The Macroeconomic Effects of Global Supply Chain Shocks

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Motivation

- **Sea trade** is the central hub of the global economy
  - **90%** of **traded goods** move by sea
- **Interplay** of **key players** and **key points**
  - **Top 3 carriers** 70% global market share
  - **Suez Canal** 30% container traffic
  - **3 largest Chinese ports** 15% container traffic
- **Quantify** the effect of **localized shocks** on business cycles

This Paper

- **Novel measure** of global supply chain shocks
  - **Narrative analysis** of **price surcharges** top 3 shipping companies
  - **Cross-checking** with port authorities, local news, etc...

- **54 exogenous disruptions** around the major trade routes **from 2014 to 2024**
  - groundings, cranes breaking down, earthquakes, piracy, strikes, etc...

- **Instrument** to study the **causal effects** of global supply chain shocks on the **US economy**

Key Drivers of Business Cycle Fluctuations

- **Negative shocks** generate **stagflationary effects** in the aggregate
  - **Consumer prices** persistently rise
  - Lower **industrial production** and higher **unemployment**
- They account for a **sizable share** of **variability** over the business cycle:
  - **30%** for consumer prices
  - **25%** for industrial production, **10%** for unemployment
- **Stagflationary effects** across **all sectors**
  - **Magnitudes** proportional to **% of inputs sourced abroad**
  - **Spillovers** extend to **non-tradables**
- **Key role** in the **Post-Pandemic** dynamic
  - They accounted for up to **45%** of the **post-pandemic inflation**
  - Counterfactual: **economic recovery** would have taken **18 months longer**

Related Literature

- **Network Theory and Sectoral Shock Propagation**

  Gabaix (2011); Acemoglu et al. (2012); Acemoglu and Tahbaz-Salehi (2020, 2025); Elliott, Golub and Leduc (2022); Elliott and Golub(2022); Guerrieri et al. (2022)

  - **Confirm theory prediction**: shocks to shipping key drivers of business cycle fluctuations

- **Empirical Evidence on Macro Effects of Supply Chain Shocks**

  Benigno et al. (2022); Bai et al. (2024); Finck and Tillmann (2022); Gordon and Clark (2023); De Santis (2024); Ascari, Bonam and Smadu (2024) Känzig and Raghavan (2026); Boehm, Flaaen and Pandalai-Nayar (2019); Carvalho et al. (2021); Carrière-Swallow et al. (2023)

  - **New empirical evidence** solving important **endogeneity concern**

- **Post-Pandemic Inflation Debate**

  Hobijn and Sahin (2022); Comin, Johnson and Jones (2023); Shapiro (2024); Rubbo (2024); Caldara, Iacoviello and Yu (2025); Di Giovanni et al. (2022); Cochrane (2022); Di Giovanni et al. (2023a,b); Jordà and Nechio (2023); and Faria-e Castro (2024); Giannone and Primiceri (2024); Hazell and Hobler (2024); Garcia Revelo, Levieuge and Sahuc (Forthcoming); Bergholt et al. (Forthcoming)

  - These shocks were **key contributors** of the **post-pandemic inflation**

Identification Strategy

Identification

- **Endogeneity**: delivery times, port congestions determined by **global demand** and **supply**.
- Top 3 shipping companies published 7000+ **price surcharge** announcements (2014-2024)
- Step 1: **keyword algorithm** to isolate **supply-side** narrative (369 survived)
- Step 2: **narrative analysis** with **cross-validation** against independent **sources** (54 events)
  - Trans-Pacific, East-West and Trans-Atlantic corridors
  - Ports with annual throughput above 250,000 FEUs

Price Surcharge

08 January 2024 - Update 02

As we have been communicating since mid-December/23, Maersk is continuing monitoring developments around the Red Sea / Gulf of Aden and making carefully considered changes to services to ensure the safety of our seafarers, vessels and customers' cargo.

The situation is constantly evolving and remains highly volatile, and all available intelligence at hand confirms that the security risk continues to be at a significantly elevated level. We have therefore decided that all Maersk vessels due to transit the Red Sea / Gulf of Aden will be diverted south around the Cape of Good Hope for the foreseeable future.

By suspending voyages through the Red Sea / Gulf of Aden, we hope to bring our customers more consistency and predictability despite the associated delays that come with the re-routing.

