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Research Report

The price of war

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KIEL INSTITUTE FOR THE WORLD ECONOMY

KIEL POLICY BRIEF

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The Price of War

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OVERVIEW/ÜBERBLICK

- In the current era of heightened geopolitical tensions, the economic effects of interstate wars are an important subject for economists to understand. We study the economic fallout of war using a comprehensive new data set covering all major wars since 1870.
- We show that the economic cost of armed conflict—in terms of lost income and reduced physical capital—is overwhelmingly borne by countries on whose territory the fighting takes place. In war sites, real GDP falls on average by 30 percent, and inflation rises by 15 percentage points.
- In an integrated global economy, wars also impose costs on countries other than the war site. Wars trigger adverse supply shocks that have particularly significant consequences for countries that are geographically close to the war site. GDP in neighboring countries typically falls by more than 10 percent relative to trend over a 5-year period, and inflation rises sharply.
- The effects decline in distance to the war site, in line with gravity models. Importantly, for faraway economies, the economic effects can even be expansionary. In contrast, whether a country is party to the war or not matters less for the spillovers from the war site. Geography shapes the spillovers for belligerents and third countries alike.
- Using the historical evidence, we calculate the expected economic costs of the war in Ukraine. Applying our estimation to this case, we expect a cumulative GDP loss in Ukraine of about 120 billion US dollars (110 billion euros) until 2026, and a loss in capital stock of more than 950 billion US dollars (879 billion euros).
- The price that non-belligerent third countries countries pay for Russia's aggression is also substantial. The European Union can expect a GDP loss of more than 70 billion US dollars (65 billion euros) by 2026, the world economy, excluding Russia and Ukraine, around 250 billion US dollars (231 billion euros). For Germany alone, the cumulative GDP loss will be in the range of 15–20 billion US dollars (14–18 billion euros).
- We also unveil a new online tool that allows to approximate the economic fallout of potential war scenarios. The Price of War Calculator is freely available at https://priceofwar.org.

Keywords: Geoeconomics, War, Spillovers, Distance, Supply Shocks

- In der aktuellen Ära erhöhter geopolitischer Spannungen werden die wirtschaftlichen Auswirkungen von bewaffneten Konflikten zu einem Thema, das Ökonomen verstehen müssen. Wir präsentieren eine umfassende Analyse der ökonomischen Auswirkungen von Kriegen. Hierfür verwenden wir einen neuen Datensatz, der mehr als 150 Kriege seit 1870 umfasst.
- Der wirtschaftliche Schaden bewaffneter Konflikte – in Form von BIP-Verlusten und reduziertem Kapitalstock – wird überwiegend von den Ländern getragen, die Kriegsschauplatz sind. Das reale BIP am Kriegsort fällt durchschnittlich um 30 Prozent, während die Inflation um 15 Prozentpunkte steigt.
- In einer integrierten Weltwirtschaft verursachen Kriege auch Kosten für Länder, die keine Zerstörung in den eigenen Grenzen erfahren. Wirtschaftlich gesehen führen Kriege zu negativen Angebotsschocks, die besonders gravierende Auswirkungen auf nahegelegene Länder haben. Das reale BIP der direkten Nachbarländer von Kriegsschauplätzen fällt nach fünf Jahren durchschnittlich um 10 Prozent, während es gleichzeitig zu einem drastischen Anstieg der Inflation kommt.
- Die Effekte auf andere Länder nehmen mit der Entfernung zum Kriegsschauplatz ab. Auf weit entfernte Länder können Kriege sogar expansiv wirken. Im Gegensatz dazu spielt es eine geringere Rolle, ob ein Land an dem Krieg teilnimmt oder nicht – solange es nicht selbst ein Kriegsschauplatz ist. Die geographische Nähe zu einem Kriegsschauplatz prägt die Auswirkungen sowohl für Kriegsparteien als auch für Drittländer in ähnlichem Maße.
- Anhand der historischen Daten berechnen wir den zu erwartenden wirtschaftlichen Schaden durch den Krieg in der Ukraine. Bis zum Jahr 2026 erwarten wir einen kumulativen BIP-Verlust in der Ukraine von etwa 120 Milliarden US-Dollar (110 Milliarden Euro). Der ukrainische Kapitalstock würde im selben Zeitraum um mehr als 950 Milliarden (879 Milliarden Euro) US-Dollar sinken.
- Gleichzeitig ist die wirtschaftliche Belastung für nicht direkt am Krieg beteiligte Drittländer mit insgesamt ca. 250 Milliarden US-Dollar (231 Milliarden Euro) ebenfalls erheblich. Von den Kosten für Drittländer entfallen etwa 70 Milliarden US-Dollar (65 Milliarden Euro) auf die Europäische Union und 15–20 Milliarden US-Dollar (14–18 Milliarden Euro) auf Deutschland.
- Wir ergänzen unser Forschungspapier mit einem neuen Online-Tool: dem Price of War Calculator (PCALC). Der PCALC ist frei verfügbar unter https://priceofwar.org und ermöglicht es, die wirtschaftlichen Auswirkungen hypothetischer Kriege abzuschätzen.

