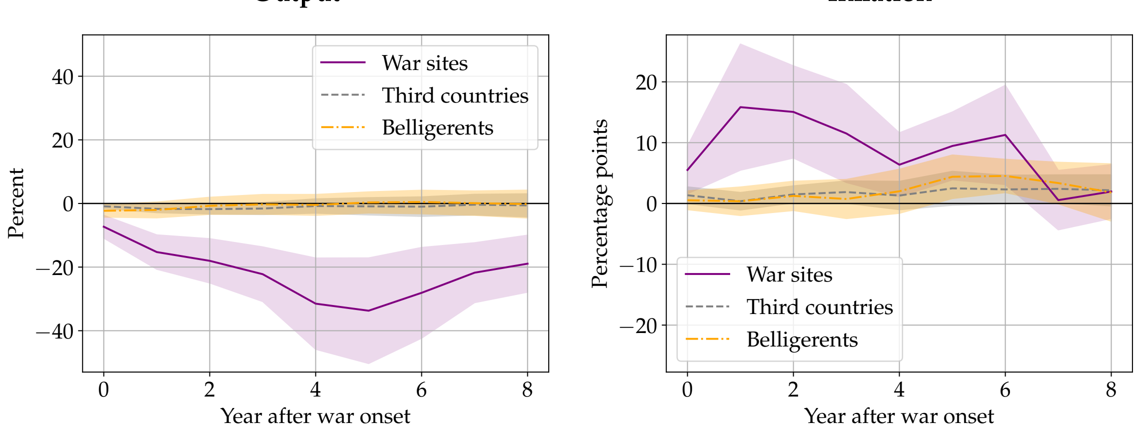
Figure A.1: Cumulative distribution of transition functions



Note: Figure shows cumulative distribution functions of the transition functions defined by equations (3.3), (3.5), and (3.6).

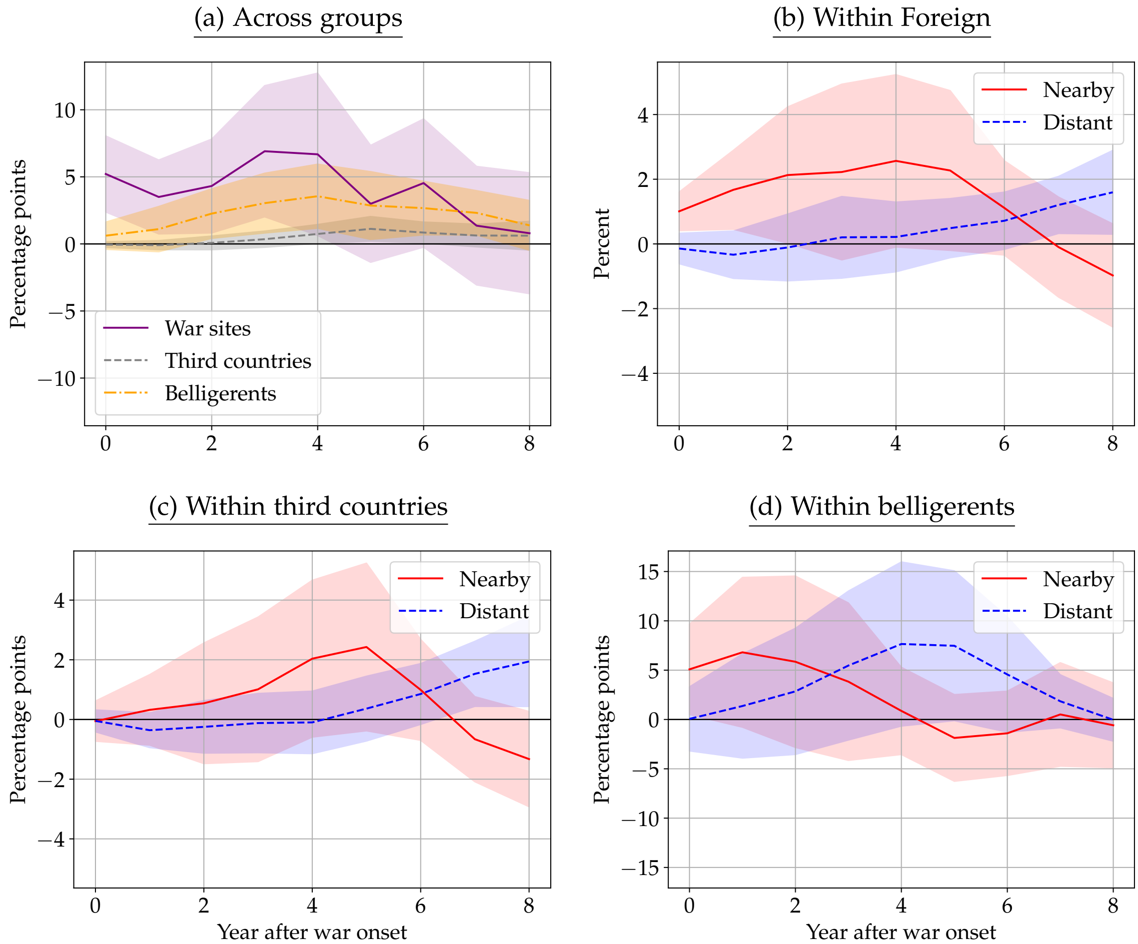
B Further evidence

Figure B.1: Belligerents v third countries (linear specification)



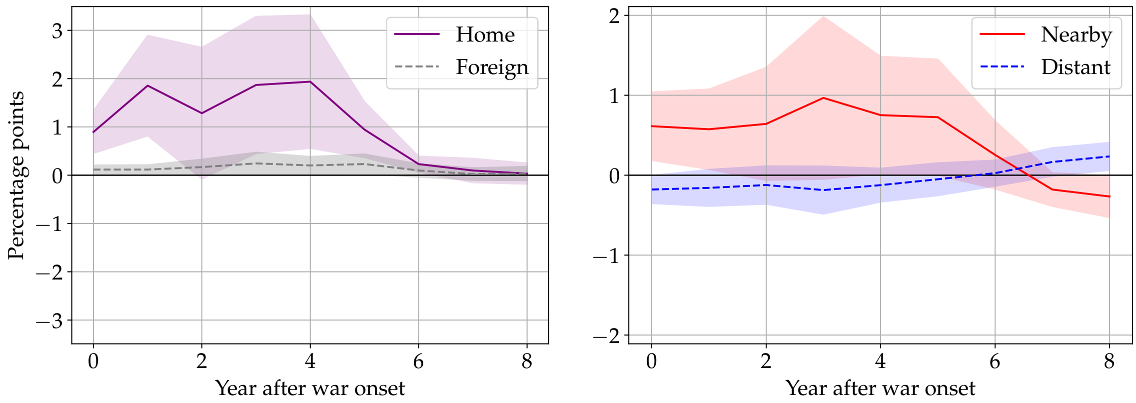
Note: Left panel shows percentage deviation of (detrended) output from its pre-war level, right panel shows deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of the war. Foreign countries are split into belligerents and third countries. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties $>$ 10k).

Figure B.2: Military expenditures—response to war



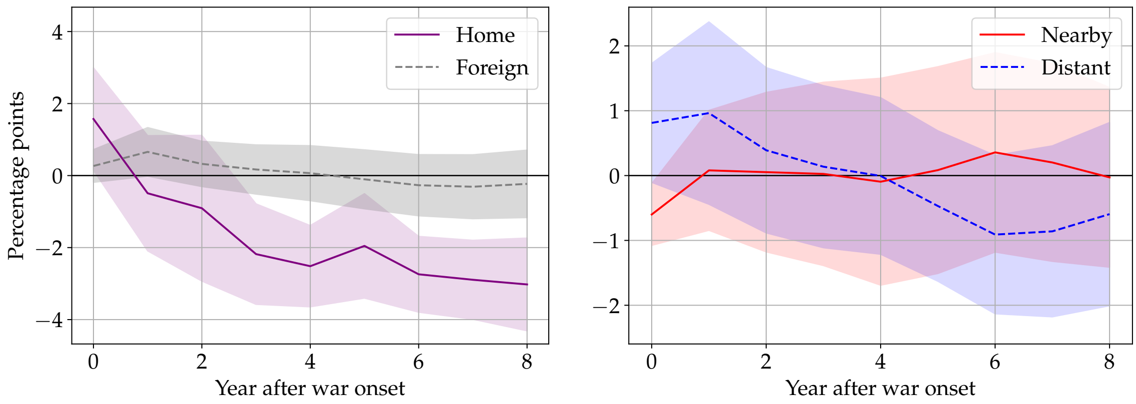
Note: Panels show deviation of military expenditures relative to pre-war GDP in percentage points. Horizontal axis measures time in years since start of the war. Panel (a) shows results for war sites, third countries, and belligerents. Panels (b), (c), and (d) show conditional projections for the Foreign countries, third countries, and belligerents, respectively. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties $>$ 10k).