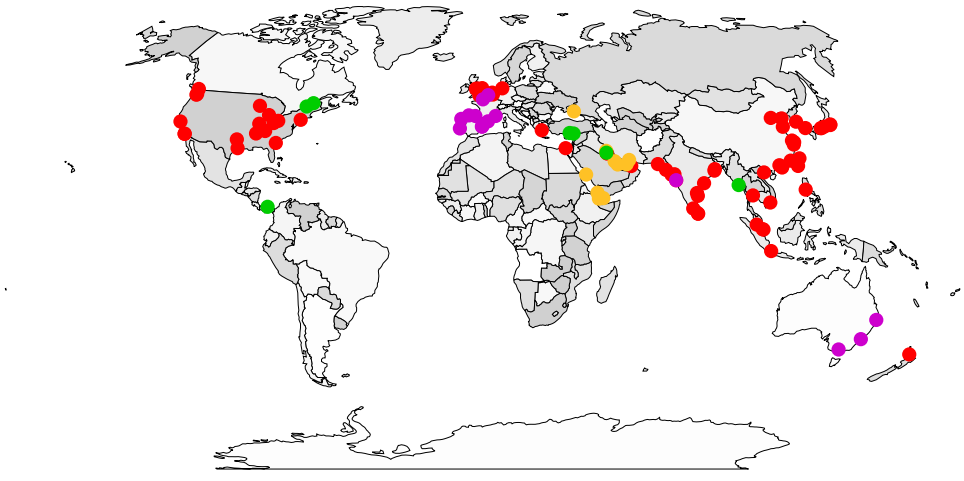
The previously announced surcharges for all cargo on vessels affected by the disruptions around the Red Sea / Gulf of Aden remain in effect:

Transit Disruption Surcharge (TDS) effective as from actual sailing date 10/01/2024 until further notice.

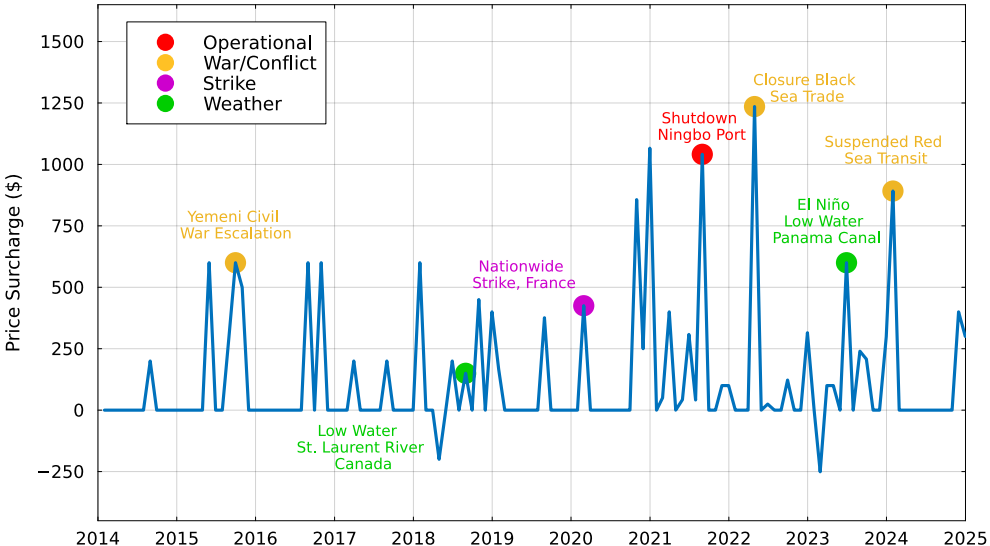
To give you as much clarity and predictability as possible, TDS will apply only to bookings confirmed as from 21/12/2023 (global announcement date) and departure date as from 10/01/2024 onwards.

TDS - USD per container	20DRY	40DRY	40HREF
All shipments diverted from Suez	200	400	450

Mapping Disruption Events



FEU Price Surcharge Series



Econometric Framework

- **Proxy-SVAR** with price surcharges as **instrument** (Z_t), for the true unobserved shock (u_{1t})
  - **Relevance**: $E[Z_t u_{1t}] = \alpha \neq 0$
  - **Exogeneity**: $E[Z_t \boldsymbol{u}_{2:nt}] = \mathbf{0}$
  - **Invertibility**: $\boldsymbol{u}_t \in \text{span}(\boldsymbol{y}_\tau, -\infty < \tau \leq t)$ ▸ Invertibility Test

- Instrument has **desirable properties** (Ramey, 2016)
  - **No serial correlation** ▸ Ljung-Box test
  - **No forecastability** by other macroeconomic variables ▸ Correlation Test
  - **Uncorrelated** with other measures of structural shocks ▸ Granger Causality

- **Estimation sample** 1998-2024, **COVID-19** as a regime with scaled-up variance. (Lenza and Primicieri, 2022)