Schlüsselwörter: Geoökonomie, Krieg, Spillovers, Distanz, Angebotsschocks

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ZUSAMMENFASSUNG

Angesichts zunehmender geopolitischer Spannungen rücken die wirtschaftlichen Folgen und Kosten von Kriegen auf die Weltwirtschaft verstärkt in den Fokus. In einer neuen Studie untersuchen wir die Kosten von mehr als 150 Kriegen seit 1870.

Kriege verursachen erheblichen wirtschaftlichen Schaden. Der Großteil dieses Schadens entfällt auf die unmittelbaren Kriegsschauplätze: Hier sinkt das reale BIP fünf Jahre nach Kriegsbeginn durchschnittlich um 30%, während die Inflation um bis zu 15 Prozentpunkte steigt.

Die Zerstörung des Kapitalstocks und der Rückgang der Produktivität wirken als negativer Angebotsschock, der sich auch auf andere Länder erstreckt. Besonders betroffen sind die direkten Nachbarländer: Das reale BIP von Kriegsnachbarn fällt nach fünf Jahren durchschnittlich um 10 Prozent, während die Inflation um 5 Prozentpunkte steigt.

Die Auswirkungen auf andere Länder nehmen mit der Distanz zum Kriegsschauplatz ab. Für sehr weit entfernte Länder können Kriege sogar expansiv wirken. Dabei spielt es eine untergeordnete Rolle, ob ein Land direkt am Krieg teilnimmt; entscheidend ist die geographische Nähe zum Kriegsschauplatz.

Anhand der historischen Daten berechnen wir den zu erwartenden wirtschaftlichen Schaden durch den Krieg in der Ukraine. Bis zum Jahr 2026 erwarten wir einen kumulativen BIP-Verlust in der Ukraine von etwa 120 Milliarden US-Dollar (110 Milliarden Euro). Der ukrainische Kapitalstock würde im selben Zeitraum um mehr als 950 Milliarden US-Dollar (879 Milliarden Euro) sinken.

Die Kosten für nicht direkt am Krieg beteiligte Drittländer belaufen sich auf 250 Milliarden US-Dollar (231 Milliarden Euro). Von den Kosten für diese Drittländer entfallen etwa 70 Milliarden US-Dollar (65 Milliarden Euro) auf die Europäische Union und 15-20 Milliarden US-Dollar (14–18 Milliarden Euro) auf Deutschland allein.

Wir präsentieren ein neues Online-Tool, um die Kosten von Kriegen nachzuvollziehen, den Price of War Calculator. Das Tool ist unter https://priceofwar.org frei verfügbar und ermöglicht es, die wirtschaftlichen Auswirkungen hypothetischer Kriege abzuschätzen.

