

The Price of War

Federle, Meier, Müller, Mutschler i Schularick (2025.)

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Paper summary

Many countries pay *The Price of War*

- First comprehensive analysis of the economic developments after war onset
- Novel data set for wars since 1870
- Establish new stylized facts while refraining from causal interpretation
- Focus on macroeconomic spillovers, equity prices and long-term interest rates

Contribution:

- Macroeconomic international spillovers of interstate wars
- Structural interpretation of the evidence through the lens of an international business cycle model

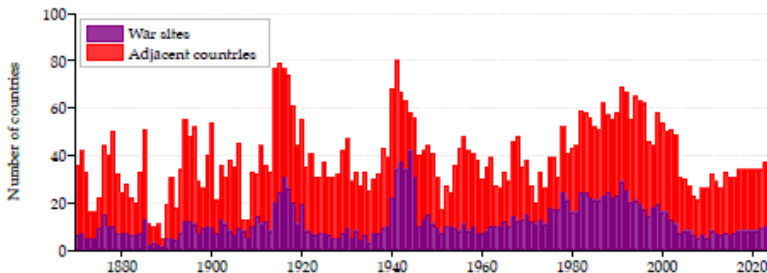
Three categories of economies:

- 1 **Home:** War-site country
- 2 **Foreign belligerents:** Countries fighting but not hosting conflict
- 3 **Third countries:** Non-participating economies

Data sources:

- *Correlates of War (COW)* project: War identification and classification
- *Jordà-Schularick-Taylor Macrohistory Database*: Long-run macroeconomic dataset

War sites and adjacent countries



Notes: Figure based on data for all countries and all interstate, intrastate, and extrastate wars, as classified by the Correlates of War project (Stinnett et al., 2002); see Section 2 for details on war sites and borders.

Although war on a country's territory is fairly rare, economies are much more often exposed to potential negative spillovers from war in their neighborhood. The frequency with which a country is adjacent to a war site (20 percent) is about five times as high as the frequency of financial crises.

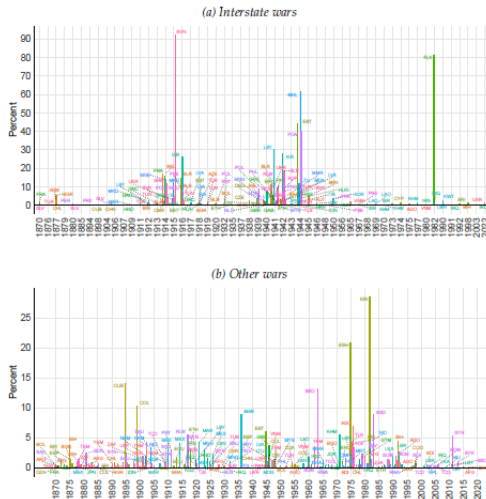
War sites

- def. Country that experiences military action on its own soil
- Differentiate *interstate* from *other* wars: *intrastate* (civil), *extrastate* (colonial, independence)
- COW defines an interstate war as combat between the armed forces of at least two states that causes a minimum of 1,000 battle-related combatant deaths within any 12-month period
- COW does not identify war sites:
 - ① Disaggregate wars to the battle level (warfare encyclopedia)
 - ② Code geolocations
 - ③ Estimate the number of casualties
 - ④ Aggregate battle-level casualties to the country level based on present-day borders

Intensity of war

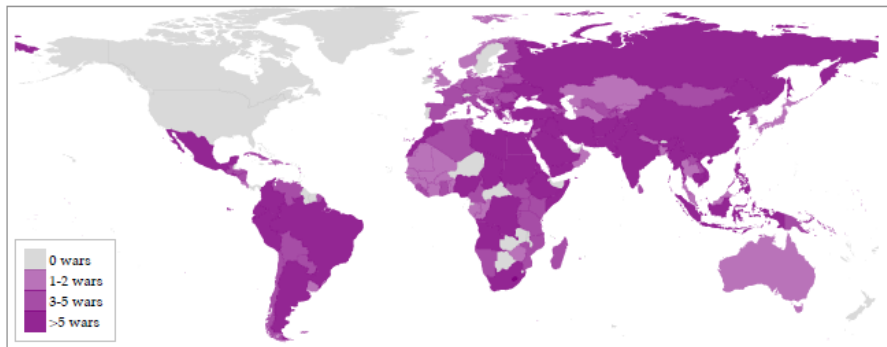
- j - war site
- $Site_{j,t}$ - intensity of war in war site j
- Divide the number of casualties by the population of the war site prior to the start of the war
- Gulf War example:
 - 1 Conflict began in 1990 with Iraq's invasion of Kuwait
 - 2 1991 US intervened shifting much of the fighting to Iraqi territory
 - 3 Saudi Arabia and Israel become targets of limited military action
 - 4 Iraq, Kuwait, Saudi Arabia, and Israel are classified as war sites