Results

The Causal Effects of Global Supply Chain Shocks

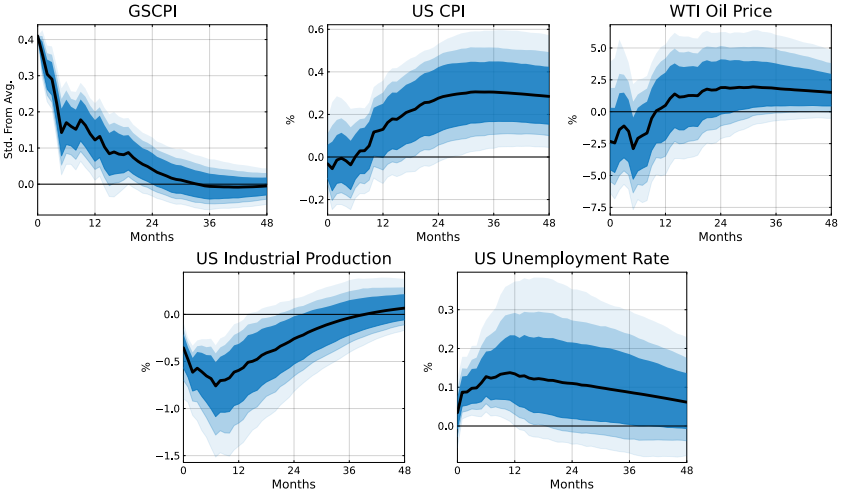
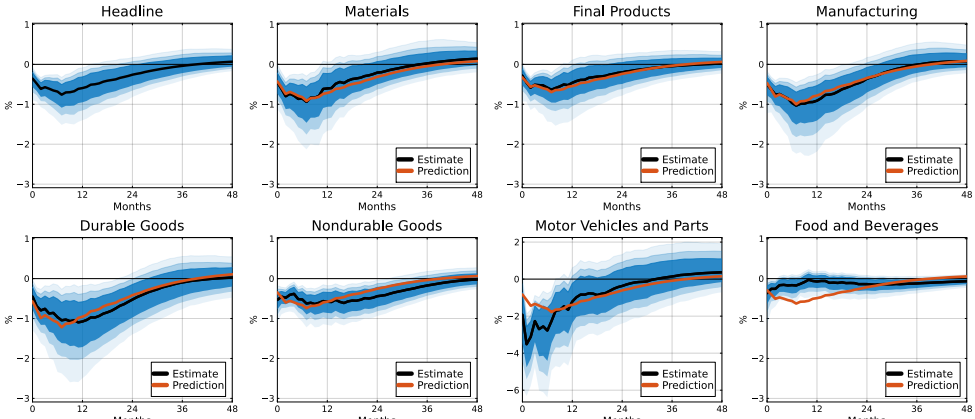


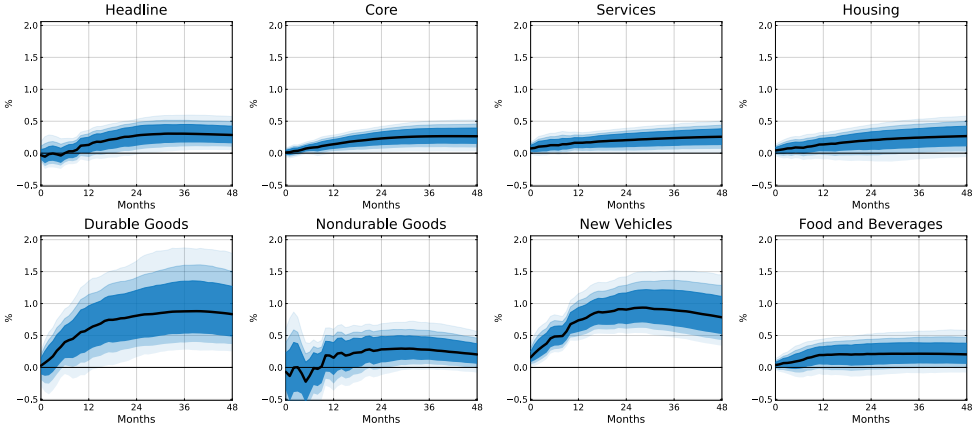
Figure: Impulse Responses to a **global supply chain shock** of **$1,066** with 68, 80, and 90 CBs.
First stage: het-robust F: 12.40, R^2 : 9.70%, Adjusted R^2 : 8.97%.
Robustness: ▸ LP vs. VAR ▸ Excluding Events ▸ Indicator IV ▸ Inv. Robust IRF ▸ Additional Controls ▸ Lag order

Industrial Production: Sectors with More Imports Are More Affected



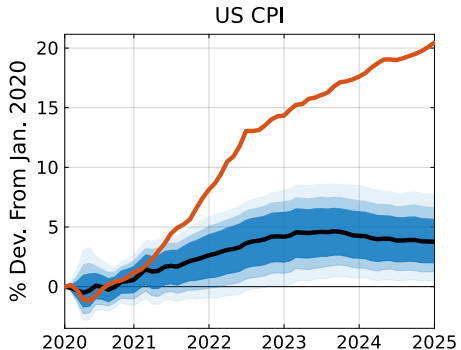
- **Prediction** (orange): $\widehat{IRF}_{i,t} = \widehat{IRF}_{headline,t} \times (LT_i / LT_{headline})$, where LT_i is the **look-through exposure** to the supply chain.