THE PRICE OF WAR

Jonathan Federle, André Meier, Gernot J. Müller, Willi Mutschler, and Moritz Schularick

1 INTRODUCTION

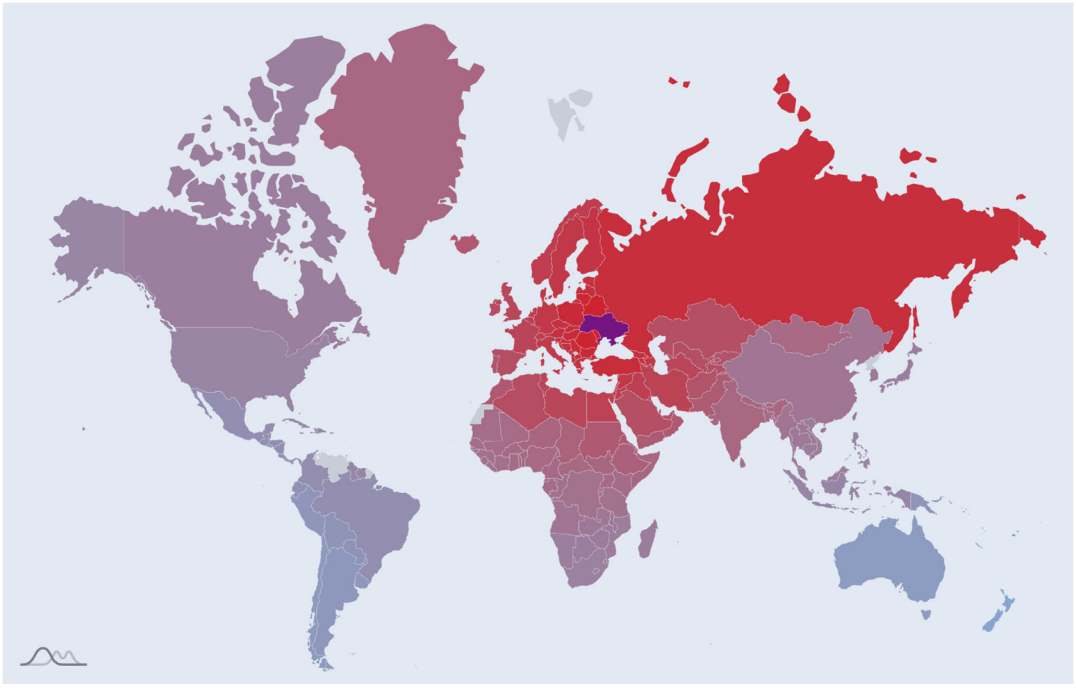
The global political and economic landscape is undergoing profound changes. Geopolitical tensions are rising and rivalries between nations are breaking into the open. The process is fueled by a volatile blend of rising nationalism and shifts in power dynamics—the two most common reasons for why nations go to war, as we show in a new comprehensive study of wars and their economic fallout since 1870 (Federle et al. 2024). Wars are likely to become an important force shaping the world economic outlook from here. The economic fallout of war is not confined to war sites and the direct parties to the war but also affects third countries.

Wars cause death and destruction, disrupt trade and wreak havoc on public finances. And, countries which suffer from a war on their own soil tend to experience outright economic disasters. Yet, wars and the associated rise in military spending can also be expansionary and pull economies out of depressions. The productive potential of an economy is a powerful factor deciding the outcome of wars. War and economics are closely linked, and we argue that understanding the economics of war will become a priority for economists.

In our paper, we estimate the direct economic fallout of wars for the war sites as well as the external effects on other economies using a new data set covering all major wars since 1870.[1] We find that the economic toll of war is not confined to war sites and the direct parties to the war. Wars have substantial repercussions on third countries too. To see this point, consider Figure 1, which shows how the war in Ukraine is expected to impact the GDP in other countries in the five years after the Russian invasion in February 2022. Countries shaded in red suffer larger losses, countries shaded in blue suffer smaller losses. The upshot is: The losses are larger, the closer a country is located to the war site. Ukraine itself suffers the most according to this calculation. Five years into the war, its capital stock will be reduced by around 950 billion US dollars. Over the same period, the war causes a cumulative GDP loss of about 120 billion US dollars. At the same time, the calculation predicts inflation in Ukraine to run higher because of the war: at an annualized rate of approximately 11 percentage points.