War sites (1870-2023)



Note: Panels display $Site_{jt}$: total casualties (dead, missing, wounded, prisoners of war) in war site j measured in percent of pre-war population of war site country. Year t refers to start of the war. Figure restricted to war sites with casualties exceeding 0.1% of local pre-war population.

Geographical distribution of war sites



Note: Colors indicate number of wars that took place on a country's soil for the period 1870–2023.

Variable coding

- Need to control for country size in order to capture the notion that spillovers to third countries may be limited if the war site is a small country (even in cases where casualties relative to the local population are very high)
- Present-day borders
- Italian-Turkish War of 1911
- Drop all naval battles as well as those battles taking place on remote islands when defining countries as war sites
- Focus on countries experiencing material destruction on their core territory
- Cross-check war-site coding of interstate wars by consulting GPT-4 (0.73 Pearson correlation; 53/58 were hallucinations)
- Distinguish war-**site** countries from **belligerents**, and **third countries** (straightforward from COW)

Descriptive statistics

- Unbalanced panel of 60 countries, which together accounted for 95 percent of global GDP in 1960, with coverage remaining between 89 and 92 percent throughout the period from 2000 to 2023
- Bilateral trade data from Fouquin and Hugot (2016)
- Total sample: 694 wars
- About one-third are interstate wars
- Interstate and other wars are not drawn from the same casualty distribution, suggesting that these conflict types are different
- Inflation: CPI is winsorized at 1 and 99 percent levels to account for hyperinflationary episodes

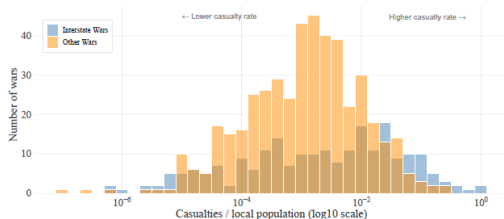
Summary statistics for war sites

| Wars | Casualties / population (in %) | | Length | | Macro time series for... | | |
|---------------------------------|--------------------------------|--------|--------|--------|--------------------------|--------------|-------|
| | Mean | Median | Mean | Median | Sites | Belligerents | Third |
| <i>Panel A: Interstate wars</i> | | | | | | | |
| 225 | 3.50 | 0.26 | 2.5 | 2 | 84 | 178 | 3,648 |
| <i>Panel B: Other wars</i> | | | | | | | |
| 469 | 0.74 | 0.13 | 3.3 | 2 | 141 | 164 | 6,788 |
| <i>Panel C: Combined sample</i> | | | | | | | |
| 694 | 1.65 | 0.15 | 3.0 | 2 | 220 | 319 | 7,126 |

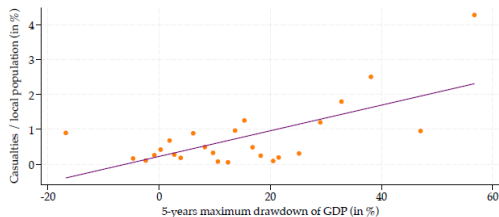
Note: Length denotes number of years that the wars span. Macro time series refers to availability of data on both local pre-war population and consumer prices in years of war onsets across sites, belligerents, and third countries. For coverage of other variables, see Table A.1 in the Appendix. As countries may become sites, belligerents, or third countries to multiple distinct wars simultaneously, numbers in macro time series of panel A and B do not necessarily add up to those outlined in Panel C.

War sites and economic activity

(a) Distributions of war casualties relative to local population



(b) Correlation with GDP



Note: Top panel shows histograms of log10-transformed $Site_{j,t}$. Bottom panel shows binned scatter plot relating $Site_{j,t}$ to maximum drawdown of GDP after removal of country-specific linear trend in war sites 5 years after war onset.