Figure B.3: Employment in the military—response to war



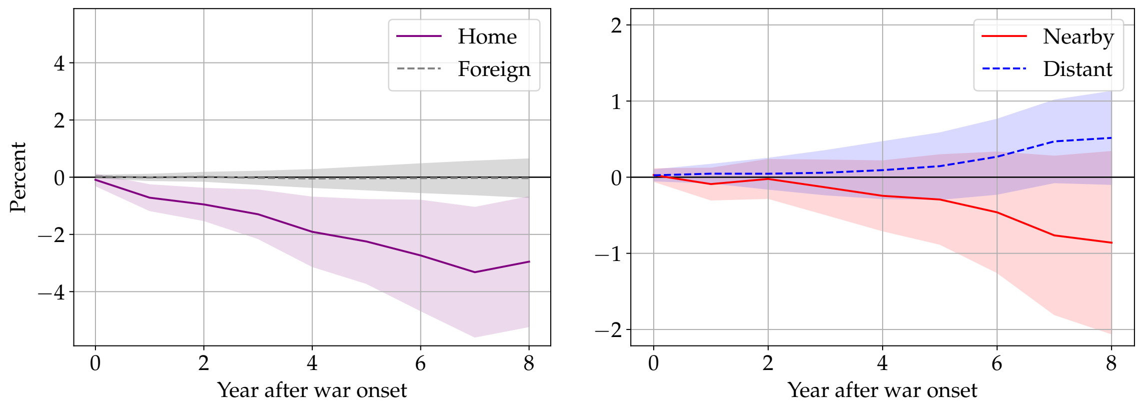
Note: Panels show change in military personnel relative to pre-war population in percentage points. Horizontal axis measures time in years since start of the war. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties $>$ 10k).

Figure B.4: Unemployment—response to war



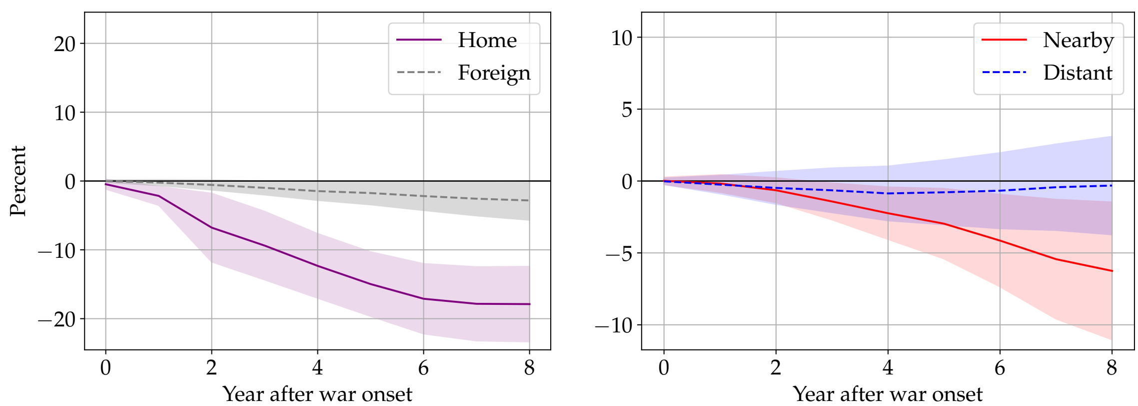
Note: Panels show the change in unemployment in percentage points. Horizontal axis measures time in years since start of the war. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties $>$ 10k).

Figure B.5: Population—response to war



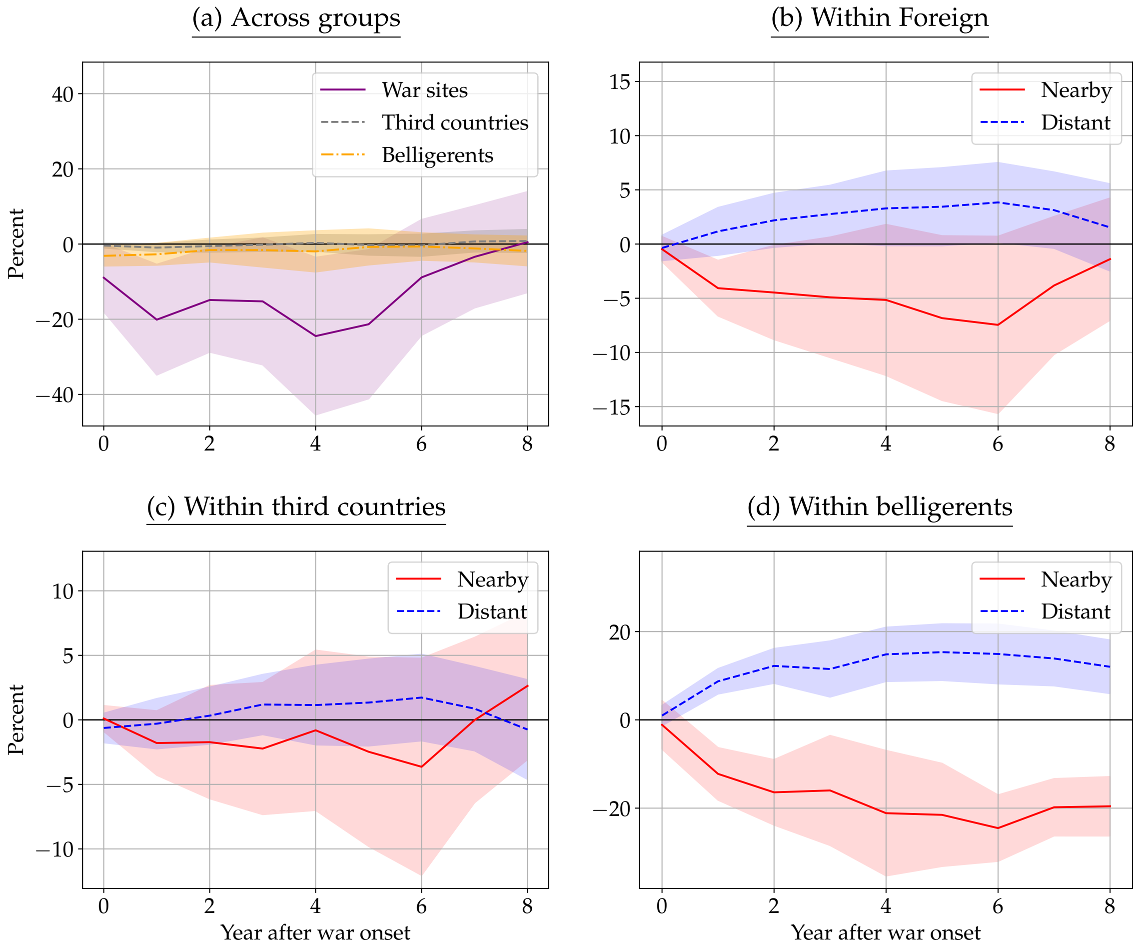
Note: Panels show deviation of population relative to pre-war population in percent. Horizontal axis measures time in years since start of the war. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k).

Figure B.6: Capital stock—response to war



Note: Panels show deviation of capital stock from pre-war capital stock in percent. Horizontal axis measures time in years since start of the war. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k).

