27th Annual DNB Research Conference

The Macroeconomic Effects of Geopolitical Uncertainty

DeNederlandscheBank

EUROSYSTEEM

The Price of War

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The questions

**What is the macroeconomic impact of war?**

- Military buildups expansionary (Ramey Shapiro 1998, Ilzetzki 2024)
- Death and destruction of the <u>war-site</u> contractionary: many economic disasters associated with wars on country's own soil (Barro 2006)

What about other countries? Do they pay a price for the war as well?

- Potentially strong economic spillovers from war site to other countries, depending on geographic distance
- Nearby countries pay substantial price of war, even if not party to war

Countries exposed to <u>interstate wars</u> 1870–2023

Unconditional prob. war site: 2.4% v 11.5% for war next door
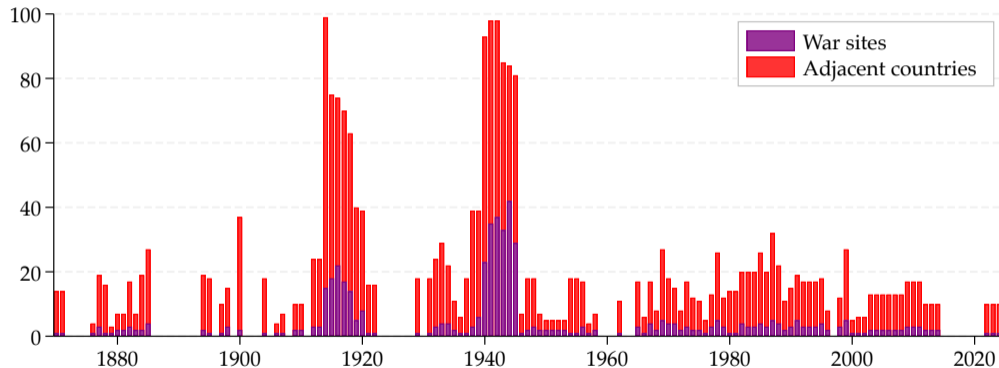
Empirical analysis

New data for all interstate wars since 1870

- Geolocate war sites and identify *casus belli* narratively
- Estimate macroeconomic effect of war <u>conditional on distance from war site</u>

Dynamic effects of war

- War sites: GDP falls by up to 20%, inflation increases by some 10ppt
- Spillover to <u>nearby</u> countries similar for <u>third</u> and <u>belligerent</u> countries: GDP falls one-for-one with the economic size of war site, inflation rises
- Spillovers decline in geographic distance
- Output spillovers turn positive for belligerent countries, if distant from war site

Structural interpretation / transmission channels

Multi-country model of world economy

- Trade integration—distance—differs across countries
- Devise war scenario: capital destruction, TFP decline, military spending and some monetary accommodation

Calibrated model can account for evidence

- Offers account of transmission channels where data coverage is limited
- Endogenous supply-side contraction as intermediate-goods trade falters
- Spillovers primarily depend on pre-war trade integration (i.e. distance)

Related literature: economic impact of war . . .

on parties to the war

- Case studies: Oliver 1941, Harrison 1998, Davis Weinstein 2002, Tooze 2006
- Growth effect somewhat elusive: Rasler Thompson 1985, Barro Lee 1994, Caplan 2002, Acemoglu et al 2005, Thies and Baum 2020
- Stronger for civil wars: Abadie Gardeazabal 2003, Novta and Pugacheva 2021, Chupilkin Kóczán 2022
- Modelling war/military buildups: Ramey Shapiro 1998, Auray Eyquem 2019

on third countries/spillovers

- Trade/networks: Martin et al 2008, 2012, Glick Taylor 2010, Couttenier et al 2022, Korovkin Makarin 2023
- From civil wars, with focus on geography: Murdoch Sandler 2002, 2004, Qureshi 2013, Verdickt 2020, Mueller et al 2022

Data and basic facts

Annual observations: 1870–2023

Outcome variables: output and inflation for up to 60 countries

- Macroeconomic History Base (Jorda Schularick Taylor), extended in Funke Schularick Trebesch (2023)

Bilateral distance from war site measured in kilometers

- Distance of two most populated cities across countries (Mayer Zignago 2011)

Analysis centered around war sites

- *Correlates of War project* (Sarkees Wayman, 2010): all interstate wars ($> 1\,000$ battle deaths) between 1816 and 2007 & updated (UCDP $+$ Invasion of Ukraine): 75 wars
- Geolocate war sites: digitize disaggregated battle-level data based on Clodfelter (2017) and various other sources

War sites

- Geolocate 1625 battles: collect number of deaths, missing, wounded (causalities)
- Aggregate back to country level **using today's borders**
- Cross-check via GPT-4 yields another 5 war sites
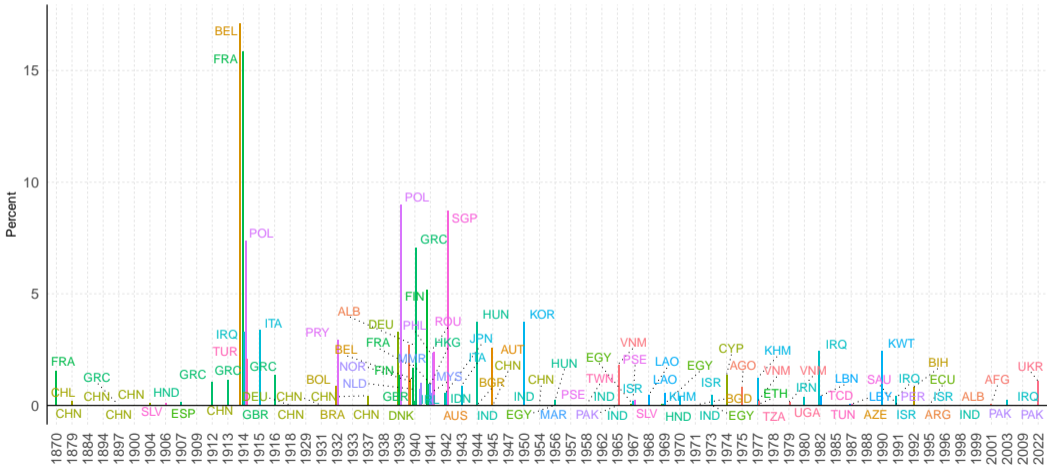- Exclude battles taking place far from core territory (e.g., Aleutian Islands in WW2)

