The Macroeconomic Effects of Supply Chain Shocks: Evidence from Global Shipping Disruptions

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July 2025

Motivation

Introduction

- Supply chains have become increasingly interconnected over the last decades
- Recent events highlight fragility of global supply chains
  - Covid pandemic, Russia's invasion of Ukraine, extreme weather events, tariffs ...
- Supply chain disruptions pose significant risks to the global economy
  - Profound macro consequences, affecting output, inflation, and employment
- Better understanding crucial to inform policy responses

This Paper

- New evidence on **causal effects** of supply chain disruptions on macroeconomy
- Leverage structure of **global supply chains** and **high-frequency** data
  - Global supply chains critically rely on maritime trade, which depend on choke points

    Key choke points: Panama Canal & Suez Canal
  - **Narrative record** of disruptive events at choke points that are exogenous to economic activity

    Examples: Groundings, collisions, or extreme weather events
  - Isolate market impact by change in shipping rates in **narrow window** around event
- Use as instrument to estimate dynamic effects of a **supply chain shock**

Preview of Results

- Adverse supply chain shocks have significant global effects:
  - **Shipping rates increase** significantly and persistently

    Disruptions slow transit, reduce capacity, create bottlenecks, rippling through supply chains
  - Passes through **commodity prices** with some lag
  - In response to scarcity, **global shipping capacity** increases sluggishly
- No effects on geopolitical risk, only sluggish increase in oil prices
- Macroeconomic consequences for the United States:
  - Longer **delivery times** & **shortages** of materials, goods, and energy
  - **Industrial production** falls, **consumer prices** increase
  - Significant **depreciation** of the dollar
  - Stark heterogeneity, strongest effects in energy- & material-intensive manufacturing

Related Literature

- **Empirical evidence on macro and sectoral impacts of supply chain shocks**

  Carvalho et al. (2021); Jacks and Stuermer (2021); Benigno et al. (2022); Carrière-Swallow et al. (2023); Bai et al. (2024); Caldara, Iacoviello, and Yu (2024); Fernández-Villaverde, Mineyama, and Song (2024); Bai et al. (2025); Blaum, Esposito, and Heise (2023); Castro-Vincenzi et al. (2024); …

  - New evidence pointing to large macroeconomic effects of supply chain disruptions

- **Production networks and supply chain propagation**

  Baqaee and Farhi (2019); Acemoglu, Akcigit, and Kerr (2016); Carvalho and Tahbaz-Salehi (2019); Bigio and La'o (2020); Rubbo (2023); Alessandria et al. (2023); Acemoglu and Tahbaz-Salehi (2024); Comin, Johnson, and Jones (2023); Afrouzi and Bhattarai (2023); Minton and Wheaton (2023); …

  - Inform key parameters such as elasticities of substitution

- **Methodology: High-frequency identification**

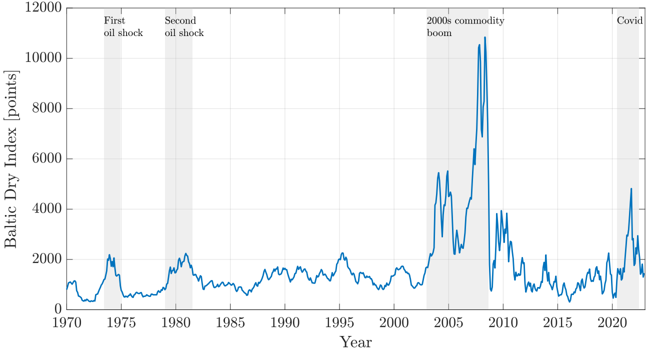
  Kuttner (2001); Gürkaynak, Sack, and Swanson (2005); Gertler and Karadi (2015); Nakamura and Steinsson (2018); Känzig (2021, 2023)

  - Ported to supply chain context for credible identification under weak structural assumptions

Identification Strategy

Identifying Supply Chain Disruptions

- Maritime trade is the backbone of global commerce ($>$80% of global trade)
- Shipping costs offer a **real-time barometer** of supply chain stress