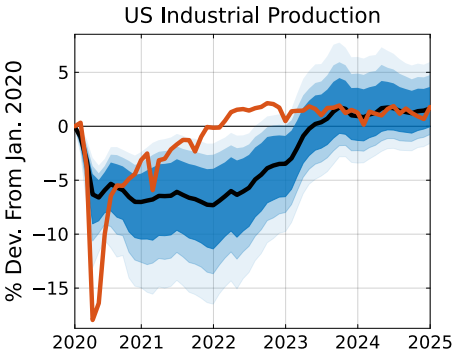
Larger Output Reduction Larger Pass-through to Prices



Key Role in Post-Pandemic Dynamic

Figure: **Historical contribution** of global supply chain shocks to **Consumer Prices** and **Industrial Production** in percentage deviation from the **pre-pandemic level** (January 2020), shaded areas are 68, 80, and 90 percent confidence bands, in orange the actual realization.





Conclusion

Conclusion

- **New identification strategy** to study the macro effects of **global supply chain shocks**
- **Key drivers** of business cycle fluctuations
  - Broad **stagflationary effects**, both aggregate and sectoral level
  - Sectoral responses depend on % input outsourced from abroad
- **New insights** into their contribution to **pandemic-era inflation** and **economic recovery**.

Appendix

Autocorrelation Instrument

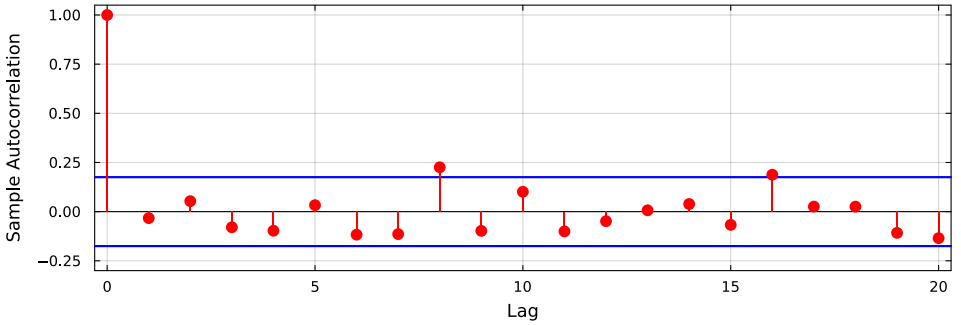


Figure: Autocorrelation function of the FEU price surcharge series. The p-value for the Ljung–Box Q-statistic testing whether all autocorrelations up to lag 20 are jointly zero is 0.39.

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Forecastability by Other Macroeconomic Indicators

Table: Granger Causality Tests

Series	Source	Transf	p-value	F-stat	df1	df2	Sample
World Oil Production	Baumeister and Hamilton (2019)	MoM	0.76	0.27	2	98	2014M8-2024M12
US Consumer Price Index	Haver Analytics	MoM	0.56	0.58	2	98	2014M8-2024M12
US Terms of Trade	Haver Analytics	Level	0.32	1.16	2	98	2014M8-2024M12
WTI Oil Price	Haver Analytics	MoM	0.72	0.33	2	98	2014M8-2024M12
US Industrial Production	Haver Analytics	MoM	0.74	0.30	2	98	2014M8-2024M12
US Unemployment Rate	Haver Analytics	Level	0.53	0.63	2	98	2014M8-2024M12
GSCPI	Benigno et al. (2022)	Level	0.43	0.85	2	98	2014M8-2024M12
World Uncertainty Index	Ahir et al. (2022)	Level	0.79	0.24	2	98	2014M8-2024M12
US Trade Policy Uncertainty Index	Baker et al. (2016)	Level	0.43	0.86	2	98	2014M8-2024M12
World Sentiment Index	Ahir et al. (2022)	Level	0.54	0.62	2	98	2014M8-2024M12
S&P500	Haver Analytics	MoM	0.66	0.42	2	98	2014M8-2024M12
Geopolitical Risk Index	Caldara and Iacovello (2022)	Level	0.78	0.25	2	98	2014M8-2024M12
Global Economic Condition	Baumeister et al. (2022)	Level	0.78	0.25	2	98	2014M8-2024M12
Oil Price Expectations 3Months	Baumeister et al. (2023)	Level	0.77	0.26	2	78	2014M8-2023M4
US - China Tension Index	Rogers et al. (2024)	Level	0.61	0.50	2	89	2014M8-2024M3
Federal Funds Rate	FRED	Level	0.62	0.47	2	98	2014M8-2024M12
Joint	–	–	0.29	1.18	32	48	2014M8-2023M4

Note: The table shows the results of a series of Granger Causality tests of the FEU price surcharge series using a selection of macroeconomic variables. The series are made stationary when necessary by taking the MoM growth rate. The tests are conducted by regressing the shock on its own 12 lags, 2 lags of the other variable and a constant. The test is on the joint significance of the lags of the additional variable. The last row (*Joint*) reports the test where the unrestricted model includes 2 lags of all variables simultaneously, and the null is that all the additional lags are jointly zero. * p<0.05, ** p<0.01, *** p<0.001.