Figure B.7: Total factor productivity—response to war



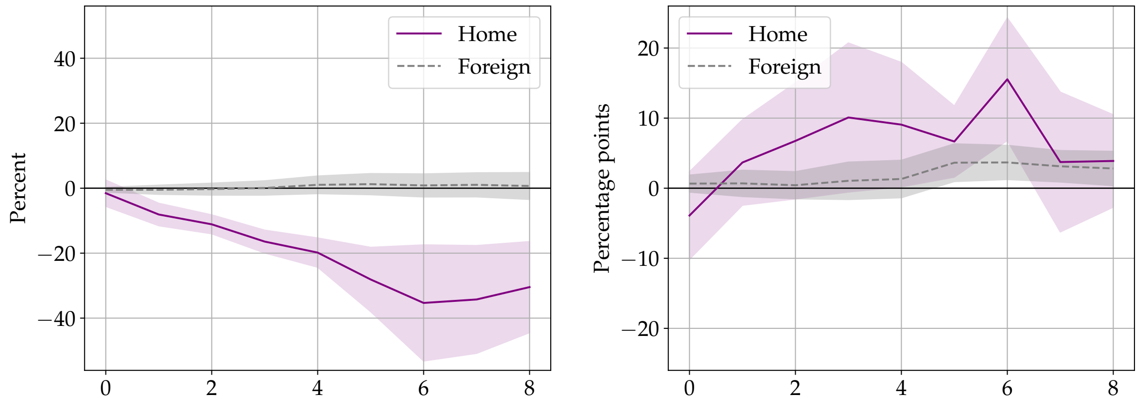
Note: Panels show deviation of total factor productivity relative to pre-war GDP in percent. Horizontal axis measures time in years since start of the war. Panel (a) shows results for war sites, third countries, and belligerents. Panels (b), (c), and (d) show conditional projections for the Foreign countries, third countries, and belligerents, respectively. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k).

C Robustness

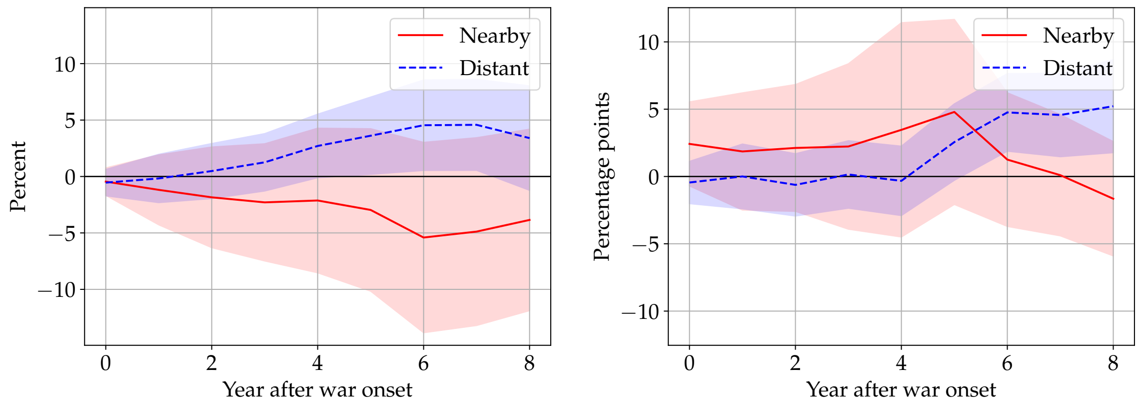
Figure C.1: Alternative start years

Output **Inflation**

(a) Home v Foreign (linear specification)



(b) Spillovers to Foreign: nearby v distant (baseline specification)

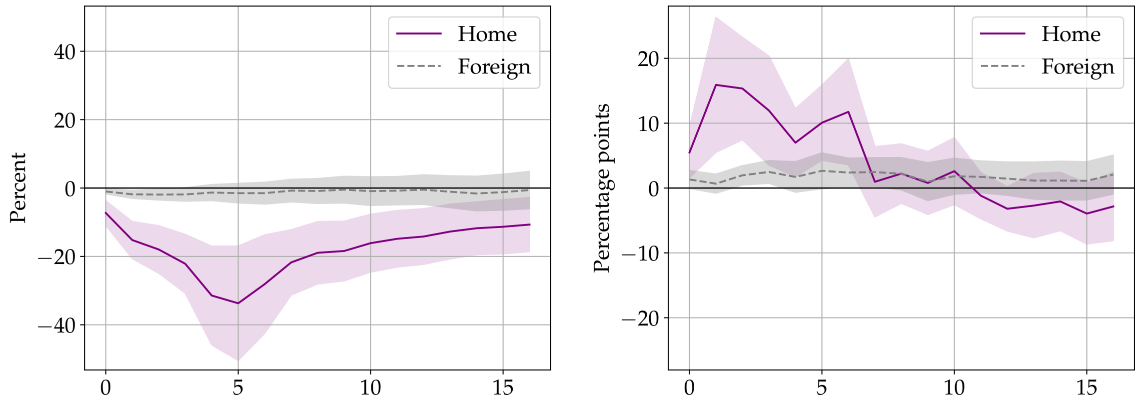


Note: Results based on large wars, sample period 1870–2022. Start of the war is no longer the year when military action starts on war site (as in baseline), but when war starts. Left panels show deviation of (detrended) output from pre-war level, right panels show deviation of inflation from pre-war rate.

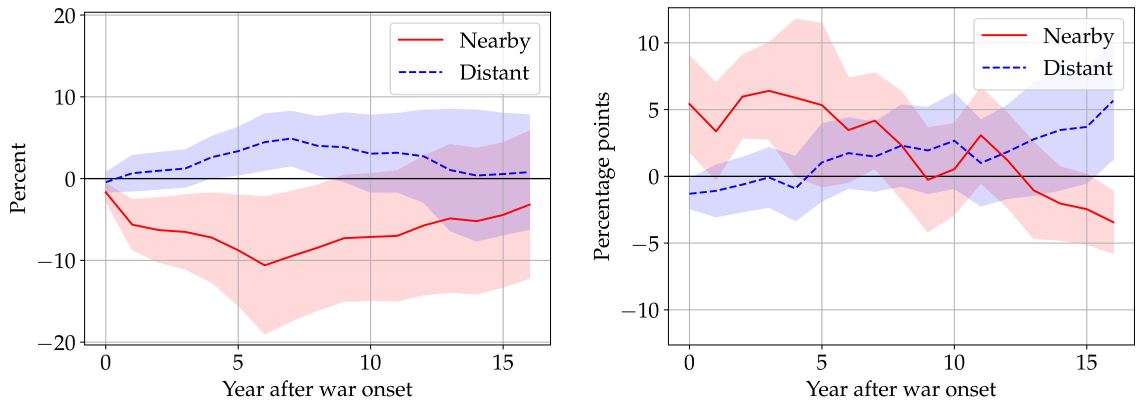
Figure C.2: Longer horizons

Output **Inflation**

(a) Home v Foreign (linear specification)