[1] We focus on the business cycle impact of war in terms of GDP and inflation and note, as a caveat, that their adjustment in response to the war does not capture all war costs or its full impact on human welfare. First and foremost, we do not account for human losses. Moreover, we do not take into consideration other economic aspects like the fiscal costs of war and GDP composition, including private consumption adjustments—an arguably more accurate indicator of economic welfare.

Figure 1:
Calculated deviation of GDP from trend by 2026 caused by the war in Ukraine[a]



[a]Shaded areas indicate calculated deviation of GDP from trend by 2026 due to the war in Ukraine. Dark red indicates larger losses. In blue areas, losses are lower. The war site, Ukraine is shaded in purple.

Source: PCALC.

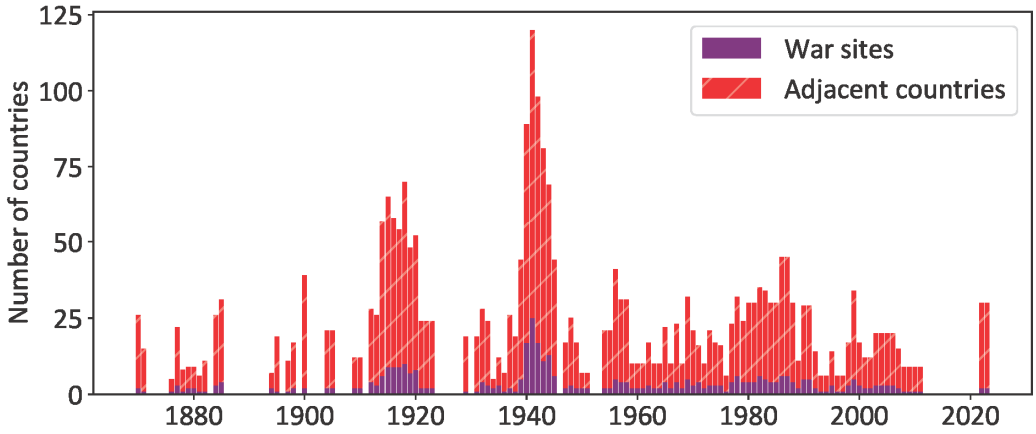
The countries that are direct neighbors of Ukraine suffer the largest GDP losses in relative terms. In absolute terms, however, the GDP loss is even higher in Germany (17 billion US dollars), France (12 billion US dollars), and the United Kingdom (13 billion US dollars).[2] The overall cumulative GDP loss over the period 2022–2026 outside of Ukraine and Russia amounts to some 250 billion US dollars, 70 billion US dollars of which is incurred by member countries of the European Union. We emphasize that these effects are still moderate compared to those of earlier wars because the economic size of Ukraine is relatively small.

On average, a large war—defined by casualties in excess of 10k—lowers GDP in the war site by approximately 30 percent relative to trend and raises inflation by 15 percentage points some 5 years after the start of the war. For countries close to the war site, we find that war can lower GDP by a still-sizeable 10 percent relative to the trend and raises inflation by 5 percentage points. In contrast, for very distant countries war appears to have no, or even a small positive effect on GDP, while prices remain stable relative to trend.

We introduce a new online tool, the Price of War Calculator (PCALC), explained in more detail below, that allows users to approximate the potential costs of war for the war site economy, other countries, and the global economy as a whole. For instance, if Iran was to become the site of a "typical" interstate war, the costs in terms of lost GDP for the world

[2] The costs are expressed in 2023 (current) US Dollars.

Figure 2:
War sites and adjacent countries (1870–2022)[a]



[a]Figure shows total number of war sites in a given year together with all adjacent countries of war sites.

Source: Correlates of War Project (Stinnett et al. 2002), Federle et al. (2024).

economy would amount to 1.5 trillion US dollars over a 5-year period, or about 300 billion US dollars per year. One third of the GDP loss would be due to the devastating effect on output in Iran itself.

These estimates are uncertain and rely on the cost of typical interstate wars in the past. Less or more severe scenarios are imaginable depending on the length and intensity of the war. It is also important to highlight that in our empirical framework, the spillovers to other countries are restricted to operate via distance and depend on the size of the Iranian economy. The international trade integration of Iran is relatively low, so that our calculation of the external costs of a war in Iran could mark an upper bound. On the other hand, other countries in the region could be drawn into it and a shock to global energy markets could amplify the costs. Our calculations provide a first quantification that needs to be backed up by more detailed analysis of the individual case.