Casualties		Length		Wars	Macro time-series for...		
Min	Mean	Mean	Median	Total	Sites	Belligerents	Third
2	220,134	2.5	2	224	86	122	2,525

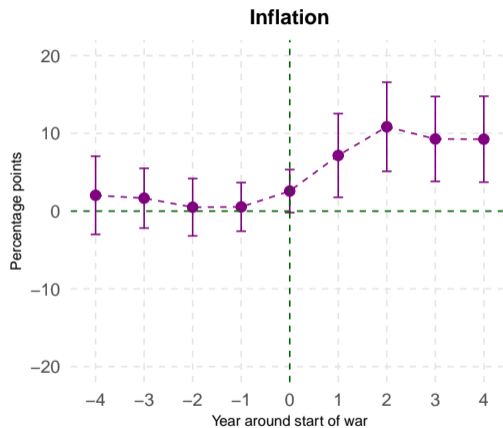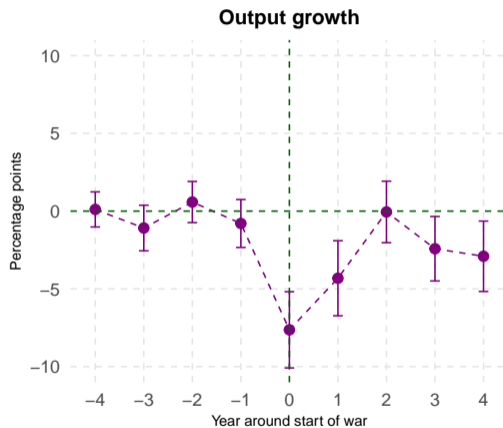# All war sites 1870–2023 (geographical distribution)
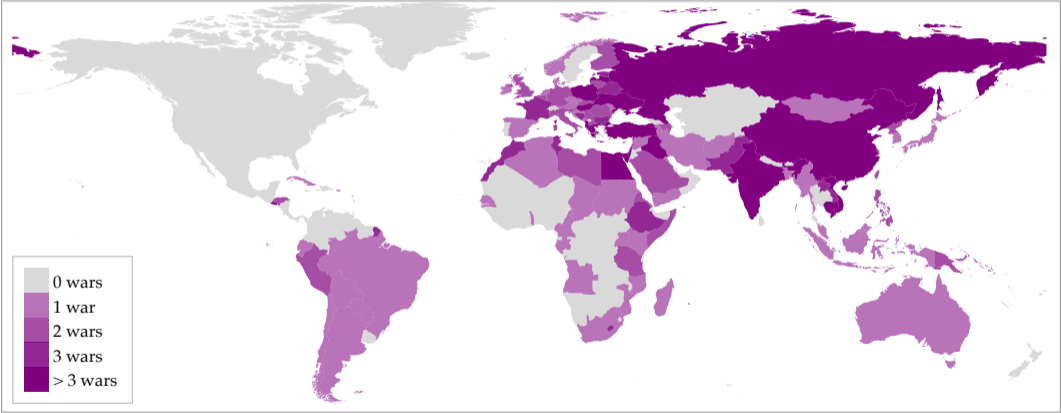
Severity of war in terms of casualties

Restricted sample (population data)

Growth and inflation around start of war

Are wars exogenous to the business cycle?

Common assumption in fiscal policy literature

- Military spending (news) good instrument (e.g., Ramey Shapiro 1998, Barro Redlick, 2011; Ramey Zubairy, 2018; Miyamoto et al 2019)

Some evidence that US Presidents more likely go to wars

- In times of economic stress (Ostrom Job 1986)
- During recession & if president up for reelection (Hess Orphanides 1995)

Verify using a narrative approach a la Romer Romer (2010)

- Classify *casus belli* for all wars in our sample
- Initial classification according to the warfare encyclopedia by Clodfelter (2017)
- Cross-checks based on more than 80 different (historical) sources

Why countries go to war: 8 non-exclusive categories

	Notion	# Wars
Nationalism	Creation of own sovereign state, wars for independence, imperialism	46
Power Transition or Security Dillemma	Rising power challenges a dominant one, arms races, security dilemma	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	Control over trade routes, markets, or valuable resources; economic rivalry and protectionism	10
Domestic Politics	Leaders may use foreign war to distract from domestic 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	Economy in severe recession (e.g., unemployment is high)	2

Empirical framework and results

Empirical framework

Variables capture <u>start of the war</u>: country i is ...