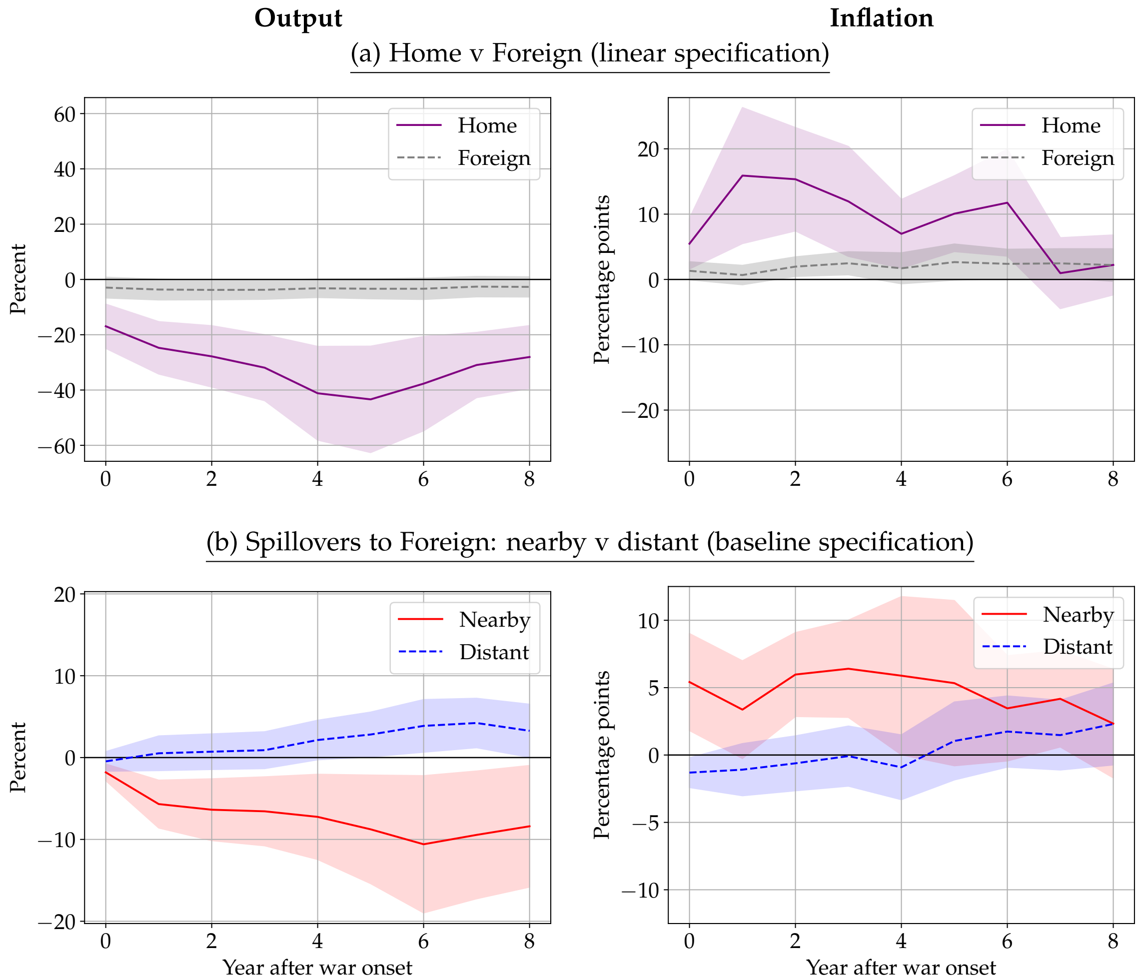


(b) Spillovers to Foreign: nearby v distant (baseline specification)



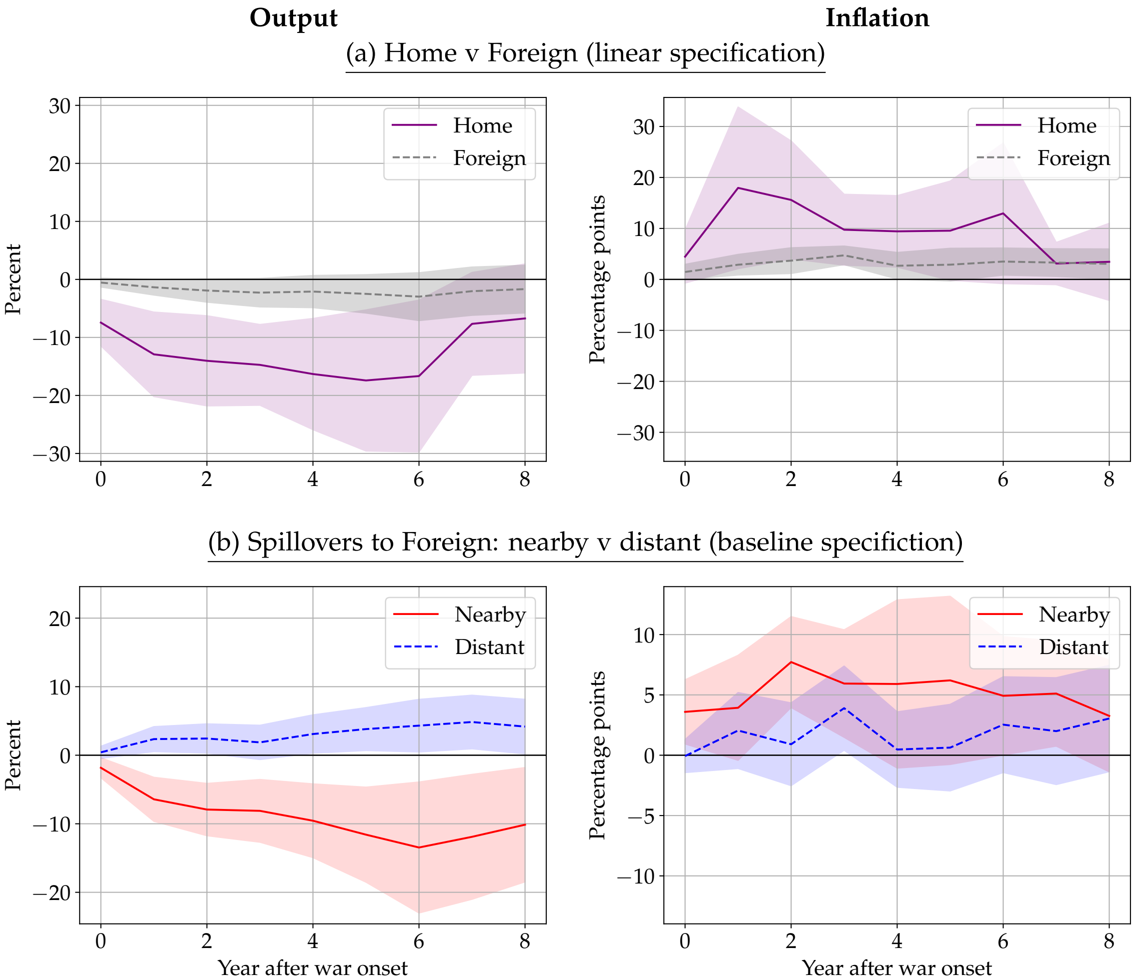
Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show response of inflation. Vertical axis measures percentage deviation from the trend, horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k).

Figure C.3: Dependent variables in levels



Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Dependent variables are not specified in differences relative to pre-war period but in levels. Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k).

Figure C.4: The macroeconomic impact of domestic and foreign wars (duration $\leq$ 2 years)

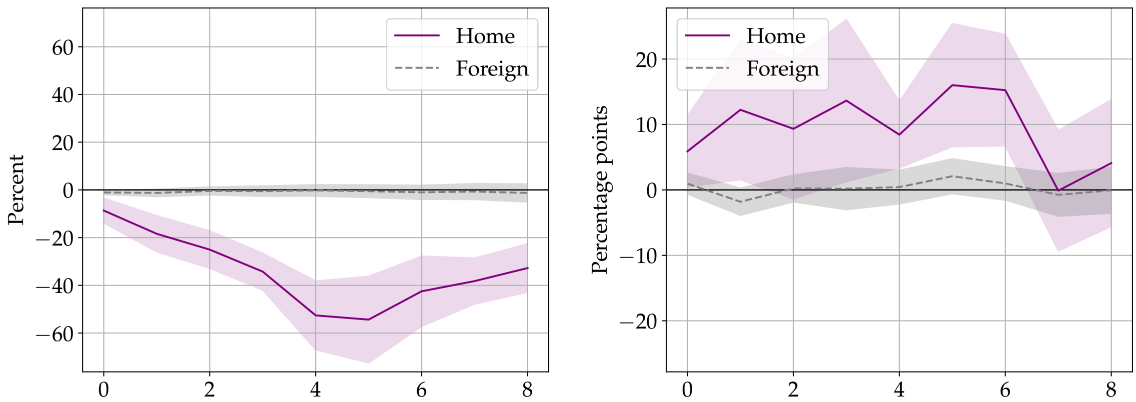


Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties $>$ 10k) with a duration of at most 2 years.

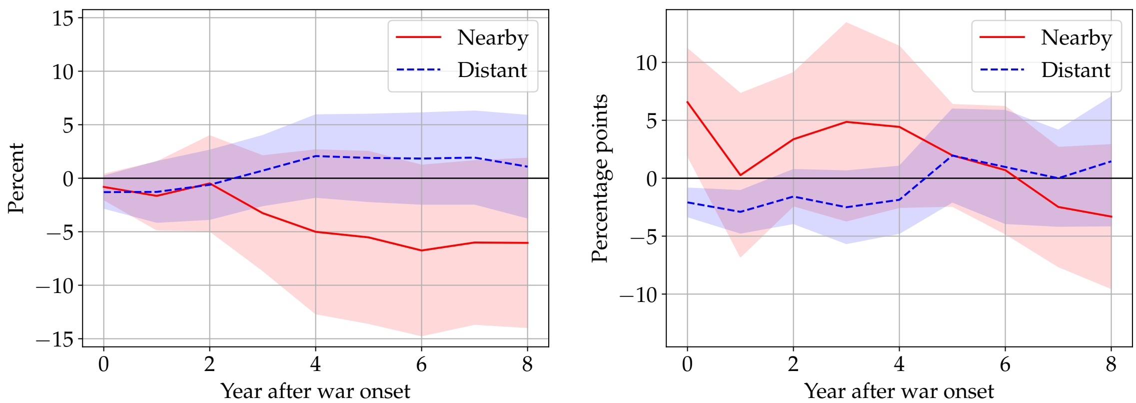
Figure C.5: The macroeconomic impact of domestic and foreign wars (duration > 2 years)