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Correlation Other Structural Shocks

Table: Correlation Test

Series	Source	ρ	p-value	t-stat	df	Sample
Oil News Shock	Kanzig (2021)	-0.05	0.62	-0.50	123	2014M8-2024M12
Carbon News Shock	Kanzig (2023)	0.11	0.37	0.91	63	2014M8-2019M12
Oil Supply Shock	Baumeister and Hamilton (2019)	-0.03	0.72	-0.36	123	2014M8-2024M12
Economic Activity Shock	Baumeister and Hamilton (2019)	0.02	0.86	0.18	123	2014M8-2024M12
Oil Consumption Demand Shock	Baumeister and Hamilton (2019)	-0.14	0.12	-1.56	123	2014M8-2024M12
Oil Inventory Demand Shock	Baumeister and Hamilton (2019)	0.01	0.91	0.12	123	2014M8-2024M12
Monetary Policy Shock	and Swanson (2023)	-0.05	0.61	-0.51	111	2014M8-2023M12

Note: The table shows the correlation of the FEU price surcharge series with a wide range of structural shocks from the literature. ρ is the Pearson correlation coefficient, the p-value corresponds to the test whether the correlation is different from zero, t-stat is the corresponding test statistic, df are the degrees of freedom. * p<0.05, ** p<0.01, *** p<0.001.

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Testing the Invertibility Assumption

Table: Invertibility Test

Lags	US CPI	WTI Oil Price	US Ind Prod	US Unemployment	GSCPI
6	0.12	0.41	0.96	0.69	0.80
7	0.17	0.15	0.96	0.74	0.88
8	0.17	0.16	0.98	0.79	0.74
9	0.18	0.19	0.99	0.86	0.58
10	0.24	0.24	0.95	0.84	0.36
11	0.32	0.30	0.92	0.89	0.40
12	0.30	0.27	0.95	0.93	0.49

Joint: 12 lags p-value = 0.99 F-stat = 0.54 $df_1 = 60$ $df_2 = 200$

Note: The first panel shows the p-values of a series of F-test that the coefficients $\alpha_1, \ldots, \alpha_m$ are zero in the regression $y_{it} = \pi_i' \mathbf{x}_{t-1} + \alpha_1 z_{t-1} + \cdots + \alpha_m z_{t-m} + \eta_{it}$. The test is conducted for each series included in the baseline VAR model, for different numbers of lags of the instrument. The lag order of the VAR is set to 12 and in terms of deterministics, only a constant is included. The second panel shows the joint system test across all i that lags of z do not appear in any of the equations. * p<0.05, ** p<0.01, *** p<0.001.

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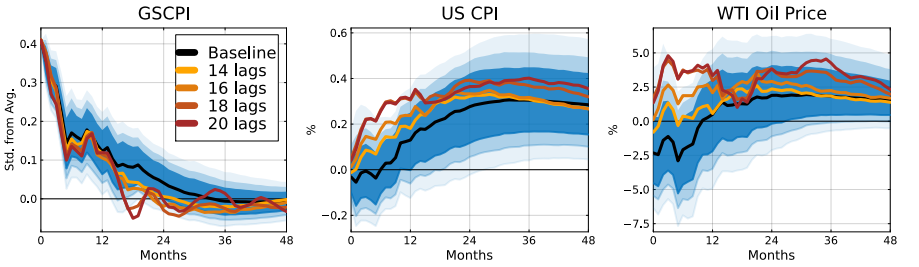
Robustness to Lag Order



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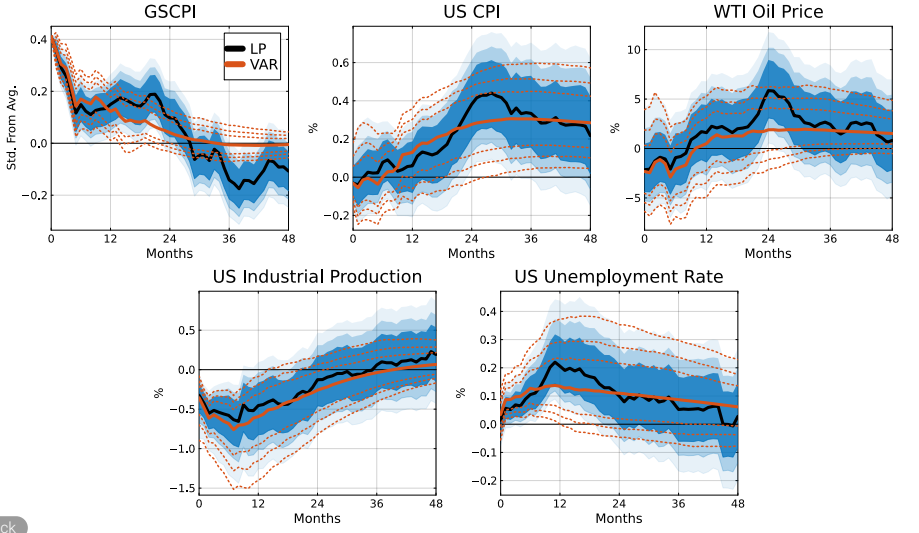
VAR vs. Local Projections