- $Site_{i,t} = 1$ if war starts on soil of country i in year t
- $Third_{i,t} = \sum_{j \in T_{i,t}} \varepsilon_{j,t}$ if war starts in country j (and i is not participating) where $\varepsilon_{j,t} \equiv GDP_{j,t-1} / GDP_{world,t-1}$ is economic size of war site
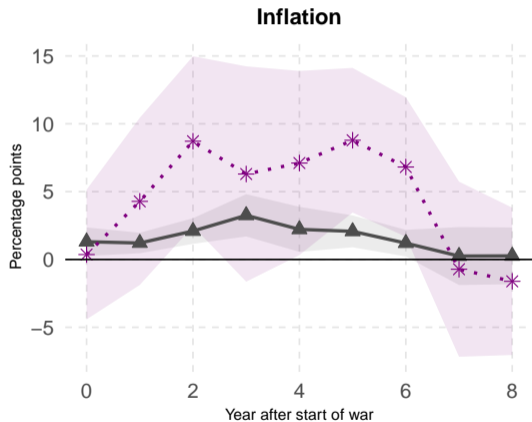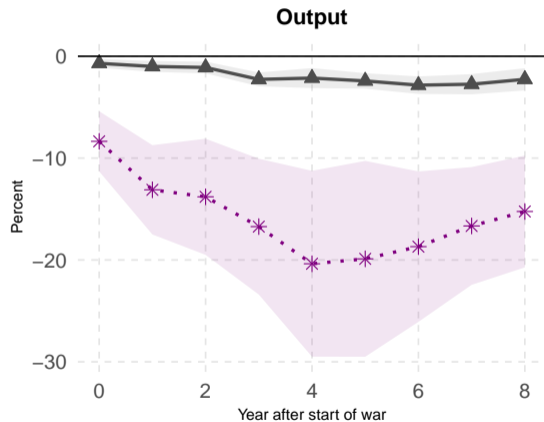
Estimate dynamic effect of war in sites and third countries

$$x_{i,t+h} - x_{i,t-1} = \alpha_{i,h} + \gamma_h Site_{i,t} + \psi_h Third_{i,t} + \zeta_h Controls_{i,t} + u_{i,t+h}$$

- $x_{i,t+h}$: output or inflation (baseline)
- Controls: 4 lags of dependent variable and regressors

Strong adverse effect on war site, small spillovers **on average**

War site accounts for 5% of world GDP

Output

Inflation

* War sites ▲ Third countries

Zooming in: condition spillovers on **<u>distance</u>** from sites

Smooth transition model

$$x_{i,t+h} - x_{i,t-1} = \cdots + \psi_{n,h}\left[1 - F(i,t)\right]Third_{i,t} + \psi_{d,h}F(i,t)Third_{i,t} + \ldots$$
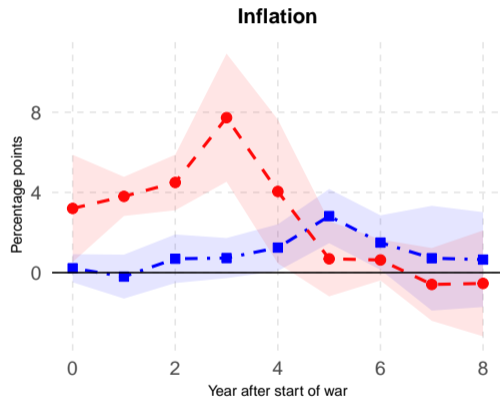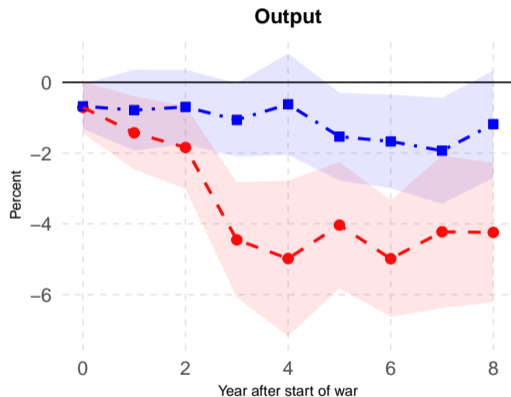
- Limiting cases: $\psi_{n,h}$ (nearby) v $\psi_{d,h}$ (distant)
- Spillovers depend on shock-weighted normalized distance

$$F(i,t) = \sum_{j \in T_{i,t}} \frac{\varepsilon_{j,t}}{\sum_{k \in T_{i,t}} \varepsilon_{k,t}} \left[\frac{\ln(1 + d_{i,j})}{\ln(1 + d^{\max})}\right],$$

where $d_{i,j}$ denotes geographic distance between countries i and j, and d^{max} maximum distance between any two countries

Strong adverse spillovers on **third countries** if close to war site

War site accounts for 5% of world GDP

Output

Inflation

Nearby   Distant

Spillovers to **belligerents**

War site accounts for 5% of world GDP

Output

Inflation

Nearby — Distant
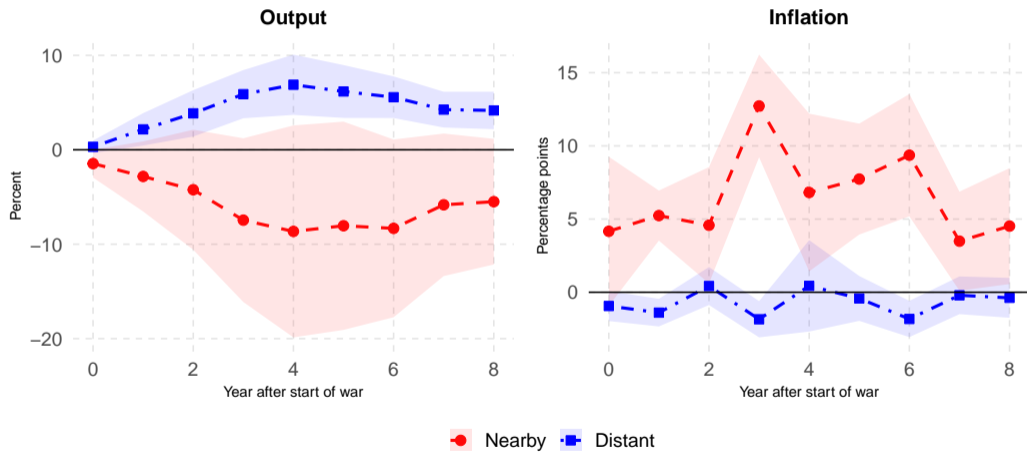
Robustness and further evidence