Output **Inflation**

(a) Home v Foreign (linear specification)



(b) Spillovers to Foreign: nearby v distant (baseline specification)

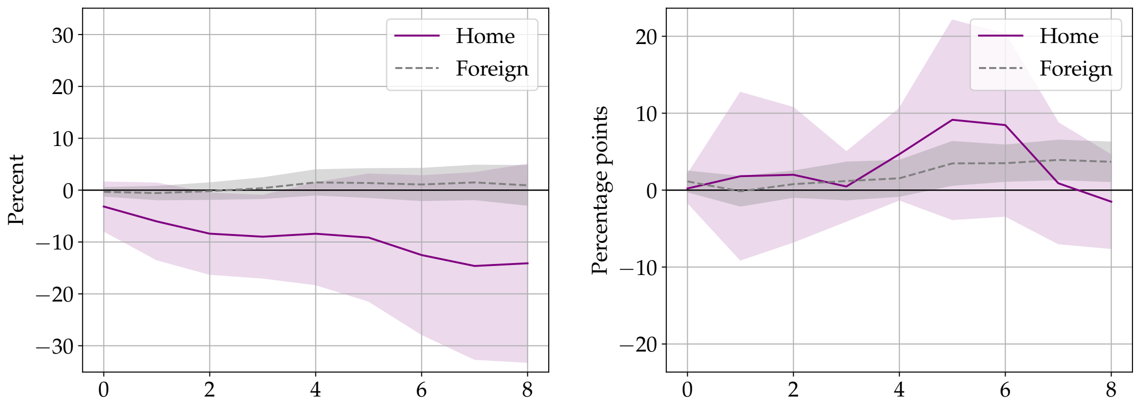


Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k) with a duration of more than 2 years.

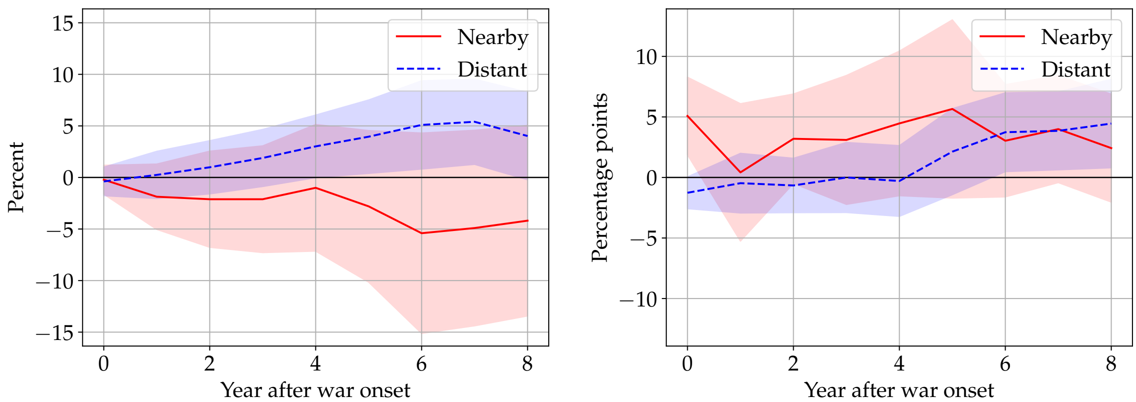
Figure C.6: Large wars without World Wars

Output **Inflation**

(a) Home v Foreign (linear specification)



(b) Spillovers to Foreign: nearby v distant (baseline specification)

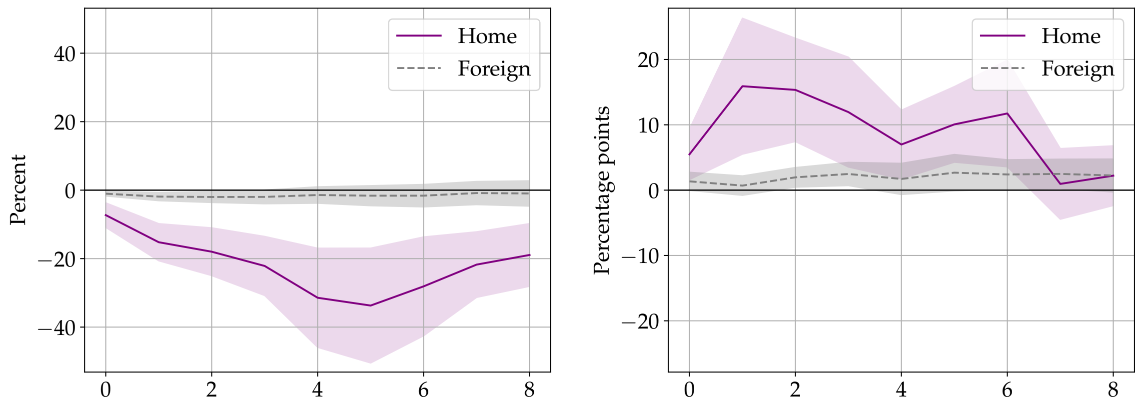


Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show response of inflation. Vertical axis measures percentage deviation from the trend, horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k) excluding those of World War I and World War II.

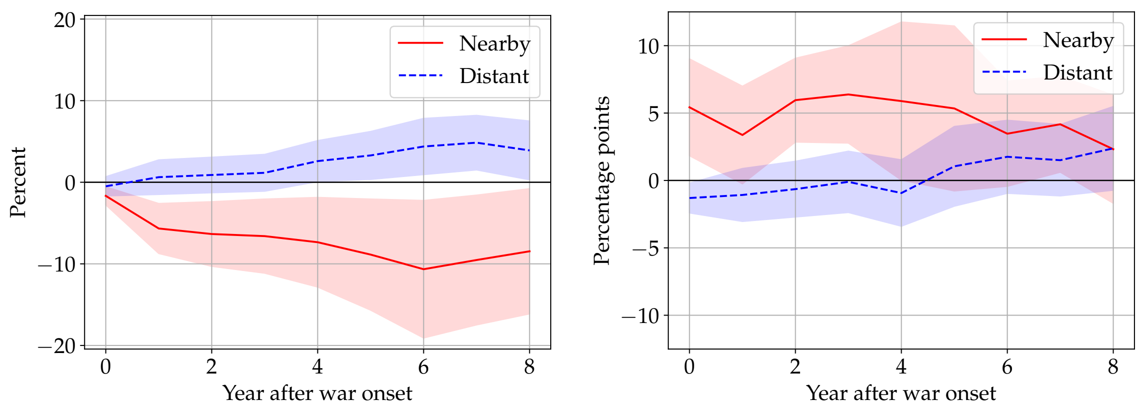
Figure C.7: Excluding the U.S.

Output **Inflation**

(a) Home v Foreign (linear specification)



(b) Spillovers to Foreign: nearby v distant (baseline specification)

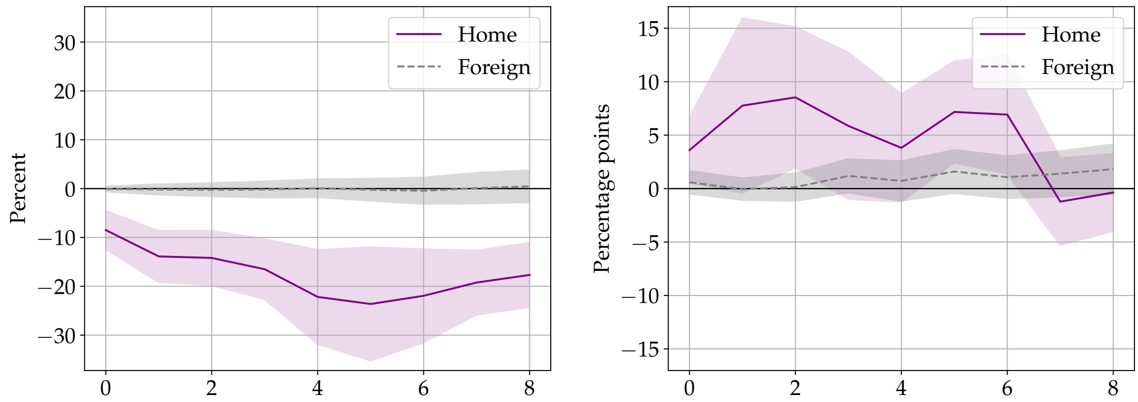


Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, large war sites (casualties > 10k) excluding the United States.