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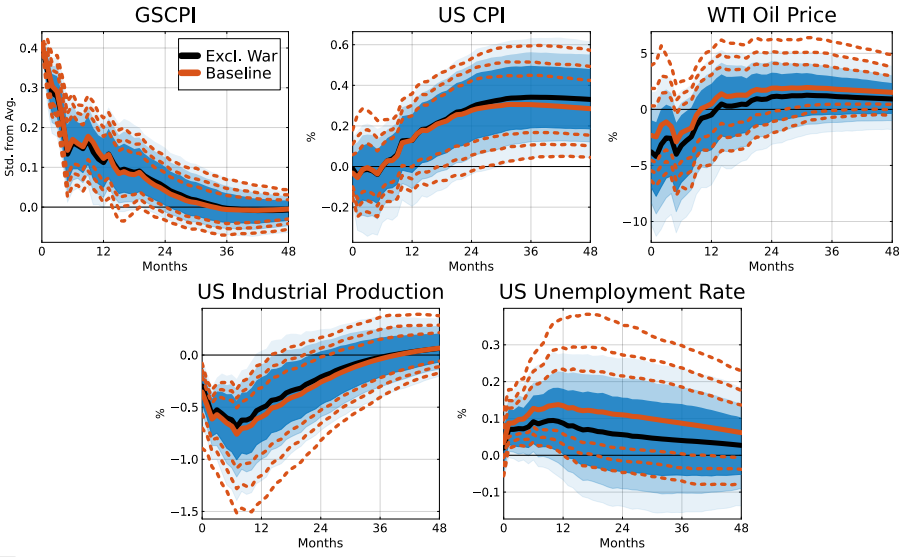
Excluding War-Related Disruptions



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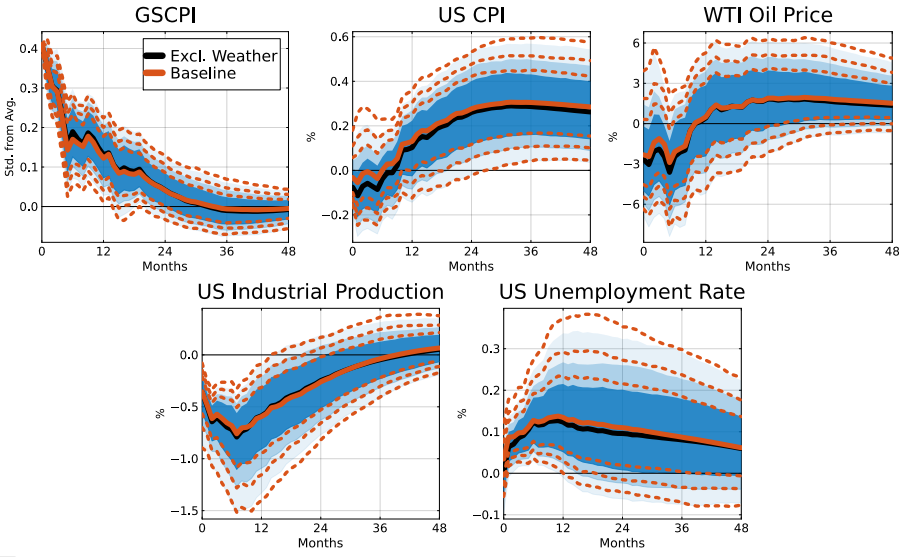
Excluding Weather-Related Disruptions