Main results robust across a number of alternative specifications `details`

- Longer horizons
- Drop US from sample
- Restrict to shorter and longer wars
- Alternative timing of war shocks
- Control for military strength

Further evidence `details`

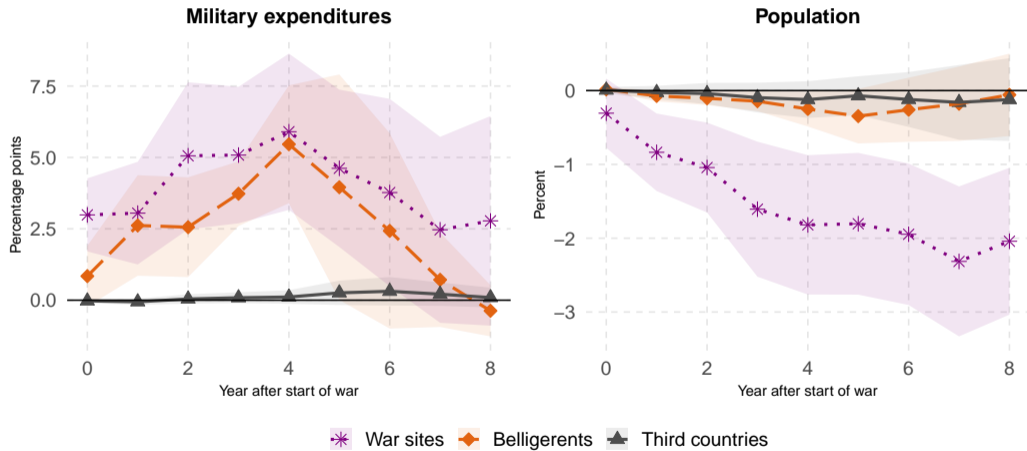- Quantitative shock measure based on casualties
- Condition on trade integration

Evidence on underlying causes

Source: Long-Term Productivity Database (Bergeaud et al 2016); restricted sample
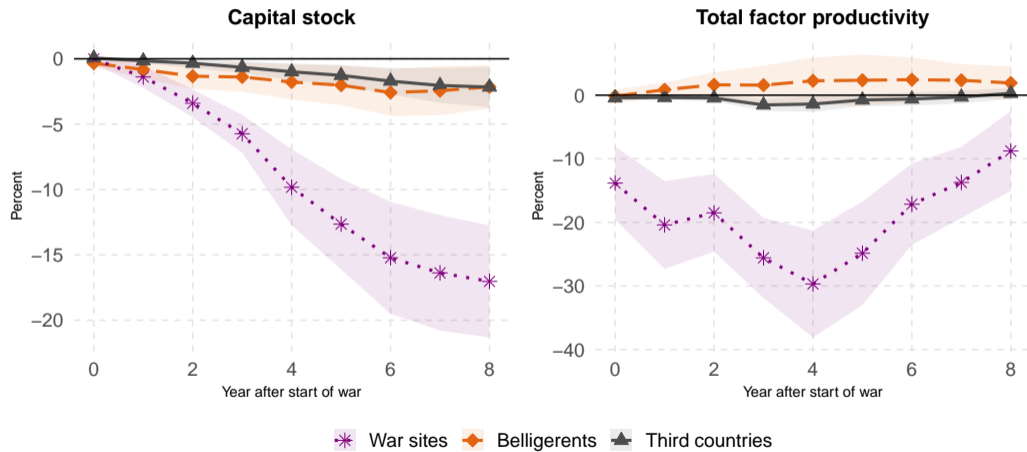
Evidence on underlying causes cont'd

Source: Correlates of War / Maddison project; restricted sample

Military expenditures (left panel)

Population (right panel)

Legend: ✳ War sites ◆ Belligerents ▲ Third countries

Structural interpretation

Structural interpretation

Multi-country model (Gopinath et al 2020, Eichenbaum et al 2021)

- Site, Nearby, Distant, each 5% of world output; and Rest of the World
- Site and Nearby fully integrated; little trade with Distant
- Intermediate inputs in production
- Incomplete financial markets; labor and capital immobile across countries
- Monopolistic competition & stickiness in labor and goods market
- Monetary policy determined by money growth rules

War as AR(2) shock with 4 dimensions

(i) Destroys capital stock in **Site (only)**, as in rare disasters (Gourio 2012)

(ii) Reduces TFP in **Site (only)**, as in rare disasters (Gourio 2012)

(iii) Raises military spending in **Site (only)**

(iv) Monetary policy accommodates **globally**, but to different degrees

Model outline

Household objective in country j

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

Owns internationally immobile capital stock, $k_{j,t}$, which evolves according to:

$$k_{j,t} = \left((1-\delta^K) k_{j,t-1} + \Phi^K \left(\frac{i_{j,t}}{k_{j,t-1}} \right) k_{j,t-1} \right) e^{-\Delta_j^K \omega_t}$$