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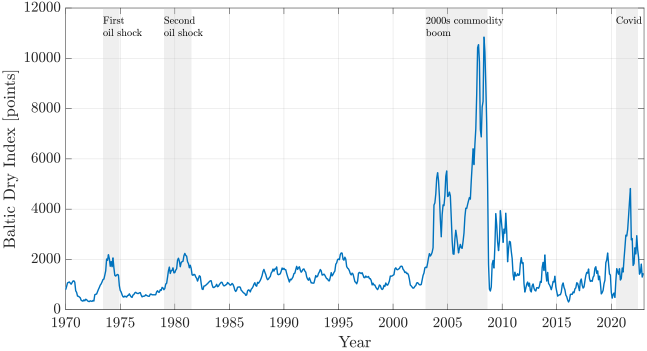
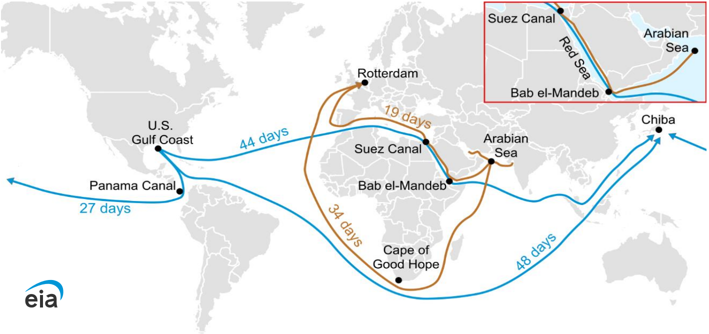


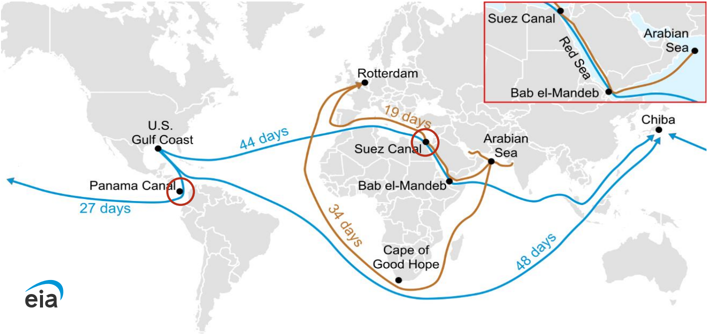
- Shipping rates reflect both demand and supply forces
- How can we isolate **exogenous supply chain disruptions**?

Choke Points in Global Supply Chains



- Global trade routes are reliant on maritime choke points
  - Narrow waterways with high traffic and few viable alternate routes

Choke Points in Global Supply Chains



- Global trade routes are reliant on maritime choke points
  - Narrow waterways with high traffic and few viable alternate routes
- Most critical choke points: **Suez Canal** and **Panama Canal**

Suez Canal

- Sea-level waterway in Egypt connecting Mediterranean Sea and Red Sea through the Gulf of Suez
  - Shortest sea trade route between Europe and Asia
  - Over 15% of global maritime trade passes through it
- Narrow, constrained passage makes it **prone to disruptions**
  - Examples: Vessel groundings and collisions, fires, piracy, adverse weather conditions
- Given **central role** in global shipping markets, widely reported by news agencies

Suez Canal

Excerpt of a news article discussing a grounding on November 8, 2004:

> *"Egypt's **Suez Canal** has been **blocked by a broken-down oil tanker** and could stay shut for another two days, the most serious closure of the strategic waterway for almost 30 years, shipping sources said.*
>
> *Navigation came to a standstill late on Saturday when the 154,000 deadweight-tonne Liberian-flagged vessel Tropic Brilliance, carrying a cargo of crude, **ran aground** while passing through the canal. […]*
>
> *Shipping sources expected traffic to be disrupted until Wednesday at least."*
>
> — *Reuters (2004)*

Panama Canal

- Waterway in Panama connecting Atlantic Ocean and Pacific Ocean
  - Shortest sea trade route between the oceans
  - Accounts for 46% of maritime trade between Northeast Asia and the U.S. East Coast
- Narrow passage, along with reliance on freshwater, makes it **prone to disruptions**
  - Examples: Adverse weather conditions, fires, vessel groundings and collisions
  - In adverse weather, traffic subject to **transit and draft restrictions** that limit number and capacity of vessels

Panama Canal

Excerpt of a news article discussing a draft restriction on August 7, 2015:

> *"The **Panama Canal Authority** will temporarily lower the maximum draft of ships passing through the canal, due to **droughts caused by El Nino**, authorities said on Friday.*
>
> *Starting on Sept. 8, the greatest draft allowed will be 39 feet, down from the current maximum of 39.5 feet, the Panama Canal Authority (ACP) said.*
>
> *The change could affect about 20 percent of ships that use this route, ACP records show."*
>
> — *Reuters (2015)*