Empirical Framework

Local projections specification:

$$y_{i,t+h} - y_{i,t-1} = \zeta'_h \mathbf{X}_{i,t} + \sum_{c \in \{S, B, T\}} \phi_{c,h} (\gamma'_{i,c,t} \cdot \text{Sites}_t) \\ + \sum_{c \in \{B, T\}} \psi_{c,h} (\epsilon'_{i,c,t-1} \cdot \text{Sites}_t) + u_{i,t+h}$$

Key variables:

- $y_{i,t}$: Outcome variable such as real GDP with $i \in N$ indexing countries
- $\mathbf{X}_{i,t}$: Control variables comprising four lags of the outcome variable in first differences to capture short-term trends, lags of the other regressors, and country fixed effects
- Sites_t : Intensity of war; 0 if no war
- $\gamma_{i,c,t}$: Loading on the site vector is country- and category-specific in each year; dummy variable; country assigned to one of the three categories S (site), B (belligerent), or T (third country)

Loading on the site vector

1 Site

- $\gamma_{i,S,t}$ captures if country i is a war site in year t
- 1 in row i if it is a war site, 0 elsewhere

2 Belligerent

- $\gamma_{i,B,t}$ captures if country i is a belligerent in a war, but not the war site
- 1 in rows corresponding to countries that became war sites in wars where i participates but is not the site, 0 elsewhere

3 Third country

- $\gamma_{i,T,t}$ captures if country i is a third-party to a war starting in year t
- 1 in rows corresponding to countries that are war sites, 0 elsewhere

Categories are not mutually exclusive; a country can appear in multiple vectors for different wars.

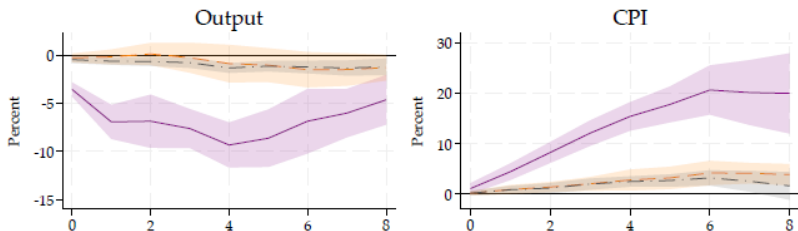
Other variables

- Parameter $\phi_{c,h}$ captures the dynamics of the outcome variable from the start of the war through year h for each category of countries
- The outcome variable is specified in differences relative to the pre-war level to account for the possibility that it changes permanently in the wake of the war
- $\epsilon_{i,c,t-1}$ is the exposure vector that measures the strength of the connection between country i and war site j , and hence allows the exposure of i to war in j to be scaled up or down as a function of specific variables
- $\psi_{c,h}$ captures how the dynamics in both belligerents and third countries depend on their exposure to the war site

Local projections

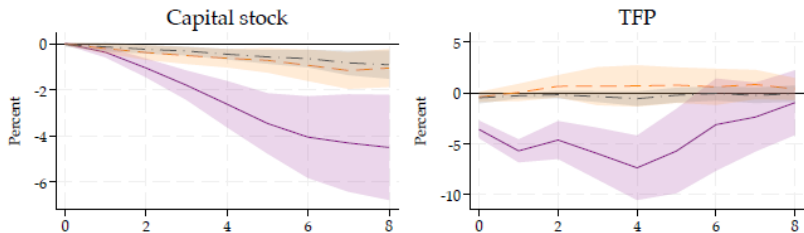
- Introduced by Jordà (2005)
- Method to estimate impulse responses; how one variable (GDP) reacts over time to a shock (war)
- Instead of estimating a big dynamic system (like a VAR), LPs estimate a series of regressions, one for each horizon h
- Each horizon h is estimated locally, with its own regression
- VARs are efficient and smooth, but sensitive to model specification
- LPs are simple and robust, but noisier and less efficient