War shock follows AR(2) process:

$$\omega_t = \rho_1^\omega \omega_{t-1} + \rho_2^\omega \omega_{t-2} + \eta_t$$

Budget constraint of county j in real per-capita terms:

$$c_{j,t} + i_{j,t} + \mathcal{E}_{Rj,t}^r b_{Rj,t} + \frac{\phi^B}{2} \left(\mathcal{E}_{Rj,t}^r b_{Rj,t}\right)^2 + \tau_{j,t}$$

$$= \frac{1}{n_j} \int_{\mathcal{N}_j} \frac{W_{j,t}(h) L_{j,t}^s(h)}{P_{j,t}} dh + r_{j,t}^K k_{j,t-1} + \mathcal{E}_{Rj,t}^r \frac{R_{R,t-1}}{\Pi_{R,t}} b_{Rj,t-1} + \sum_i div_{ji,t}$$

Final good is CES aggregate of wholesale goods from country i

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

with $\gamma_{jj} = 1 - \sum_{i \neq j} \gamma_{ij}$. σ is trade-price elasticity and $\varphi_{ij,t}$ import-adjustment costs. Import shares reflect size and home bias

$$\gamma_{ij} = \Omega_{ij} \ n_i, \text{ where in calibration } \Omega_{HN} = \Omega_{NH} = 1$$

Producers operate under monopolistic competition with Calvo price setting constraint assuming producer currency pricing (PCP)

Production function:

$$A_{j,t}(X_{j,t}^d(m))^{\alpha^X}\left(K_{j,t}^d(m)^{\alpha^K}L_{j,t}^d(m)^{1-\alpha^K}\right)^{1-\alpha^X} = \sum_i Y_{ji,t}^d(m).$$

where $x_{j,t} = \frac{1}{n_j}\int_{\mathcal{N}_j} X_{j,t}^d(m)dm$ are intermediate inputs in production (sourced from final goods)

Productivity subject to war shock:

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

Market clearing for final goods

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

where $g_{j,t}$ is per-capita government spending (funded through lump-sum taxes) and impacted by war shock

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

Monetary policy

$$\left(\frac{M_{j,t}}{M_{j,t-1}}\right) = (1-\rho^M_j)\Pi_j + \rho^M_j\left(\frac{M_{j,t-1}}{M_{j,t-2}}\right) + \Delta^M_j\ \omega_t$$