Narrative Account of Shipping Disruptions

Disruptive Events at Choke Points

Panama Canal		Suez Canal	
Event Type	Number	Event Type	Number
Grounding	1	Grounding	57
Collision	1	Collision	8
Fire	1	Fire	5
El Nino/Rainfall	30	Weather	9
Landslide/Flooding	3	Sandstorm	7
Drought	6	Piracy/Rebels	2
Other	3	Other	6
Total	45	Total	94

- **Comprehensive** data collection:
  - Suez Canal: News archives
  - Panama Canal: News archives + official shipping advisories
- Dataset identifies **139 events** that disrupted shipping traffic between 1970 and 2022
- Plausibly exog. to the economy
  - Exclude events related to geopolitical tensions

High-Frequency Identification

- Disruptive events along global trade routes closely **monitored by market experts**
- Reporting of these events can lead to significant **market reactions**
- **Idea:** Identify shipping cost surprise as the change in shipping rate in a tight window around disruption:

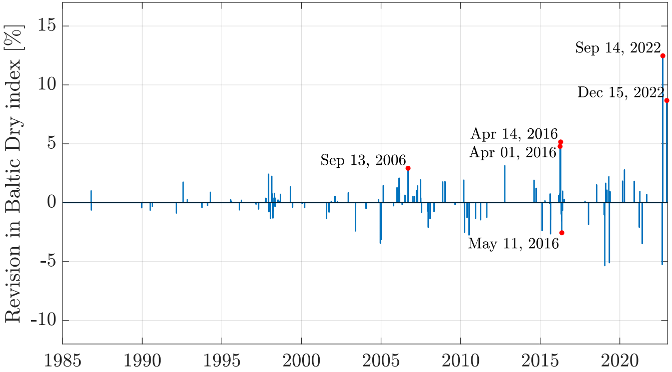
$$SCsurprise_d = \frac{P_d^{SC} - P_{d-1}^{SC}}{P_{d-1}^{SC}}$$

  - P_d^{SC} is a measure of global shipping costs
  - d indicates the date of the event

Measuring Changes in Shipping Cost

- How can we measure global shipping costs in a consistent way?
- We rely on Baltic Dry Index (BDI), a widely used **benchmark for shipping rates**
  - Composite of **timecharter rates** for major dry bulk vessels (e.g., Panamax, Supramax)
- Has **long historical coverage** (since the 1980s), available at **daily frequency**
- Covers **dry bulk**, not containerized freight
  - Raw materials and commodities, but not manufactured goods
- Still, rates are often correlated due to shared market drivers and constraints

Shipping Cost Surprise Series



- **September 13, 2006:** Egyptian dredger sank in the Suez Canal; temporary closure of the waterway
- **April 1, 2016 and April 14, 2016:** Draft restrictions implemented by the Panama Canal Authority due to El Nino-related droughts
- **May 11, 2016:** Draft restrictions postponed due to rainfall
- **September 14, 2022:** Rare overflow at the Panama Canal's Gatun Locks; temporarily blocked the west lane
- **December 15, 2022:** Fire at the Panama Canal's Miraflores locks; traffic temporarily suspended

Predictability

- Are surprises in the shipping markets **predictable**?
  - Variation in weather could be forecastable to some extent. Is it priced?

- Run **predictive regressions** à la Bauer and Swanson (2023):

$$SCsurprise_d = \alpha + \beta' X_{d-} + \eta_d$$

  - X_{d-} is a set of predictors known before the event day d

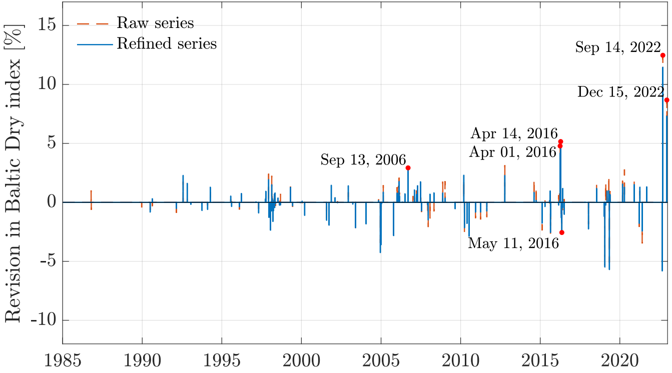
    Macro news, financial variables, commodity prices, geopolitical news, …