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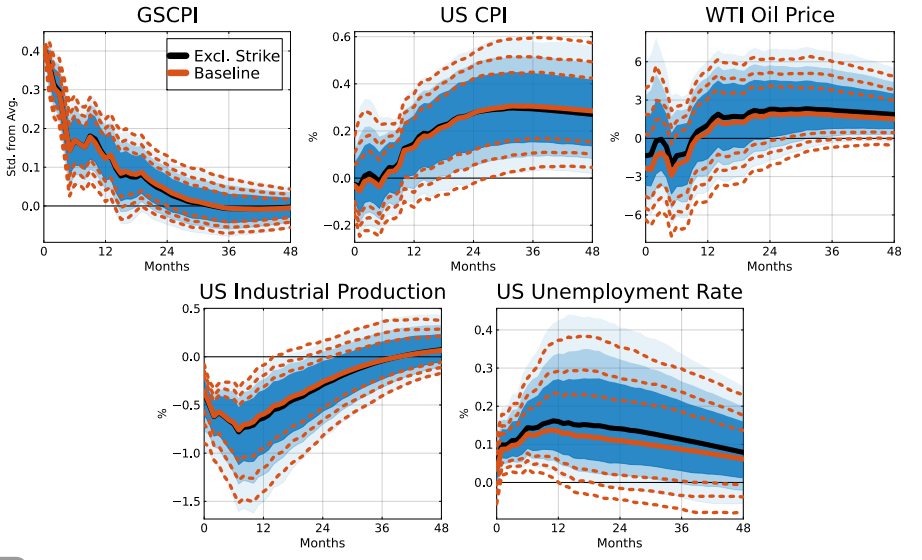
Excluding Strike-Related Disruptions



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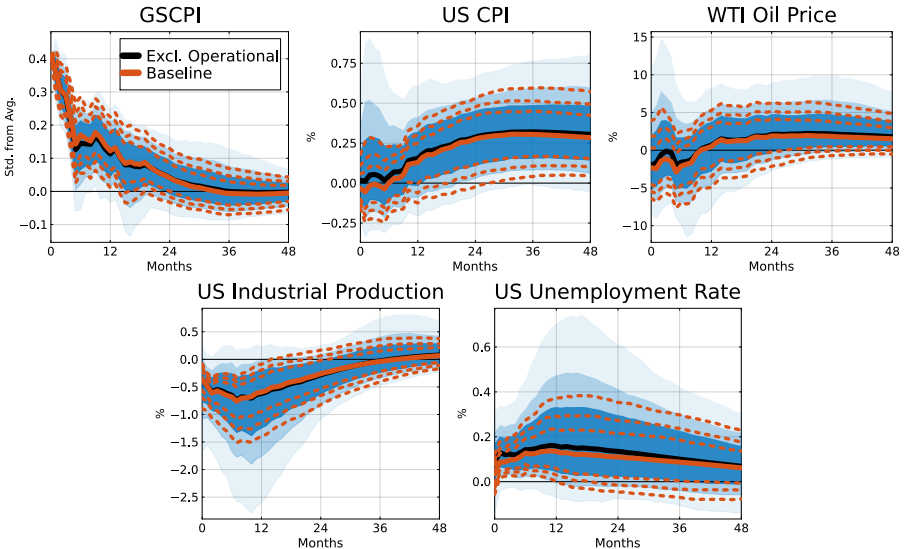
Excluding Operational Failures



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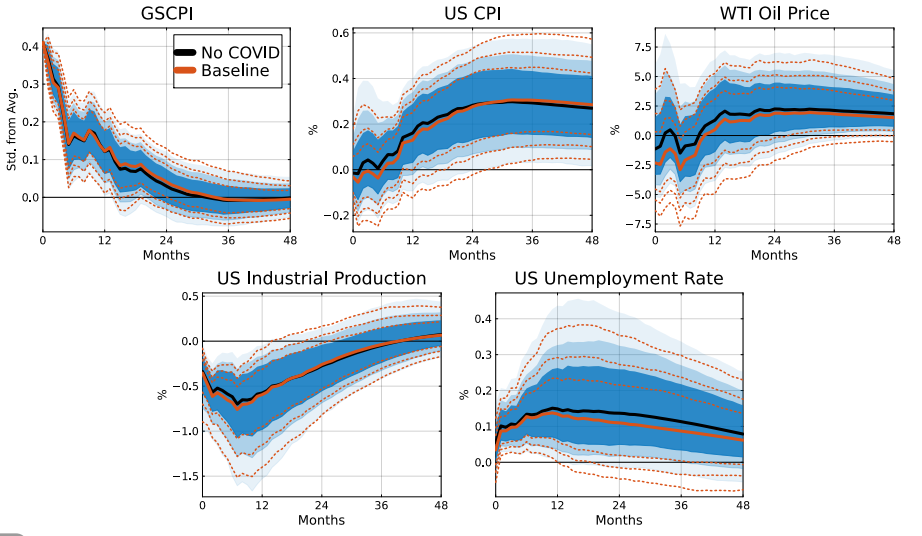
Excluding COVID-Related Disruptions