We also offer a structural perspective based on a state-of-the-art business cycle model. It shows that the economic fallout of war is dominated by a supply-side contraction in the war site: the capital stock declines because of physical destruction and because of a lack of investment, which in turn, is caused by a collapse of productivity. These effects spill over to countries in the vicinity of the war site: while there is no destruction of physical capital or productivity drop in nearby countries, output and the capital stock decline endogenously as a result of trade linkages. The supply contraction, both in the war-site and the nearby economy, also triggers a substantial rise in inflation. Wars are adverse supply shocks that have particularly significant consequences for countries that are geographically close to the war site, whether they are a party to the war or not.

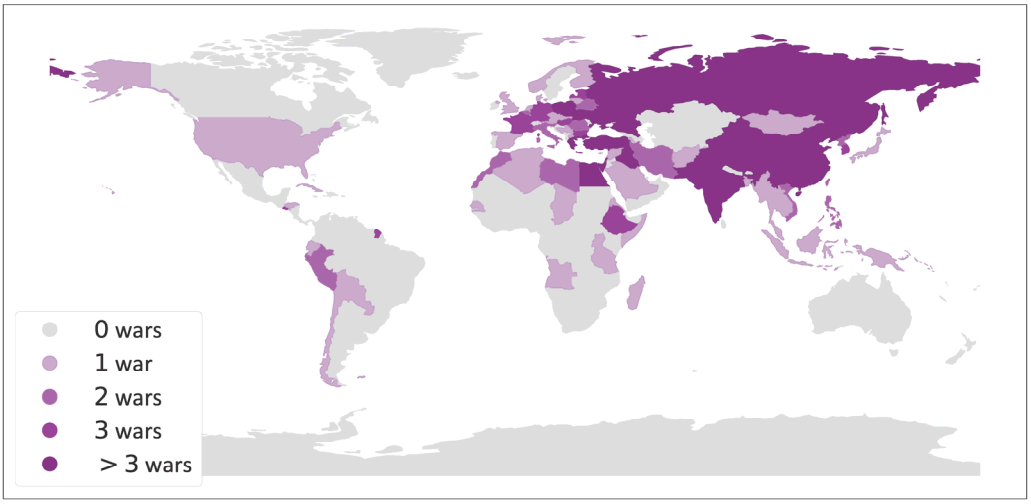
2 DESCRIPTION OF DATA AND ANALYSIS

Identifying the spatial repercussions of war is important: while it is true that countries rarely suffer from war on their own territory, they are frequently exposed to wars in their vicinity. Figure 2 illustrates this fact. It shows that in a long-run sample starting in 1870, the annual frequency with which a country is a war site in a given year is very low at 1.39 percent. By contrast, the frequency with which a country is adjacent to a war site is much higher at 8.22 percent, and hence about twice as high as the (unconditional) frequency of financial crises (Schularick and Taylor 2012).

To understand the economic impact of war, the notion of war sites is key. Yet, it has largely been ignored in earlier work, most likely for lack of data. Indeed, a key contribution of our analysis is to geolocate the war sites for each interstate war in our sample. Other countries are potentially exposed to spillovers from the war site but do not suffer (significant) fighting on their own soil. These other countries may include both countries that are party to the war and non-belligerent countries.

Overall, our sample comprises 176 war sites, which experienced fighting on their own soil, in the period 1870–2022. Their global distribution is shown in Figure 3: a darker color indicates that a country was a war site in several wars. Our sample shows war sites 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, which is the reason why our estimates are based on large war sites with more than 10k casualties.

Figure 3:
Global distribution of war sites (1870–2022)[a]



[a]Figure shows all countries along with the number of wars which took place on their soil.

Source: Federle et al. (2024).