Predictability

Shipping cost surprise:	(a) Macro news	(b) Financials	(c) Commodities	(d) Other
IP surprise	-0.068	-0.276	-0.226	-0.225
	(0.410)	(0.364)	(0.326)	(0.332)
ISM surprise	0.152	0.169	0.216	0.216
	(0.095)	(0.107)	(0.103)	(0.103)
PPI surprise	-0.056	-0.020	0.115	0.113
	(0.534)	(0.511)	(0.563)	(0.578)
Trade balance surprise	0.076	0.099	0.104	0.104
	(0.066)	(0.073)	(0.073)	(0.073)
S&P 500 (3M log change)		-2.163	-1.036	-1.019
		(2.653)	(2.753)	(2.591)
Yield curve slope (3M change)		-0.804	-0.653	-0.652
		(0.719)	(0.774)	(0.769)
WTI price (3M log change)			0.040	0.045
			(0.777)	(0.743)
Coal price (3M log change)			-2.724	-2.731
			(2.169)	(2.105)
Geopolitical risk (3M log change)				0.000
				(0.003)
R^2	0.030	0.067	0.092	0.092
Adj. R^2	0.000	0.023	0.034	0.026

- Some predictability from ISM surprises, though R^2 is modest
- Could be weather related
- Alternatively, high ISM may:
  - Signal tight supply chains, making disruptions more binding
  - Increase the salience of a given disruption
- **Purify surprises** by removing predictability

Purified Surprise Series



- We use **purified surprises** in the analysis
- But: The series are quite similar
- Correlation is high at 0.96

Aggregation

- We are interested in outcome variables at the **monthly frequency**
- **Aggregate daily surprises:** (Lee and Sekhposyan, 2024)

$$SCsurprise_t = \sum_{k=1}^{62} \beta_k SCsurprise_{t_d - k}$$

  - t is the month and t_d indexes time at daily frequency
  - Instrument for monthly average $\rightarrow$ Use triangular weights β_k (Gertler and Karadi, 2015)
- Purge monthly surprise from serial correlation: (Miranda-Agrippino and Ricco, 2021)

$$SCsurprise_t = \phi_0 + \sum_{j=1}^{12} \phi_j SCsurprise_{t-j} + SCsurprise_t^{\perp}$$

Diagnostic Checks

- Resulting surprise series has desirable properties:
  - **Narrative account:** ✓ Accords well with accounts on key historical episodes
  - **Autocorrelation:** ✓ Purified series is not autocorrelated (Ljung-Box p-val: 0.99)
  - **Forecastability:** ✓ Purified series not forecastable by macro or financial variables
  - **Orthogonality:** ✓ Uncorrelated with other structural shocks

    (e.g. uncertainty, oil, or productivity shocks)

▸ More

Econometric Framework

- Starting point: SVMA model

$$\mathbf{y}_t = \mathbf{B}(L)\mathbf{S}\varepsilon_t,$$

  - ε_t: Mutually uncorrelated structural shocks
  - $\mathbf{S}$: Structural impact matrix
  - $\mathbf{B}(L)$: Matrix lag polynomial

- Use shipping surprises $z_t = SCsurprise_t^{\perp}$ as instrument for supply chain shock $\varepsilon_{1,t}$
- **Identifying assumptions**:

$$\mathbb{E}[z_t \varepsilon_{1,t}] = \alpha \neq 0 \qquad \text{(Relevance)}$$

$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_{2:n,t}] = \mathbf{0} \qquad \text{(Exogeneity)}$$

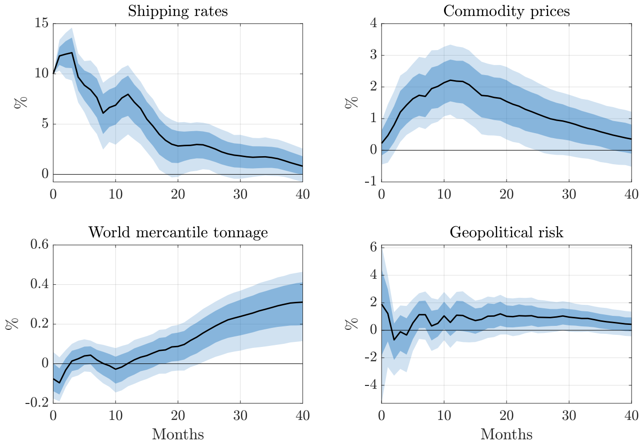
$$\varepsilon_t \in \text{span}\left(\mathbf{y}_\tau, -\infty < \tau \leq t\right) \qquad \text{(Invertibility)}$$