Real GDP defined as value added: $gdp_{j,t} = y_{j,t} - x_{j,t}$

Calibration

Macroeconomic impact of war in Site, Nearby, and Distant

Data ✳ War sites   Model · · War sites   Data ⬤ Nearby ◼ Distant   Model — Nearby · — Dista
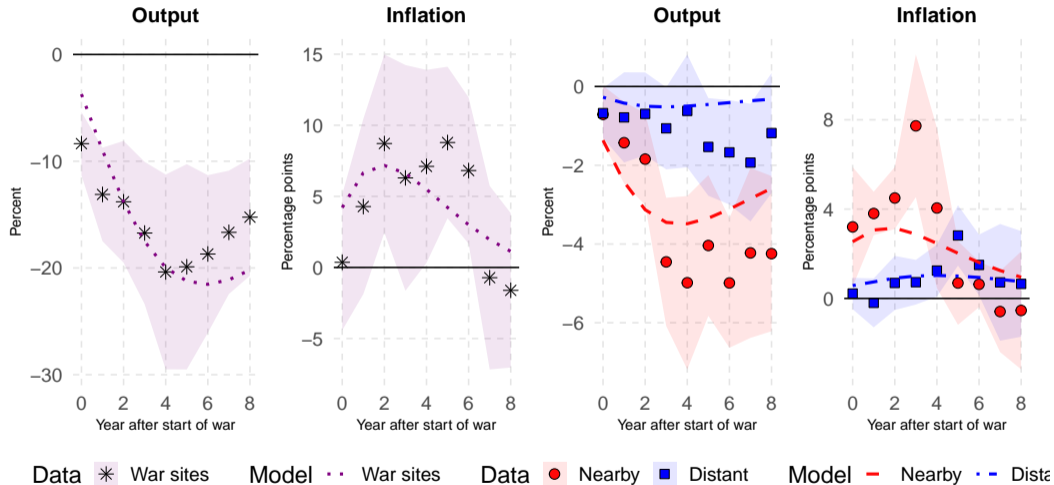
Implications of calibrated model—External validation
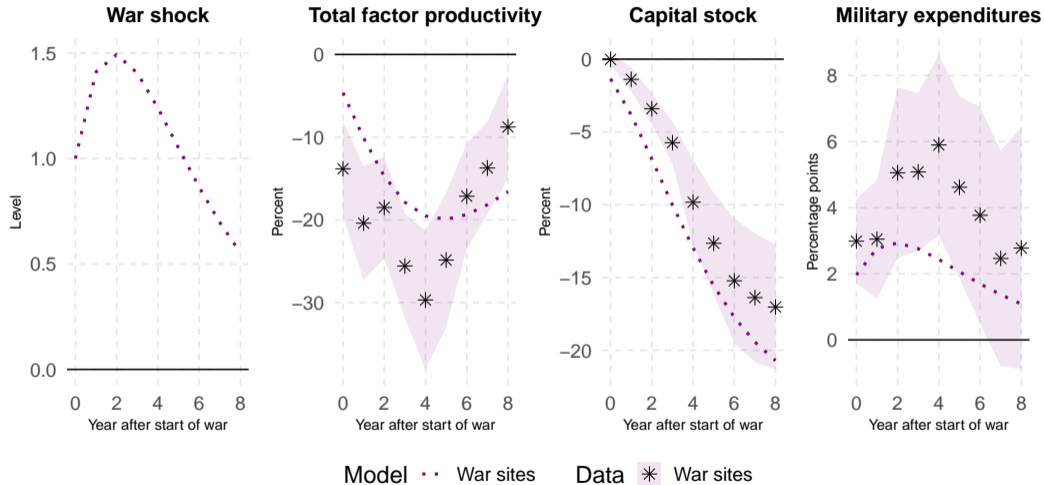
Inspecting the mechanism: Supply side spillovers
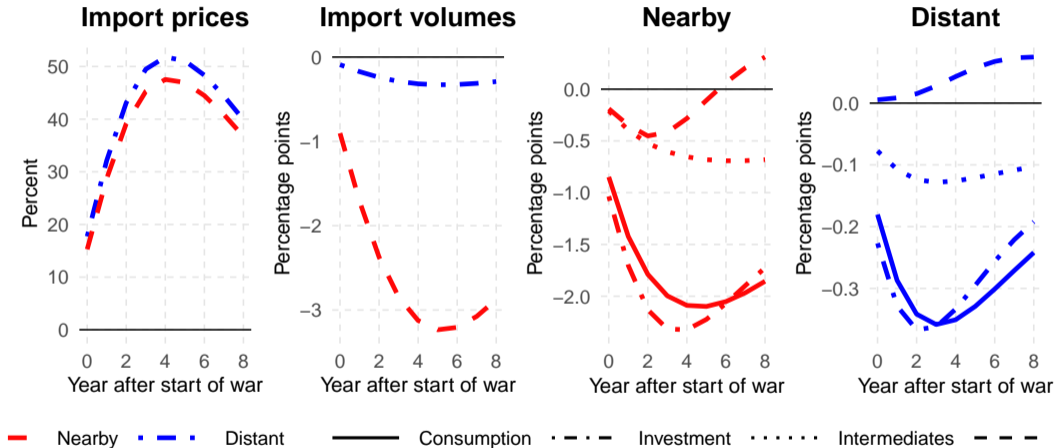
Implications of calibrated model—More external validation
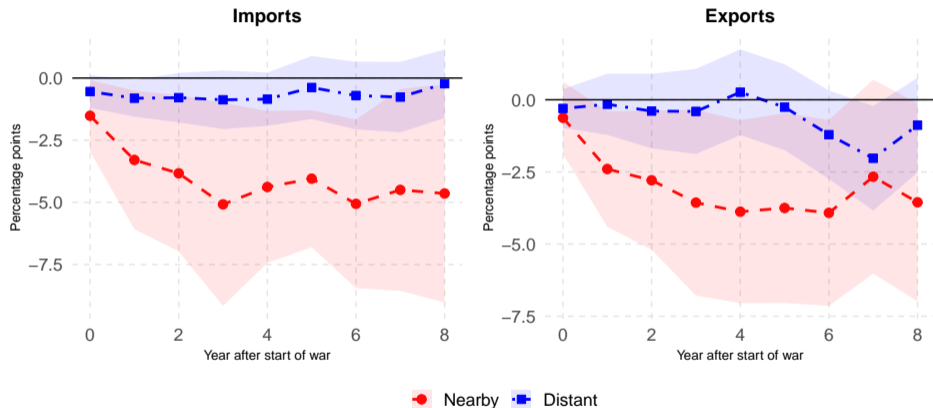
Decomposing the macroeconomic impact of war

Average annual effect (year 0 to 8) on . . .

Output / **Inflation**

★ Total   Monetary accommodation   Military expenditures   Productivity decline   Capital destruction
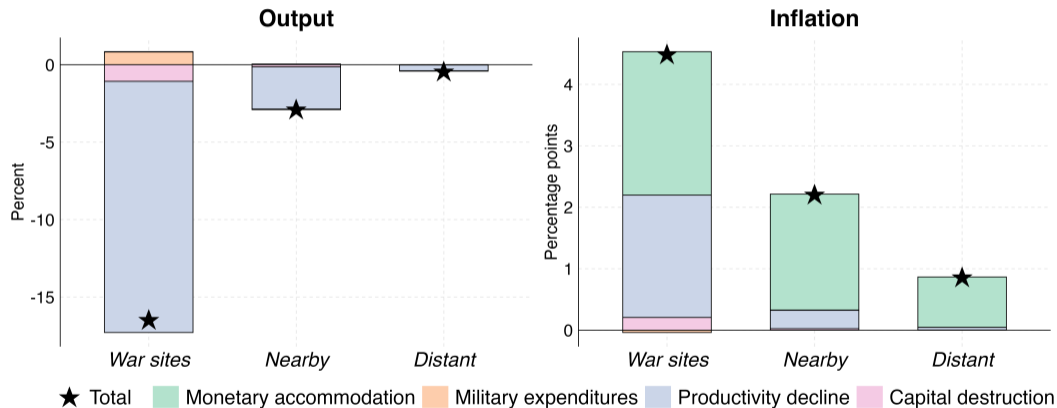
Conclusion

Macroeconomic impact of war
- Large adverse effects in <u>war site</u>
- Yet <u>nearby countries</u> pay substantial price too, even if not party to war

Mechanism / policy
- adverse <u>supply shock dominates</u> in war site and Nearby as trade falters: effect <u>declines with distance</u>
- for belligerents: might be (partly) offset by increased military spending
- Monetary policy (in Nearby): difficult trade-off for stabilization policy