We identify the war sites in our sample by disaggregating the battles for all wars contained in one of the largest war databases, the Correlates of War project (Sarkees and and Wayman 2010). To illustrate the concept of war sites vs other countries, consider the Iraq War in 2003. While several countries were party to this war, major battles took place in Iraq only. The United States and other members of the coalition, in turn, are not classified as war sites because they do not meet the criterion of at least 10k casualties on their own territory.

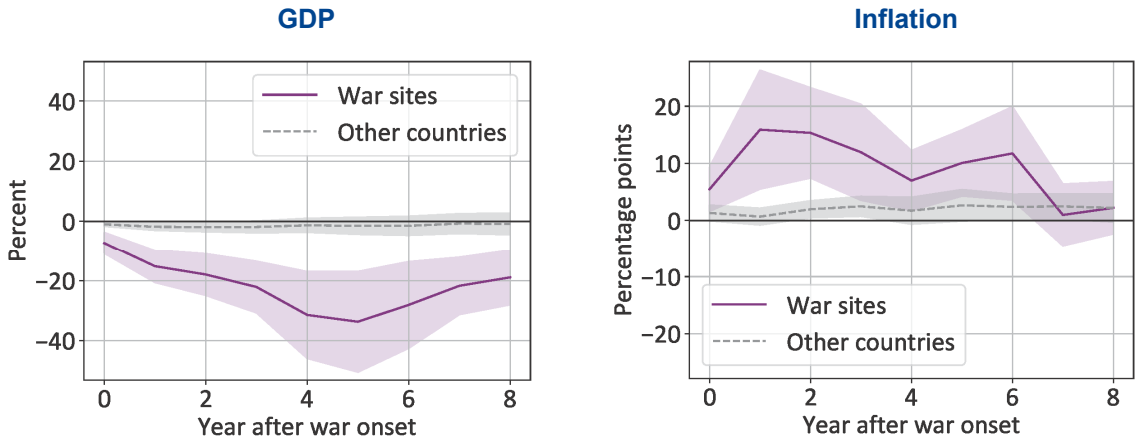
The data for our key economic outcome variables, GDP and inflation, are based on a new dataset assembled from Jordà, Schularick, and Taylor (2017), Funke et. al (2023) and several other sources. Our sample covers annual observations for the period 1870–2022 for an unbalanced panel of 60 countries. The 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. Focusing on large war sites, for which we have macro-time series data, we estimate the average response to becoming a war site across 38 different wars. Turning to the other countries, our sample comprises 1,798 instances in which they have been exposed to a large war which took place on foreign soil. We source data on bilateral distances between countries from the CEPII (Mayer and Zignago 2011).

3 RESULTS

Our empirical analysis is based on a set of local projections (Jordà 2005). We find that wars tend to have a devastating effect on the war-site economy itself. Specifically, we track their effect over time and consider a period of 8 years after the start of the war. To put our results into perspective, we stress upfront that our estimates reflect the average effect of wars (and wars clearly differ across various dimensions, including their duration and the number of casualties). The sample for which we report our estimates also includes the world wars. Thus, the average war site experiences a loss of almost 350,000 casualties, and hostilities last for about 3 1/2 years. As such, the average war site in our sample is smaller than the current war in Ukraine: Estimates from August 2023 put the number of troop deaths and injuries near 500,000 (Cooper et al. 2023). Since an end to the violence is not yet in sight, we can reasonably expect this number to grow further.

Turning to the left panel of Figure 4, we see the change in real GDP due to the war. The solid purple line shows the estimate for the war site, while the shaded area indicates the statistical uncertainty (90 percent confidence bounds). GDP falls strongly in the war site already in the year in which the war starts. Five years later, GDP is reduced by more than 30 percent relative to trend. The right panel of Figure 4 shows how inflation responds to the onset of war. The war sites experience a large and persistent increase in inflation. It peaks at about 15 percentage points in the first year following the start of the war and remains high afterwards. In a nutshell, the war represents a massive supply shock, with economic activity contracting amid strong inflationary pressures.

Figure 4:
Domestic effects of wars[a]



[a]Figure shows how GDP and Inflation adjust in response to start of war, in war site (solid purple line) and in other countries (gray dashed line). Left panel shows percentage deviation of GDP from trend, right panel shows deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of war.