Econometric Framework

- **Estimation:** VAR techniques
- **Sample:** 1970 – 2022
  - Exclude Covid / exclude 1970s as robustness
- **Specification:** 8 variables ▸ Data
  - Global shipping: Shipping rates, commodity prices, mercantile tonnage, and geopolitical risk
  - U.S. economy: U.S. industrial production, consumer prices, 3M treasury yield, real effective FX rate
- **Controls:** 12 lags & linear trend

Aggregate Results

The Causal Effects of Supply Chain Shocks



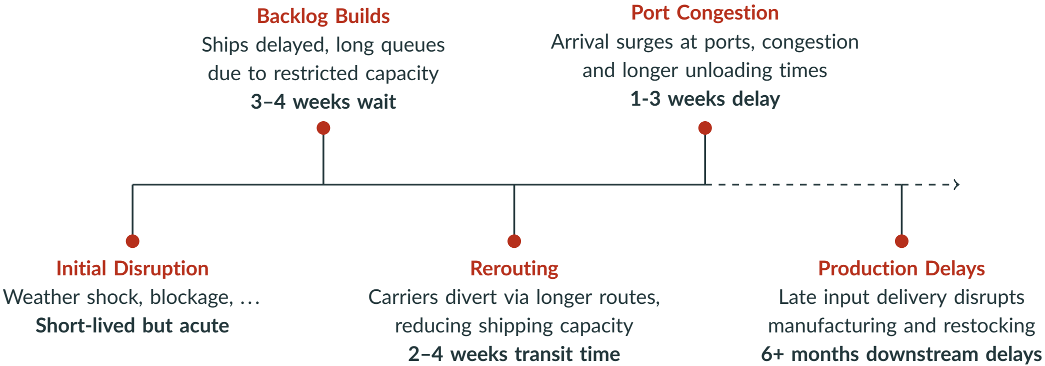
First stage: Robust F-statistic: 24.44, R^2: 4.18%, Adjusted R^2: 4.03%

Notes: Point estimate with 68% and 90% confidence bands.

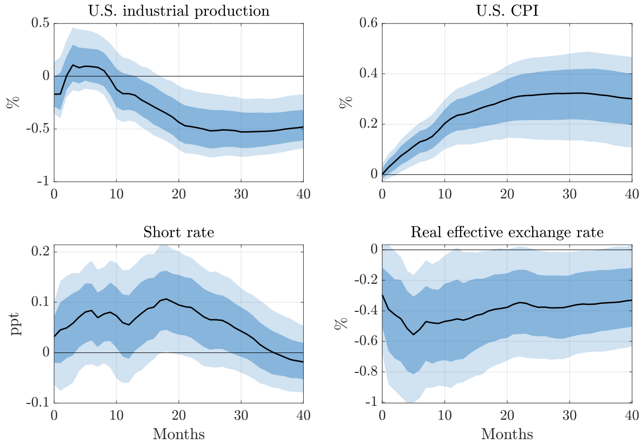
Supply chain shocks lead to:

- Persistently higher **shipping rates**
- Sluggish rise in **commodity prices**
- Slow increase in shipping capacity
- No effect on geopolitical risk

Short-Lived Disruptions, Prolonged Effects



Impact on the U.S. Economy



- U.S. **industrial production** falls sluggishly
- **Consumer prices** increase
- **Interest rates** tend to rise
- **Dollar** depreciates

Relaxing VAR Assumptions

VAR approach relies on two **potentially restrictive** assumptions:

1. **(Partial) invertibility**

   $\Rightarrow$ Assess robustness using invertibility-robust internal IV (Plagborg-Møller and Wolf, 2019)