Appendix

Distance of war sites almost uniformly distributed in sample

Cumulative distribution function of
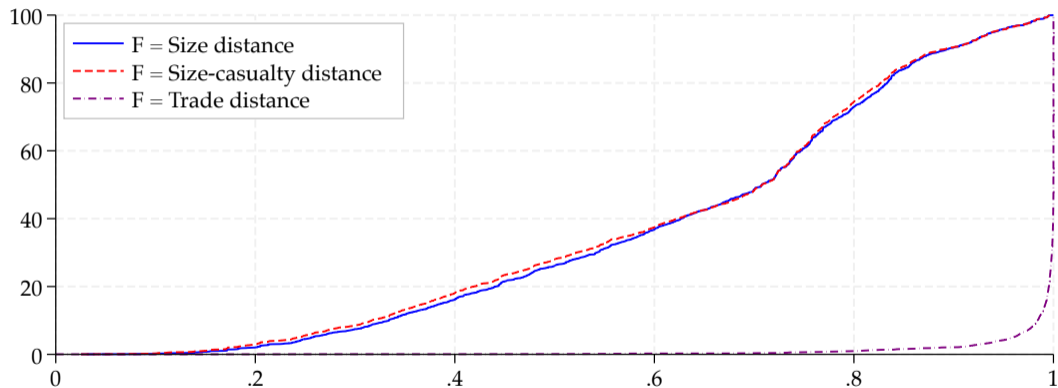
Longer horizons: effects very persistent

Output — War sites, Third countries

Inflation — War sites, Third countries

Nearby, Distant

Sample w/o US

Output

Inflation
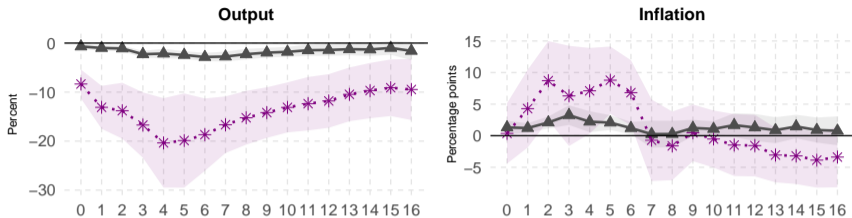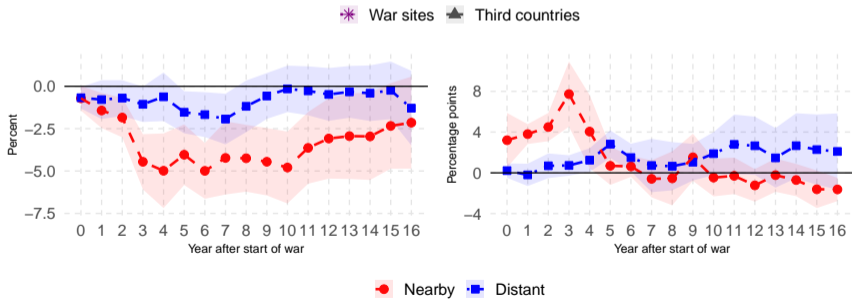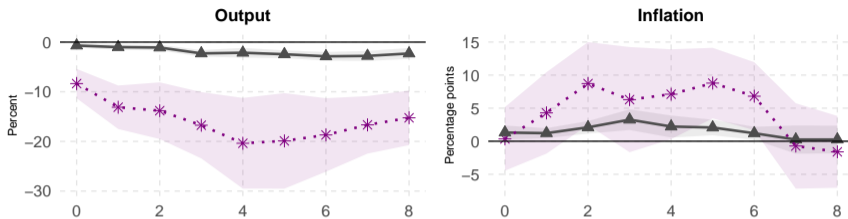
* War sites ▲ Third countries
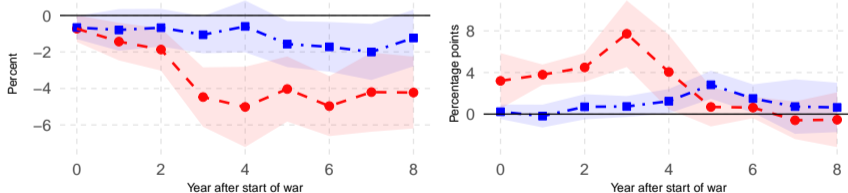
● Nearby ■ Distant

Alternative start years

Output

Inflation
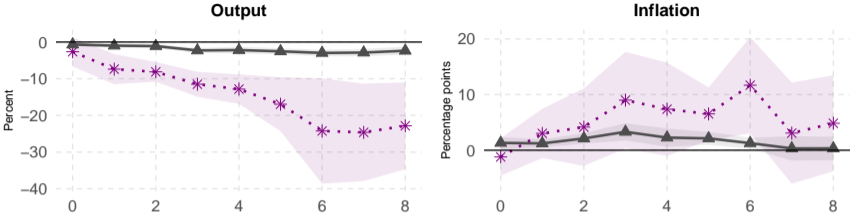
War sites · Third countries
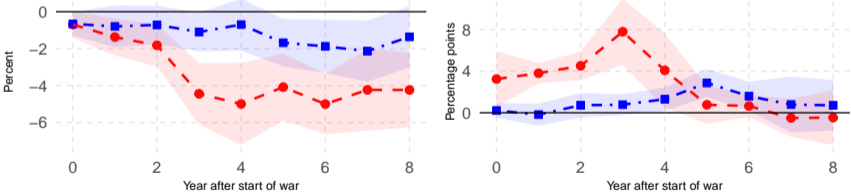
Nearby · Distant

Short wars (duration $\leq$ 2 years)