Macroeconomic dynamics following the start of war

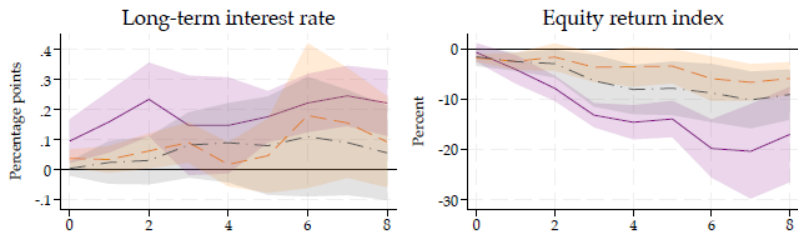


Intensity of war set to 2 percent (casualties/population); size of war site to 3 percent (war-site population/world population). Vertical axis measures deviation from pre-war level/trend, measured in percent or percentage points of pre-war output (military spending) or of pre-war population (military personnel). Shaded areas indicate 90% confidence intervals, computed using standard errors that are robust to heteroskedasticity as well as serial and crosssectional correlation.

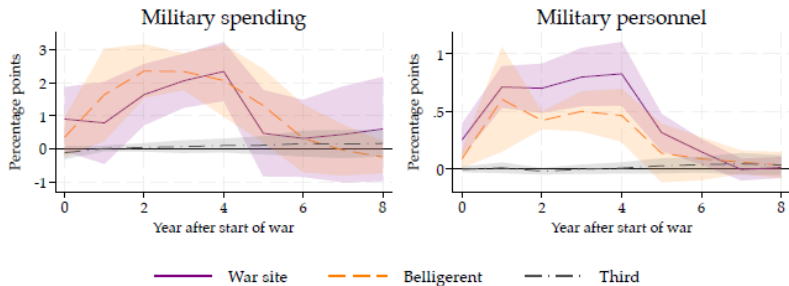
Macroeconomic dynamics following the start of war



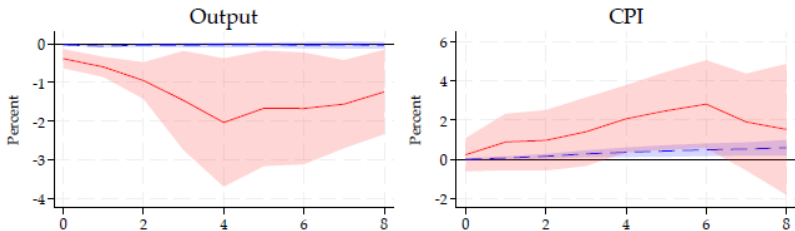
Macroeconomic dynamics following the start of war



Macroeconomic dynamics following the start of war

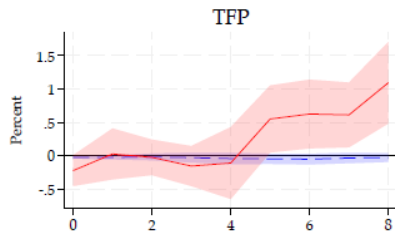
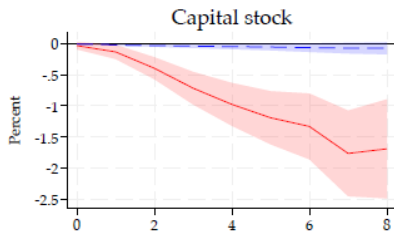


Dynamics in third countries by exposure to war site

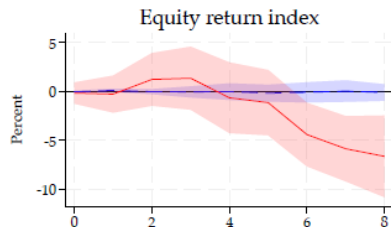
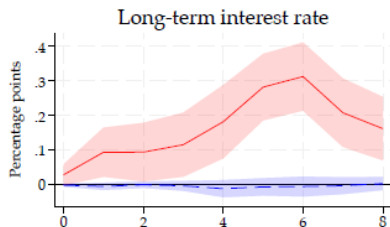


Intensity of war set to 2 percent (casualties/population); trade exposure (imports from war site(s)/GDP) 3 percent (solid red line) v zero (dashed blue line). Vertical axis measures deviation from pre-war level/trend, measured in percent or percentage points of pre-war output (military spending) or of pre-war population (military personnel). 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.