Source: Federle et al. (2024).

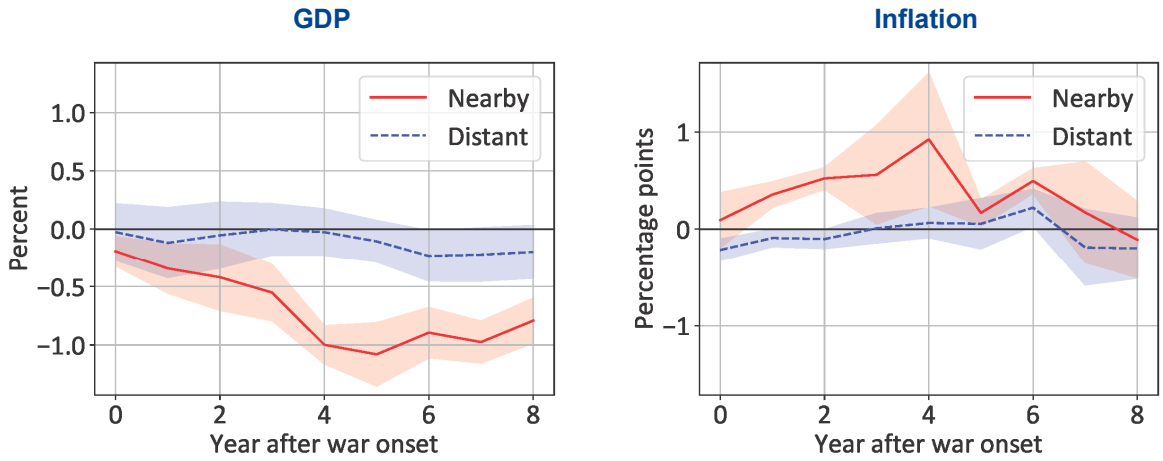
Figure 4 also shows the average spillovers in terms of GDP and inflation to other countries, depicted by the gray dashed line in both panels. The average spillovers on other countries are very mild. However, it turns out that these average spillovers mask considerable heterogeneity across countries: as we allow spillovers to depend on geographic distance from the war site, we find large differences across countries. Countries close to the war site are exposed to large adverse spillovers; countries that are geographically distant from the war site are not.

A second apparent determinant of spillovers from the war site is its economic importance. We take this into account in the estimation and compute estimates of spillovers from a war site that accounts for 1 percent of world GDP. Figure 5 shows the responses of this specification for two limiting cases. The red solid line represents estimates for a "nearby" country, that is, a direct neighbor to the war site. The blue dashed line, in turn, represents a country that is "distant", and indeed as far away as possible from the war site.[3]

The difference across these examples is stark, and it bears noting that spillovers for actual countries will fall somewhere in the range spanned by these two limiting cases. In the nearby country, real GDP declines on impact and persistently so. Five years after the start of the war, GDP has declined by about 1 percent compared to the pre-war trend. At the same time, inflation rises considerably. Hence, the supply shock in the war sites generates strong supply-side spillovers to the neighboring economy. In contrast, countries located at the other end of the world are not experiencing any spillovers.

[3] For example, in the war in Ukraine, we could think of nearby depicting the stylized response of Poland or Moldova. Likewise, distant is set to roughly capture the average response of New Zealand.

Figure 5:
Foreign effects (War sites = 1 percent of the world GDP)[a]



[a]Figure shows how GDP and Inflation respond to start of war in hypothetical nearby country (red solid line) and hypothetical distant country (blue dashed line). Left panel shows percentage deviation of GDP from trend, right panel shows deviation of inflation from pre-war rate in percentage points. Horizontal axis measures time in years since start of war.

Source: Federle et al. (2024).

Depending on the econometric specification, we sometimes even find small positive GDP spillovers for distant countries, while inflation spillovers are consistently insignificant.

Importantly, the effects on other countries hold independently of whether a country is a party to the war—spillovers are somewhat stronger for belligerents than for third countries, but the overall pattern is strikingly similar. Insofar, we can exclude the possibility that the economic fallout of war on other countries is driven by actual participation in the war.