Output

Inflation
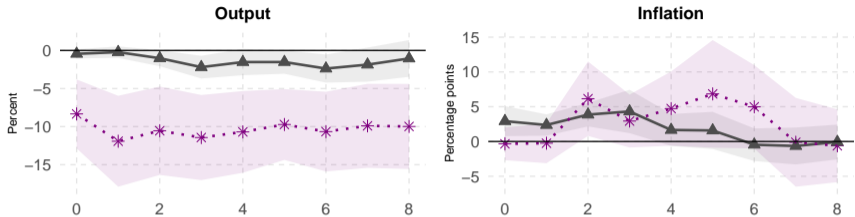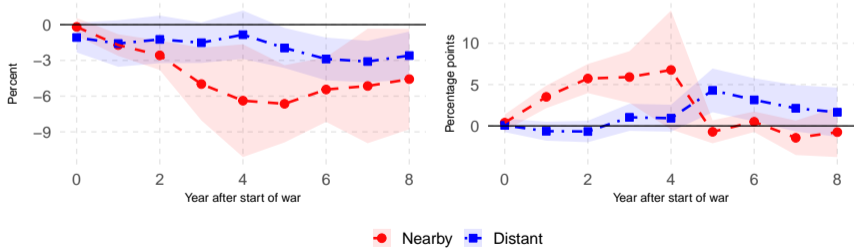
✳ War sites ▲ Third countries
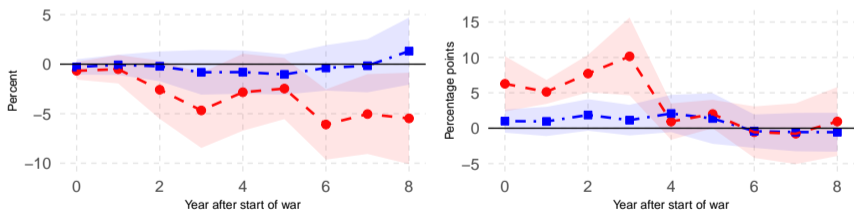
🔴 Nearby 🟦 Distant

Long wars (duration > 2 years)

Output

Inflation

* War sites ▲ Third countries
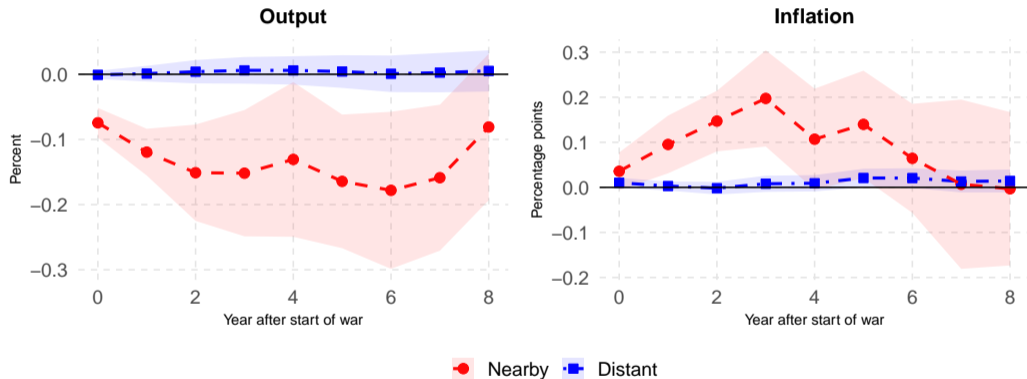
● Nearby ■ Distant
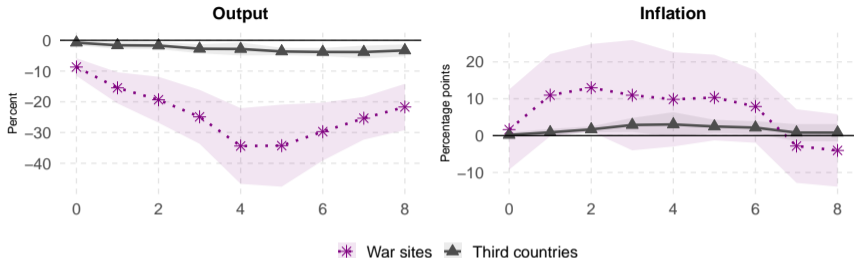
Casualty specification

Site$_{i,t}$ = 0.03 (casualties amount to 3% of population in war site) and *Third*$_{i,t}$ = 0.03 * 0.05
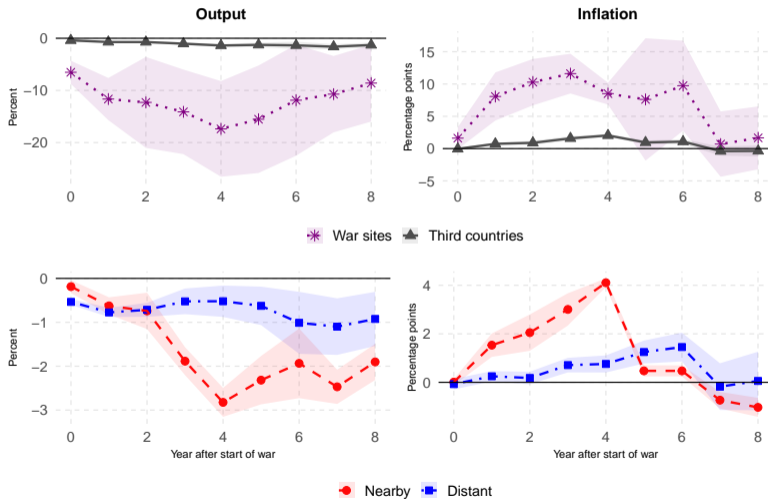
Spillovers from foreign war depend on import share

Point estimates and 90% confidence bounds based on Driscoll-Kraay SE