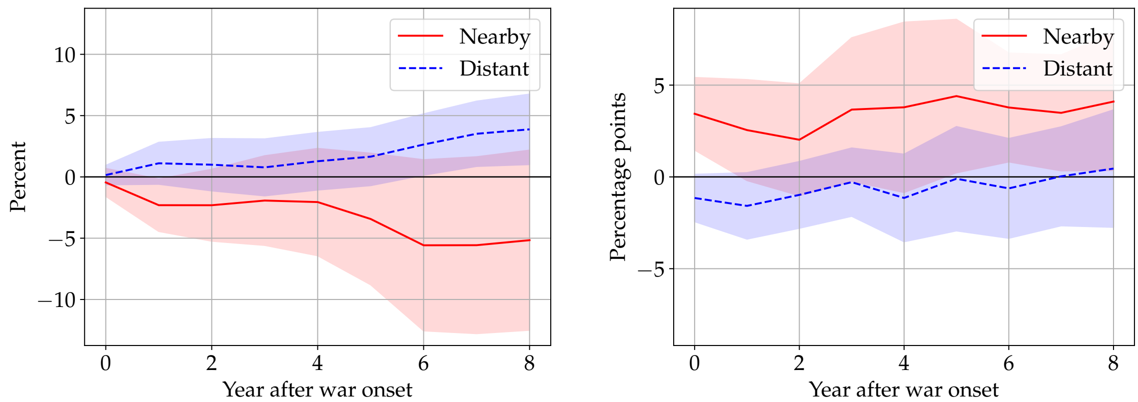
Figure C.8: All sites

Output **Inflation**

(a) Home v Foreign (linear specification)



b) Spillovers to Foreign: nearby v distant (baseline specification)

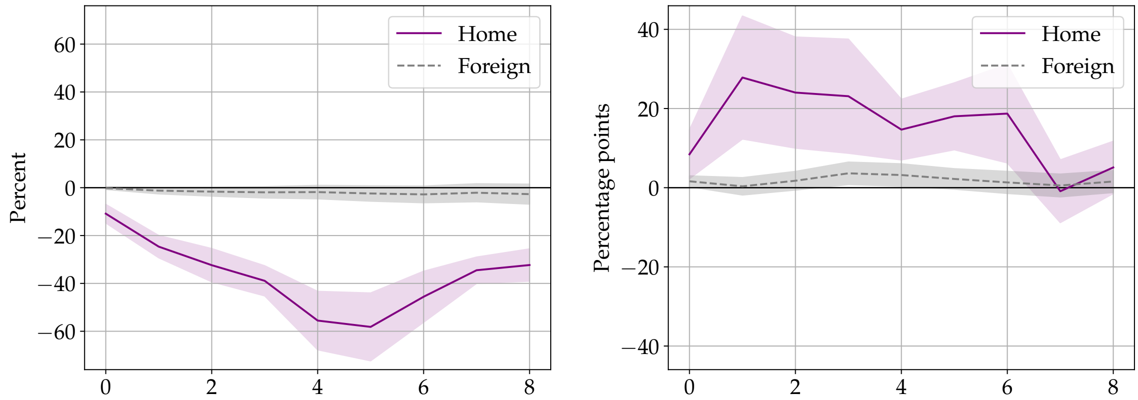


Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show response of inflation. Vertical axis measures percentage deviation from the trend, horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, all war sites.

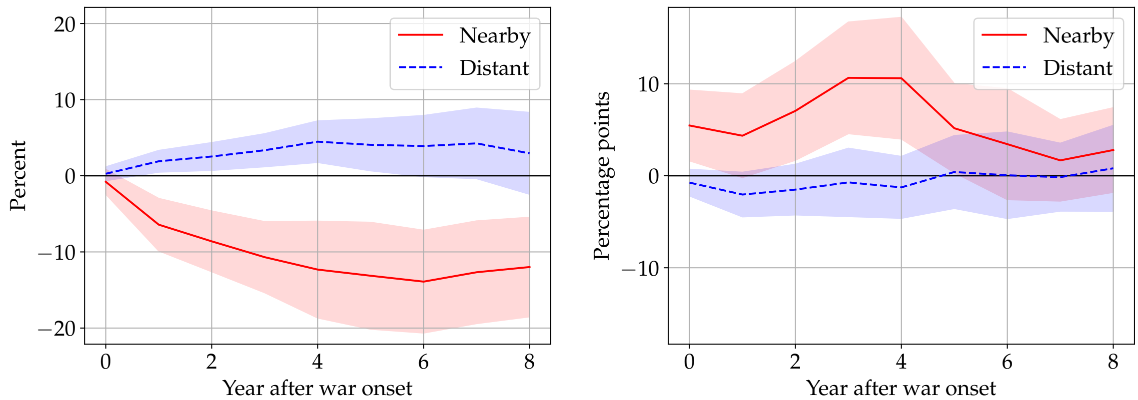
Figure C.9: Major sites

Output **Inflation**

(a) Home v Foreign (linear specification)

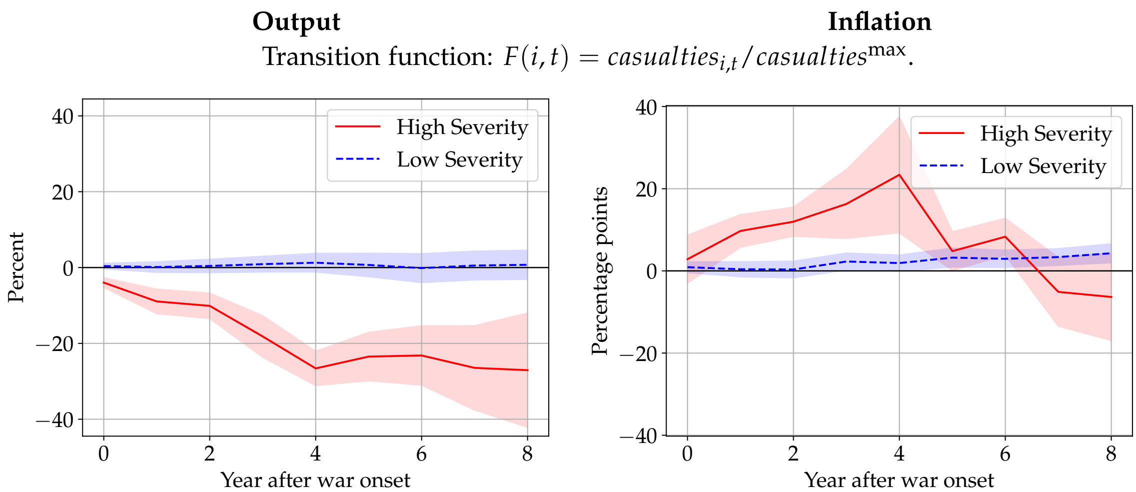


(b) Spillovers to Foreign: nearby v distant (baseline specification)



Note: Left panels show percentage deviation of (detrended) output from its pre-war level, right panels show response of inflation. Vertical axis measures percentage deviation from the trend, horizontal axis measures time in years since start of the war. Top panels (a) show results for linear specification (3.1). Bottom panels (b) show response for smooth-transition specification (3.2). Shaded areas indicate 90% confidence bands. Sample 1870–2022, major war sites (casualties $>$ 100k).

Figure C.10: Spillovers from foreign nearby war by severity



Note: Results based sample period 1870–2022. Left panel shows deviation of (detrended) output from its pre-war level, right panel shows deviation of inflation from pre-war rate.