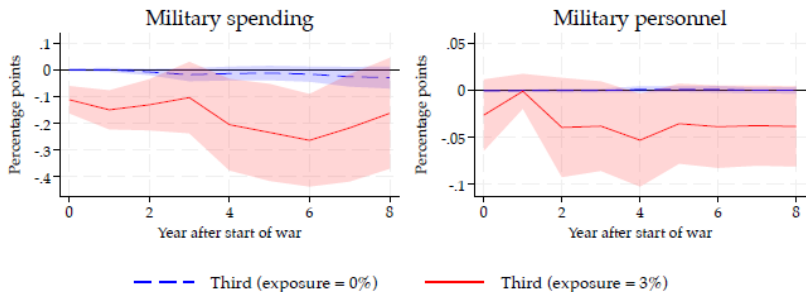
Dynamics in third countries by exposure to war site



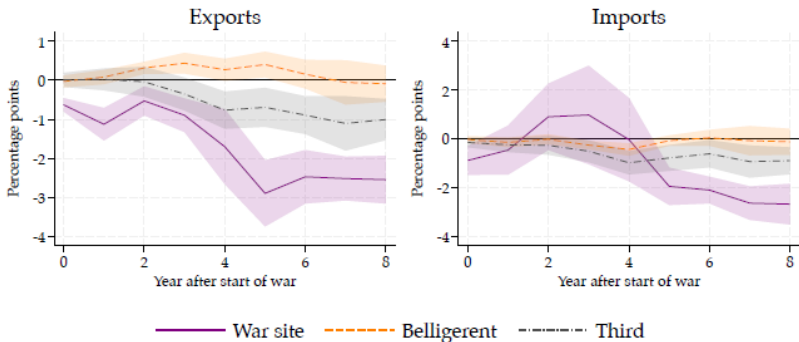
Dynamics in third countries by exposure to war site



Dynamics in third countries by exposure to war site

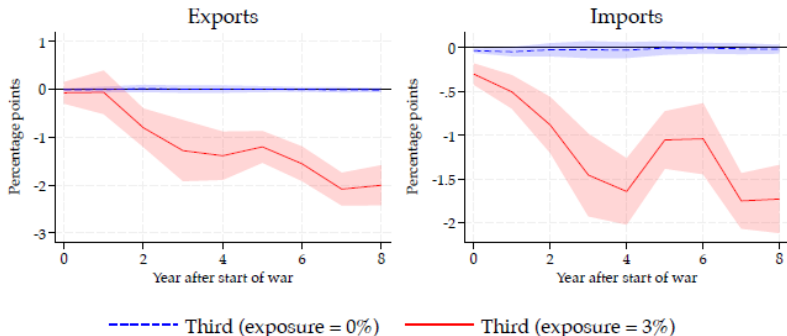


Trade dynamics following the start of war



Intensity of war set to 2 percent (casualties/population); average outcome for war sites, belligerents, and third countries for size of war site equal to 3 percent (war-site population/world population). Vertical axis measures deviation from pre-war level/trend in percentage points of pre-war GDP. 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.

Trade dynamics following the start of war



Intensity of war set to 2 percent (casualties/population); results for third countries with trade exposure (imports from war site(s)/GDP) set to 3 percent and zero. Vertical axis measures deviation from pre-war level/trend in percentage points of pre-war GDP. 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.

Robustness 1 & 2

- Subsamples

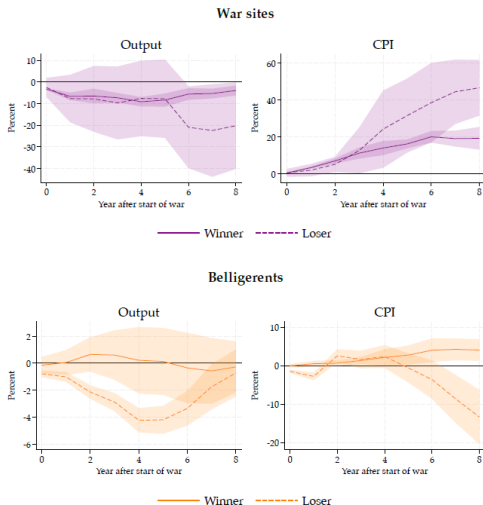
- Excluding observations around territorial changes
- Excluding World Wars
- The Kellogg-Briand Pact (<1928)
- Subsample ≥ 1928
- Restricting to 18 countries from Macrohistory
- Only war sites with casualties $\geq 1,000$
- Only other wars
- Regional variation (Americas, Europe, and Asia)