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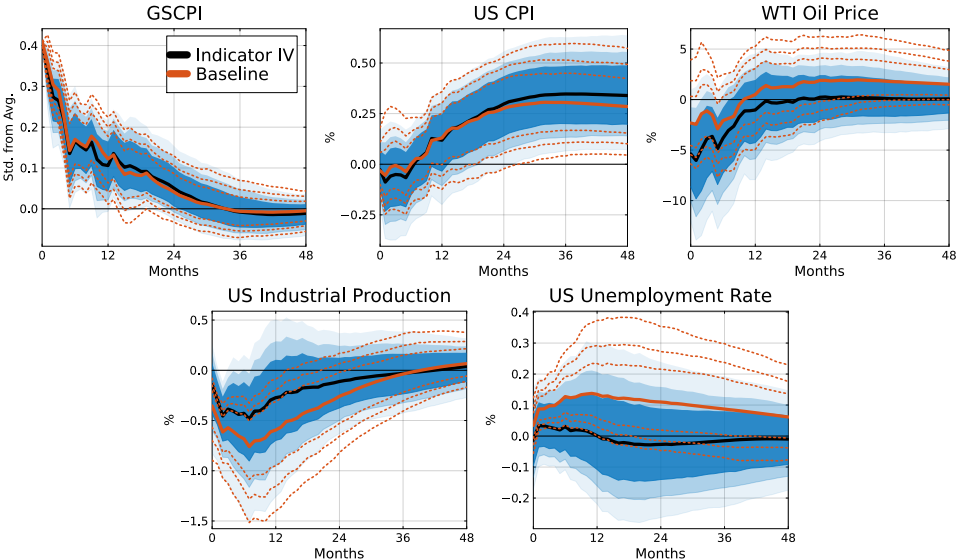
Indicator IV



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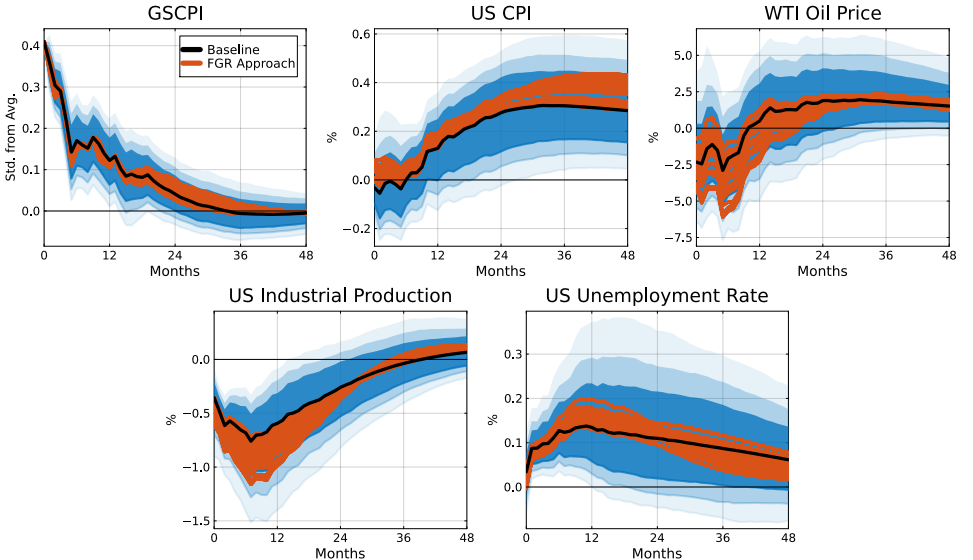
Invertibility Robust IRF - Forni, Gambetti, Ricco (2022)



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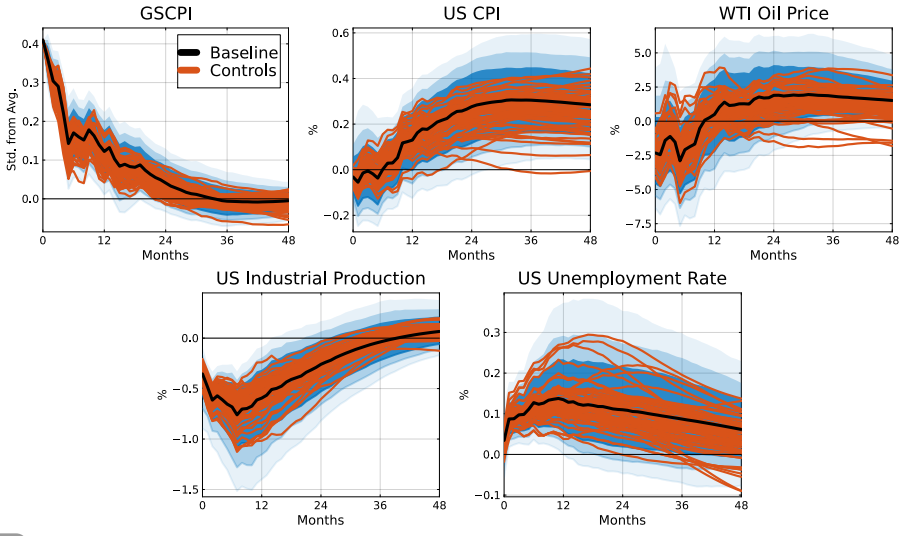
Additional Control Variables



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