D Casus belli coding

Table D.1: Wars and their casus belli

War	Onset	Nationalism	Religion or Ideology	Power Transition	Border Clashes	Economic Long-Run	Domestic Politics	Revenge Retribution	Economic Short-Run	Secondary Sources
Franco-Prussian	1870		✓							Britannica. 2023. Franco-German War. Accessed August 19, 2023. `https://www.britannica.com/event/Franco-German-War`
First Central American	1876	✓								Bancroft, Hubert H. 1887. "History of Central America." p. 402.
Second Russo-Turkish	1877	✓	✓							Britannica. 2014. Russo-Turkish Wars. Accessed August 20, 2023. `https://www.britannica.com/topic/Russo-Turkish-wars`
War of the Pacific	1879					✓				Britannica. 2023. War of the Pacific. Accessed August 20, 2023. `https://www.britannica.com/event/War-of-the-Pacific`
Conquest of Egypt	1882					✓	✓			Hopkins, Antony. G. 1882. "The Victorians and Africa: A Reconsideration of the Occupation of Egypt, 1882." The Journal of African History.
Sino-French	1884	✓								Britannica. 2023. Sino-French War. Accessed August 20, 2023. `https://www.britannica.com/event/Sino-French-War`
Second Central American	1885	✓	✓	✓						Palmer, Steven. 1993. "Central American Union or Guatemalan Republic? The National Question in Liberal Guatemala, 1871-1885." The Americas.
First Sino-Japanese	1894		✓			✓				Britannica. 2023. First Sino-Japanese War. Accessed August 19, 2023. `https://www.britannica.com/event/First-Sino-Japanese-War-1894-1895`
Greco-Turkish	1897	✓		✓						Britannica. 2016. Greco-Turkish wars. Accessed August 19, 2023. `https://www.britannica.com/event/Greco-Turkish-wars`
Spanish-American	1898	✓								Britannica. 2023. Spanish-American War. Accessed August 20, 2023. `https://www.britannica.com/event/Spanish-American-War`

War	Onset	**N**	**RI**	**PT**	**BC**	**EL**	**DP**	**RR**	**ES**	Secondary Sources
Boxer Rebellion	1900			✓					✓	Britannica. 2023. Boxer Rebellion. Accessed August 19, 2023. `https://www.britannica.com/event/Boxer-Rebellion`
Sino-Russian	1900	✓		✓						Glebov, Sergey. “11 Blagoveshchensk Massacre and Beyond: The Landscape of Violence in the Amur Province in the Spring and Summer of 1900.” Russia’s North Pacific: 211. Heidelberg University Publishing. ; Britannica. 2023. Boxer Rebellion. Accessed August 19, 2023. `https://www.britannica.com/event/Boxer-Rebellion`
Russo-Japanese	1904	✓								Britannica. 2023. Russo-Japanese War. Accessed August 20, 2023. `https://www.britannica.com/event/Russo-Japanese-War`
Third Central American	1906	✓								Slade, William F. 1917. “The Journal of Race Development.” The Federation of Central America
Fourth Central American	1907		✓							Slade, William F. 1917. “The Journal of Race Development.” The Federation of Central America; Martin, Percy F. 1911. “Salvador of the Twentieth Century”. P. 72-74
Second Spanish-Moroccan	1909	✓	✓							Chandler, James A. 1975. “Spain and Her Moroccan Protectorate 1898 - 1927.” Journal of Contemporary History.
Italian-Turkish	1911	✓					✓		✓	Clark, Christopher M. 2012. “The Sleepwalkers: How Europe Went to War in 1914.” Allen Lane. p. 177.; See “Libyen, verheißenes Land,” Die Zeit, May 15, 2003.
First Balkan	1912	✓								Britannica. 2023. Balkan Wars. Accessed August 19, 2023. `https://www.britannica.com/topic/Balkan-Wars`
Second Balkan	1913	✓								Britannica. 2023. Balkan Wars. Accessed August 19, 2023. `https://www.britannica.com/topic/Balkan-Wars`
World War I	1914	✓	✓							Norwich University Only. 2017. “Six Causes of World War I.” Accessed August 20, 2023. `https://online.norwich.edu/academic-programs/resources/six-causes-of-world-war-i`
Estonian Liberation	1918	✓		✓				✓		Minnik, Taavi. 2015. “The Cycle of Terror in Estonia, 1917–1919”.; Republic of Estonia, Ministry of Foreign Affairs. “Estonian War of Independence 1918-1920 Estonia’s Allies”

War	Onset	N	RI	PT	BC	EL	DP	RR	ES	Secondary Sources
Latvian Liberation	1918	✓		✓						Britannica. 2023. Baltic War of Liberation. Accessed August 20, 2023. https://www.britannica.com/event/Baltic-War-of-Liberation
Russo-Polish	1919	✓								Britannica. 2023. Russo-Polish War. Accessed August 20, 2023. https://www.britannica.com/event/Russo-Polish-War-1919-1920
Hungarian Adversaries	1919		✓							University of Central Arkansas. https://uca.edu/politicalscience/home/research-projects/dadm-project/europerussiacentral-asia-region/hungary-1918-present/
Second Greco-Turkish	1919				✓					Britannica. 2016. Greco-Turkish wars. Accessed August 19, 2023. https://www.britannica.com/event/Greco-Turkish-wars
Franco-Turkish	1919	✓	✓							Britannica. 2023. The nationalist movement and the war for independence. Accessed August 19, 2023. https://www.britannica.com/biography/Kemal-Ataturk/The-nationalist-movement-and-the-war-for-independence
Lithuanian-Polish	1920	✓	✓	✓	✓					Balkelis, Thomas. 2018. "War, Revolution, and Nation-Making in Lithuania, 1914–1923" via Tauber, Joachim. 2019. "Tomas Balkelis, War, Revolution, and Nation-Making in Lithuania, 1914–1923." European History Quarterly.; Britannica. 2023. Vilnius Dispute. Accessed August 20, 2023. https://www.britannica.com/event/Vilnius-dispute
Manchurian	1929	✓					✓			Siegelbaum, Lewis. "Chinese Railway Incident". Michigan State University. Accessed August 20, 2023. https://soviethistory.msu.edu/1929-2/chinese-railway-incident/
Second Sino-Japanese	1931	✓			✓					Britannica. 2022. Mukden Incident. Accessed August 20, 2023. https://www.britannica.com/event/Mukden-Incident
Chaco	1932		✓			✓				Britannica. 2023. Chaco War. Accessed August 19, 2023. https://www.britannica.com/event/Chaco-War
Saudi-Yemeni	1934		✓		✓					Britannica. 2023. The Kingdom of Saudi Arabia. Accessed August 20, 2023. https://www.britannica.com/place/Saudi-Arabia/The-Kingdom-of-Saudi-Arabia

War	Onset	**N**	**RI**	**PT**	**BC**	**EL**	**DP**	**RR**	**ES**	Secondary Sources
Conquest of Ethiopia	1935	✓								Britannica. 2023. Italo-Ethiopian War. Accessed August 19, 2023. `https://www.britannica.com/event/Italo-Ethiopian-War-1935-1936`
Third Sino-Japanese	1937	✓								Britannica. 2023. Second Sino-Japanese War. Accessed August 20, 2023. `https://www.britannica.com/event/Second-Sino-Japanese-War`
Changkufeng	1938		✓							Blumenson, Martin. 1960. "The Soviet Power Play at Changkufeng". World Politics.
World War II	1939	✓	✓			✓	✓			Vasquez, John A. 1996. "The Causes of the Second World War in Europe: A New Scientific Explanation."
Nomonhan	1939	✓	✓							Otterstedt Charles. 2000. "The Kwantun Army and the Nomonhan Incident: Its Impact on National Security". USAWC Strategy Research Project.; Britannica. 2023. Mongolia - Counterrevolution and Japan. Accessed August 20, 2023. `https://www.britannica.com/place/Mongolia/Reform-and-the-birth-of-democracy`
Russo-Finnish	1939		✓							Britannica. 2023. Russo-Finnish War. Accessed August 20, 2023. `https://www.britannica.com/event/Russo-Finnish-War`
Franco-Thai	1940				✓					Flood Thadeus. 1969."The 1940 Franco-Thai Border Dispute and Phibuun Sonkhraam's Commitment to Japan." Journal of Southeast Asian History
First Kashmir	1947	✓								Britannica. 2023. Kashmir. Accessed August 19, 2023. `https://www.britannica.com/place/Kashmir-region-Indian-subcontinent`
Arab-Israeli	1948	✓					✓			Cashman, G., and Leonard C. Robinson. 2007. "An Introduction to the Causes of War: Patterns of Interstate Conflict from World War I to Iraq." Rowman & Littlefield Publishers, Inc.
Korean	1950	✓	✓	✓						Britannica. 2023. Korean War. Accessed August 20, 2023. `https://www.britannica.com/event/Korean-War`
Off-shore Islands	1954	✓	✓							Office of the Historian, Foreign Service Institute United States Department of State. "The Taiwan Straits Crises: 1954–55 and 1958."