- Alternative specifications

- Shock measure based on GPR (Caldara and Iacoviello, 2022)
- Longer horizons
- Trade exposure to the war site for belligerents
- Alternative start years (broader relevant conflict)
- Control for the presence of nationalist governments
- Control for trade openness
- Winsorize the war intensity measure by capping it at 10%
- Hodrick-Prescott filter instead of constant linear country-specific trend
- Allow for non-linear dynamics
- Shorter vs longer wars

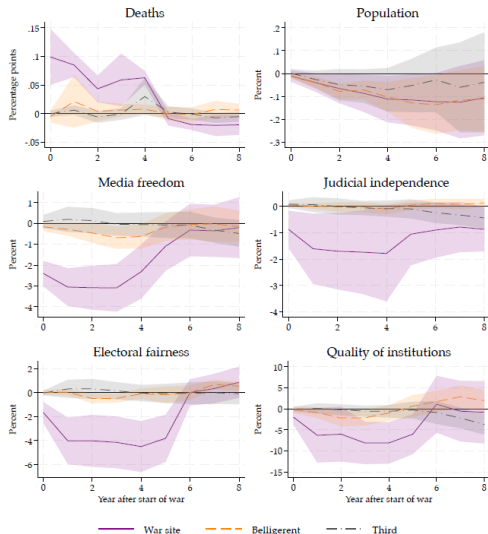
Robustness 3

- Whether winning or losing an interstate war is associated with different macroeconomic dynamics



Robustness 4

• Additional outcome variables



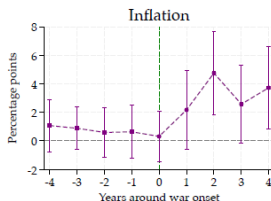
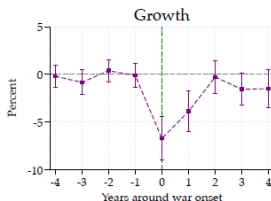
Causal approach

To assess whether their findings can be interpreted as war causing economic changes, they restrict the sample to interstate wars and pursue three lines of analysis:

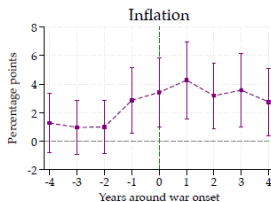
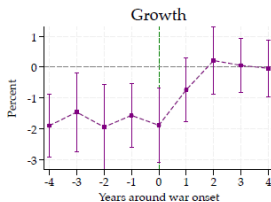
- 1 Verify that interstate wars are not typically caused by business-cycle conditions (if so, exclude those instances)
- 2 For the restricted sample, show that neither GDP growth nor inflation improves the prediction of whether a country becomes a war site or not
- 3 Discuss potential biases and outline the assumptions under which the results for output and inflation permit a causal interpretation

The *casus belli* of interstate wars: a narrative classification

Interstate wars



Other wars



Other wars are endogenous to the state of the economy in ways that interstate wars do not appear to be. Proceed by restricting the sample to interstate wars.

Reasons for going to war

Classify the apparent *casus belli* for all interstate wars in the sample, based on the following procedure:

- ➊ For every conflict, consult narrative excerpts from Gibler (2018) and Martel (2012, 2018)
- ➋ Complement these with various additional sources (Morillo, Black and Lococo, 2008; and Parker, 2020)
- ➌ If sources suggest different reasons, all of them are included in the classification

Reasons for going to war

| Reason | Explanation | # Wars |
|--------------------------------------|--|--------|
| Nationalism | Creation of own sovereign state, wars for independence, imperialism | 57 |
| 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. | 37 |
| Religion or Ideology | Deep-rooted disagreements over religious beliefs or ideologies (e.g., communism) | 35 |
| Economic, Long-Run | States might go to war to gain control over trade routes, markets, or valuable resources; economic rivalry and protectionism | 35 |
| Border Clashes | Unclear borders or intensifying border clashes | 28 |
| 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 | 18 |
| Domestic Politics | Leaders may use foreign war to distract from domestic political issues or to rally their population around a common cause | 13 |
| Economic, Short-Run | The economy is in a severe recession (e.g., unemployment is high) | 6 |

Predictive regressions and Granger causality

Do business cycle conditions help to predict the onset of war?