It is nevertheless possible to rationalize the macroeconomic impact of war within a state-of-the-art model of the world economy. Specifically, for this purpose, we assume, consistent with evidence provided in the paper that the war affects the war site in two ways. First, a sizable fraction of its capital stock is destroyed. Second, productivity declines persistently. The decline in productivity is consistent with the notion, that a shift to a war economy entails significant efficiency losses. Both the destruction of the capital stock and the decline in productivity formalize the idea that war, in economic terms, represents an adverse supply shock: economic activity contracts and inflation increases, just as we observe in the data. These effects spill over to the nearby country which maintains strong trade linkages with the war-site economy.

Finally, in our model simulations we also account for the sizable increase of military expenditures that we document during war time (in the paper). In the war site, military expenditures increase by up to 10 percentage points of GDP during an average war. But there is a significant increase in other countries, too, both in nearby and distant. This explains partly why GDP increases in distant countries in some instances: the boost to economic activity due to higher spending dominates adverse spillovers from the war site, which are weak in distant countries.

4 PRICE OF WAR CALCULATOR (PCALC)

We complement our paper with a new online tool: the PCALC. The PCALC is freely available to use for journalists, policy-makers, and interested parties at https://priceofwar.org.[4] It allows users to assess the economic impact of a war on the war site as well as the economic spillovers to other countries. The calculation is based on the empirical estimates reported in the paper and, as such, condenses the historical experience of the last 150 years. By design, this implies that the results come with a caveat when applied to new or hypothetical war scenarios: these may differ in various ways from the historical average encapsulated in our estimates, and a more specific, granular analysis would be necessary to account for this. That said, the calculation offers a ballpark estimate which may then be adjusted to account for specific circumstances. The figures about the GDP losses due to war in Ukraine discussed above illustrate the way in which PCALC may in inform the debate about the economic toll of war.

Naturally, the stylized nature of our analysis comes at a cost since it restricts the spillovers of wars to solely operate via the distance from war sites and their economic size. To the extent that geographic distance is a prime determinant of trade, our analysis does account for trade relationships. Yet, it explicitly does not account for other factors arguably needed to provide a more precise point estimate for the economic price tag of wars. Such omitted factors include, among others, diplomatic relationships, language and culture, or geopolitical dependencies. Implicitly, we assume that the war sites specified in the respective calculations correspond to the average large war site since 1870. Thus, we stress that scenarios developed in PCALC provide an informed guess only, rather than a precise estimate applicable to individual cases.

5 CONCLUSIONS AND POLICY IMPLICATIONS

Who is paying the price of war? Which countries feel its economic impact most strongly? Our study highlights two aspects. First, we show that the adverse impact of war extends far beyond the war site and that the "external costs" of war affect not only the parties to the war but also "third" countries. Second, geography turns out to be a key determinant of these costs—much more so than whether a country is a warring party or a not. Neighbor countries of the war site experience substantial adverse spillovers, with damages diminishing as distance from the war zone increases and depending on the level of trade integration.

In essence, the war-site economy experiences a pronounced disruption on the supply side, reflecting both the actual destruction of the capital stock and efficiency losses due war-time disruptions and the reallocation of resources from the private civilian to the military sector. These effects spill over into nearby countries. By contrast, the spillovers to more distant countries are small and may even be outweighed by the effect of higher government (military) spending. The economic downturn coincides with substantial price pressures, not only within

[4] PCALC is not yet optimized for mobile devices. We recommend opening the tool on a computer using the latest version of Google Chrome.

the war site but also in neighboring countries. As such, the onset of war represents an adverse supply shock, not dissimilar from an energy price shock, which is also often linked to conflicts.

Our findings establish these adverse supply-side spillovers as a pervasive feature of wars, and one that tends to last for a more extended period than other supply shocks. This also points to the resulting challenge for monetary policymakers. A lasting adverse supply shock may generate an inflationary impact where the central bank cannot simply „look through." Our analysis broadly supports the reaction of central banks in recent years which have tightened monetary policy in response to a series of adverse supply shocks, including—notably for Europe—the ongoing war iicn Ukraine.

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