War	Onset	**N**	**RI**	**PT**	**BC**	**EL**	**DP**	**RR**	**ES**	Secondary Sources
Sinai War	1956			✓		✓				Wright, William M., Michael C. Shupe, Niall M. Fraser, and Keith W. Hipel. 1980. "A Conflict Analysis of the Suez Canal Invasion of 1956." Conflict Management and Peace Science
Soviet Invasion of Hungary	1956	✓								Britannica. 2023. Hungarian Revolution. Accessed August 20, 2023. `https://www.britannica.com/event/Hungarian-Revolution-1956`
IfniWar	1957	✓	✓							Studies Institute, US Army War College. 2013. "War and Insurgency in the Western Sahara"; Britannica. 2023. Ifni. Accessed August 19, 2023. `https://www.britannica.com/place/Ifni`
Taiwan Straits	1958	✓	✓							Office of the Historian, Foreign Service Institute United States Department of State. "The Taiwan Straits Crises: 1954–55 and 1958."
Assam	1962				✓					Britannica. 2023. Sino-Indian War. Accessed August 19, 2023. `https://www.britannica.com/topic/Sino-Indian-War`
Vietnam War, Phase 2	1965	✓		✓						Britannica. 2023. Vietnam War. Accessed August 20, 2023. `https://www.britannica.com/event/Vietnam-War`
Second Kashmir	1965			✓						Britannica. 2023. Kashmir. Accessed August 20, 2023. `https://www.britannica.com/place/Kashmir-region-Indian-subcontinent`
Six Day War	1967		✓	✓	✓					Britannica. 2023. Six-Day War Accessed August 20, 2023. `https://www.britannica.com/event/Six-Day-War`
Second Laotian, Phase 2	1968			✓						Britannica. 2023. History of Laos. Accessed August 20, 2023. `https://www.britannica.com/topic/history-of-Laos`
War of Attrition	1969		✓	✓	✓					Britannica. 2020. War of Attrition. Accessed August 20, 2023. `https://www.britannica.com/event/War-of-Attrition-1969-1970`; Britannica. 2023. Six-Day War Accessed August 20, 2023. `https://www.britannica.com/event/Six-Day-War`
Football War	1969	✓								Britannica. 2023. El Salvador - Military Dictatorships. Accessed August 19, 2023. `https://www.britannica.com/place/El-Salvador/Military-dictatorships#ref468021`
Communist Coalition	1970	✓	✓	✓						Pradhan, P. C. "Cambodian Crisis of 1970." Proceedings of the Indian History Congress.

War	Onset	**N**	**RI**	**PT**	**BC**	**EL**	**DP**	**RR**	**ES**	Secondary Sources
Bangladesh	1971	✓								The National Archive. "The Independence of Bangladesh in 1971 ." Accessed 2023-08-19. `https://www.nationalarchives.gov.uk/education/resources/the-independence-of-bangladesh-in-1971`
Yom Kippur War	1973		✓	✓	✓					Britannica. 2023. Yom Kippur War. Accessed August 20, 2023. `https://www.britannica.com/event/Yom-Kippur-War`; Britannica. 2023. Six-Day War Accessed August 20, 2023. `https://www.britannica.com/event/Six-Day-War`
Turco-Cypriot	1974			✓						Bishku, Michael B. 1991."Turkey, Greece and the Cyprus Conflict." Journal of Third World Studies
War over Angola	1975	✓	✓							Britannica. 2023. Angola - Independence and Civil War. Accessed August 20, 2023. `https://www.britannica.com/place/Angola/Independence-and-civil-war`
Second Ogaden War, Phase 2	1977	✓								Lewis, Ioan M. 1989. "The Ogaden and the Fragility of Somali Segmentary Nationalism." African Affairs.
Vietnamese-Cambodian	1977	✓	✓				✓			Abuza, Zachary. 1995."The Khmer Rouge and the Crisis of Vietnamese Settlers in Cambodia." Contemporary Southeast Asia
Ugandan-Tanzanian	1978	✓			✓					Thomas, C. 2022. Uganda–Tanzania War. Oxford Research Encyclopedia of African History. Accessed August 20, 2023. `https://oxfordre.com/africanhistory/display/10.1093/acrefore/9780190277734.001.0001/acrefore-9780190277734-e-1040`
Sino-Vietnamese Punitive	1979		✓					✓		Britannica. 2023. 20th Century International Relations - American Uncertainty. Accessed August 20, 2023. `https://www.britannica.com/topic/20th-century-international-relations-2085155/American-uncertainty#ref305042`
Iran-Iraq	1980			✓	✓	✓				Britannica. 2023. Iran-Iraq War. Accessed August 19, 2023. `https://www.britannica.com/event/Iran-Iraq-War`
War over Lebanon	1982	✓		✓	✓					Britannica. 2023. Lebanese Civil War. Accessed August 20, 2023. `https://www.britannica.com/event/Lebanese-Civil-War`
Falkland Islands	1982	✓					✓			Britannica. 2023. Falkland Islands War. Accessed August 19, 2023. `https://www.britannica.com/event/Falkland-Islands-War`

War	Onset	**N**	**RI**	**PT**	**BC**	**EL**	**DP**	**RR**	**ES**	Secondary Sources
War over the Aouzou Strip	1986	✓				✓				Naldi, Gino J. 2009. “The Aouzou Strip Dispute — A Legal Analysis.” Journal of African Law; Britannica. 2011. Aozou Strip. Accessed August 20, 2023. `https://www.britannica.com/place/Aozou-Strip`
Sino-Vietnamese Border War	1987		✓				✓			Yu, Miles M. 2022. “The 1979 Sino-Vietnamese War and Its Consequences .” Hoover Institution.; Britannica. 2023. 20th Century International Relations - American Uncertainty. Accessed August 20, 2023. `https://www.britannica.com/topic/20th-century-international-relations-2085155/American-uncertainty#ref305042`
Gulf War	1990		✓			✓				Britannica. 2023. Persian Gulf War. Accessed August 19, 2023. `https://www.britannica.com/event/Persian-Gulf-War`
Bosnian Independence	1992	✓								Britannica. 2023. Bosnian War. Accessed August 19, 2023. `https://www.britannica.com/event/Bosnian-War`
Azeri-Armenian	1993			✓						Melander, Erik. 2001. “The Nagorno-Karabakh Conflict Revisited.” Journal of Cold War Studies.
Cenepa Valley	1995				✓	✓				The Economist. 1998. Peace in the Andes.
Badme Border	1998				✓			✓		Pratt, Martin. 2006. “A Terminal Crisis? Examining the Breakdown of the Eritrea-Ethiopia Boundary Dispute Resolution Process.” Conflict Management and Peace Science; Britannica. 2023. Independent Eritrea. Accessed August 19, 2023. `https://www.britannica.com/place/Eritrea/Independent-Eritrea`
War for Kosovo	1999	✓		✓						Larson, Eric V. and Bogdan Savych. 1999. “Operation Allied Force (Kosovo, 1999).” in Misfortunes of War. RAND Corporation.
Kargil War	1999		✓		✓					Tellis, Ashley J., C. Christine Fair, and Jamison Jo Medby. 2001. “Limited Conflicts Under the Nuclear Umbrella: Indian and Pakistani Lessons from the Kargil Crisis.” 1st ed. RAND Corporation.; Britannica. 2023. Kargil War. Accessed August 20, 2023. `https://www.britannica.com/event/Kargil-War`
Invasion of Afghanistan	2001		✓	✓						Britannica. 2023. Afghanistan War. Accessed August 19, 2023. `https://www.britannica.com/event/Afghanistan-War`

War	Onset	**N**	**RI**	**PT**	**BC**	**EL**	**DP**	**RR**	**ES**	Secondary Sources
Invasion of Iraq	2003		✓	✓						Britannica. 2023. Iraq War. Accessed August 19, 2023. `https://www.britannica.com/event/Iraq-War`
Invasion of Ukraine	2022	✓	✓							The Economist. 2022. "John Mearsheimer on why the West is principally responsible for the Ukrainian crisis.".

Note: Table provides an overview of reasons for which wars were fought. Except for the 2022 invasion of Ukraine, primary sources always are Sarkees and Wayman (2010) and Clodfelter (2017). Secondary sources as outlined in table were used to cross-check and complement casus belli coding, where applicable.

E Structural model

The replication files include a detailed derivation of the equilibrium conditions and alternative calibrations:

`https://github.com/wmutschl/price-of-war`