- Binarize the variable $Site_{j,t}$ and estimate a logistic regression that includes macroeconomic indicators, political-institutional controls, and other relevant variables as covariates
- Lagged values (up to 4 years) of GDP growth, inflation, military spending relative to GDP, and trade openness
- Additional geopolitical variables: the number of land borders, major power status, V-Dem liberal democracy index
- Number of years of peace in polynomial form to capture potential nonlinear duration effects
- Estimate a generalized linear model with a logistic link function and cluster standard errors by country to correct for within-country correlation of errors

Significance of predictors Across selected logit models

| | Probability of being war site | | | | | | | |
|-------------------------|-------------------------------|--------|--------|--------|------------|--------|--------|--------|
| | Interstate wars | | | | Other wars | | | |
| | (21) | (22) | (29) | (30) | (21) | (22) | (29) | (30) |
| GDP growth (any lag) | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ |
| Inflation (any lag) | ○ | ○ | ○ | ○ | ○ | ● | ○ | ● |
| Openness (any lag) | | | ● | ● | | | ● | ● |
| Military exp. (any lag) | | | ● | ● | | | ● | ● |
| Borders (t-1) | | | ○ | ● | | | ○ | ○ |
| Democracy (t-1) | | | ● | ● | | | ● | ● |
| Major power (t-1) | | | ○ | ○ | | | ● | ○ |
| Peace years (any term) | ● | ● | ● | ○ | ● | ● | ● | ○ |
| Country fixed effects | | ✓ | | ✓ | | ✓ | | ✓ |
| Observations | 7030 | 4386 | 5314 | 2790 | 6883 | 3825 | 5169 | 2326 |
| War sites | 77 | 77 | 56 | 56 | 120 | 120 | 75 | 75 |
| Pseudo-R ² | 0.03 | -0.03 | 0.05 | 0.07 | 0.15 | 0.12 | 0.13 | 0.05 |
| Log-Likelihood | -402.4 | -355.7 | -273.1 | -207.3 | -503.0 | -428.3 | -318.6 | -269.9 |

Note: Logit model estimates for binary war-site indicator variable with standard errors clustered at the country level. ○ and ● refer to variables included in regressions; ● denotes that the most significant lag has $p < 0.05$. The column numbers refer to the columns of the Tables in Appendix O-F, which report the full regression results and further specifications.

Formal Granger test

Do recessions or inflation spikes precede wars often enough that we can say the economy *Granger-causes* wars?

- If adding past GDP growth improves the prediction of war onset, GDP growth “Granger-causes” war in the forecasting sense
- Logistic regression model in a dynamic panel framework
- Cannot reject the null hypothesis that the coefficients on the lags of GDP and/or inflation are jointly zero
- No evidence of Granger causality in the interstate sample
- Past economic performance does not help predict the onset of war
- There's no Granger causality from GDP or inflation to war

Results for restricted sample and potential biases

- Re-estimate the baseline specification on the restricted sample, which includes only interstate wars and excludes cases in which the narrative analysis identified short-run economic developments as a potential cause of the war
- Given these arguments and results, a causal interpretation—whereby war causes the business cycle dynamics documented—appears justified
- However, this interpretation is still subject to a number of caveats:
 - ➊ **Expectations about the future:** even though past GDP growth does not predict wars, expected future growth might still matter, and that could blur cause and effect; however, military strength is significantly correlated with output, but not with output growth, which means wars probably do not depend much on temporary growth rates
 - ➋ **Endogeneity bias:** if some of the reasons for going to war also directly affect the economy; nationalism is a plausible contender in this regard; add controls for nationalist governments in their robustness checks and find that including this variable does not change their results, which strengthens their confidence that war really is the main driver of the observed economic effects

Conclusion

- Adverse outcomes—lower output and higher inflation—not only in countries directly exposed to war on their own soil but also among other belligerents and even in third countries, especially those with strong trade ties to the war site
- For a subset of interstate wars, there is evidence that war is indeed the likely driver of these changes
- War acts as an adverse supply shock for the war-site economy: its destructive nature hampers productive capacity, disrupts output, and drives up prices. These effects spill over through trade. For countries neighboring the war site, there is an added risk of military spillovers, reflected in weak equity returns
- *The Price of War*—in economic, political, and socio-demographic terms—is paid by many countries, well beyond the actual war site