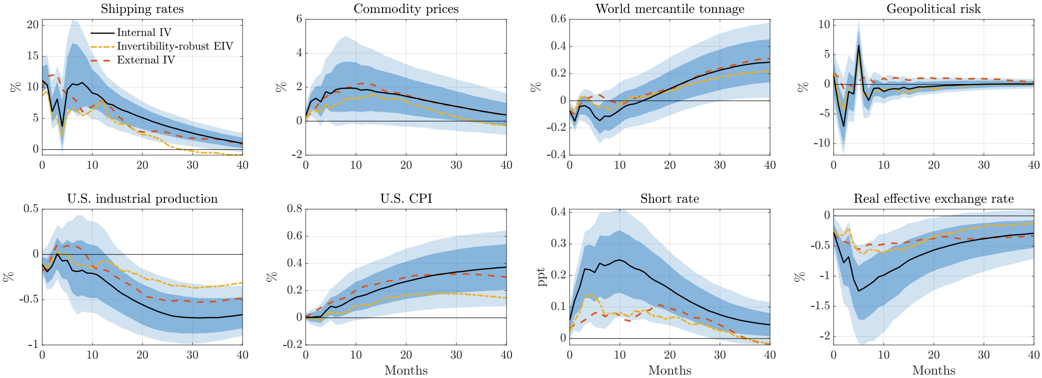
2. **Negligible lag truncation bias**

   $\Rightarrow$ Estimate dynamic responses using local projections on VAR shock

$$y_{i,t+h} = \beta^i_{h,0} + \theta^i_h \varepsilon_{1,t} + \beta^i_{h,1} y_{i,t-1} + \ldots + \beta^i_{h,p} y_{i,t-p} + \xi_{i,t,h}$$

Internal Instruments VAR

Impulse Responses to a Supply Chain Shock



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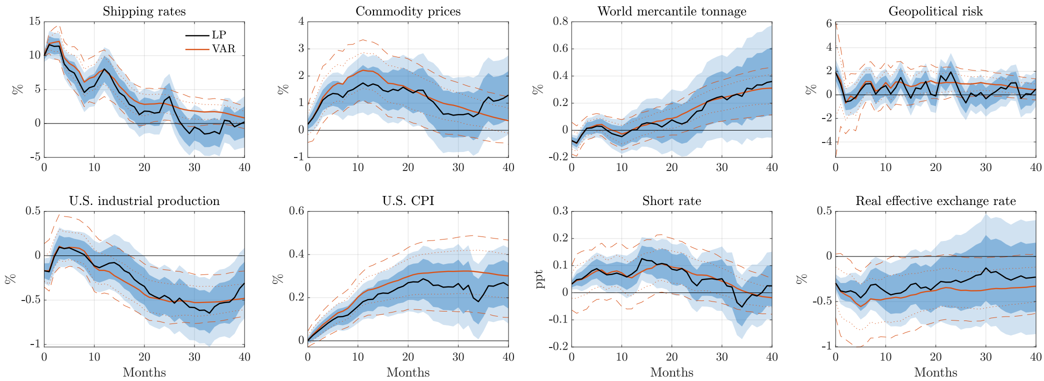
Local Projections

Impulse Responses to a Supply Chain Shock



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Identification Concerns

Additional sensitivity

1. **Collisions** may be more frequent in times of economic booms
   - Robust to excluding collisions (More)
2. Events in the Suez canal may coincide with **geopolitical news**
   - Robust to using only events in the Panama canal or events in the Suez canal (More)
3. Potential **confounders** such as big oil shocks, Russian invasion, or Great Recession
   - Results robust to excluding 1970s or Covid period / controlling for GFC dummy
   - Results not driven by any given event (More)
4. **Negative surprises** could be confounded by noise
   - Robust to keeping only positive surprises / varying event window (More)
5. Could potentially **unaccounted predictability** affect results?
   - Robust to keeping only first events which are less predictable
   - Robust to not removing predictabilty (More)

Shock Interpretation and Propagation

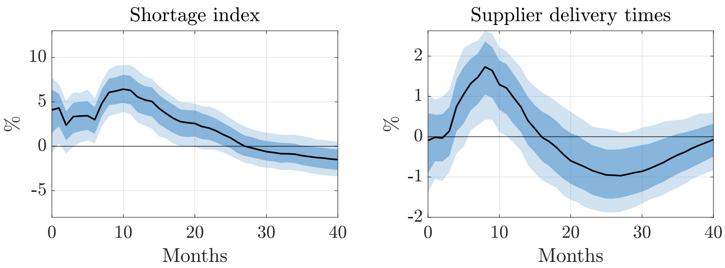
- Sharpen shock interpretation and propagation by studying **wider effects**
- **At monthly frequency:** Augment baseline VAR by one variable at a time and compute response
- **At lower frequency:** Aggregate supply chain shock $\varepsilon_{1,t} = \sum_{t_m} \varepsilon_{1,t_m}$ and estimate impacts using local projections:

$$y_{i,t+h} = \beta^i_{h,0} + \psi^i_h \varepsilon_{1,t} + \beta^i_{h,1} y_{i,t-1} + \ldots + \beta^i_{h,p} y_{i,t-p} + \xi_{i,t,h}$$

Sharpening the Interpretation of the Shock

- Supply chain shock should lead to **shortages** and **increased delivery times**
  - Use indices for shortages and supplier delivery times to validate claim

(Caldara, Iacoviello, and Yu, 2024, ISM, 2025)

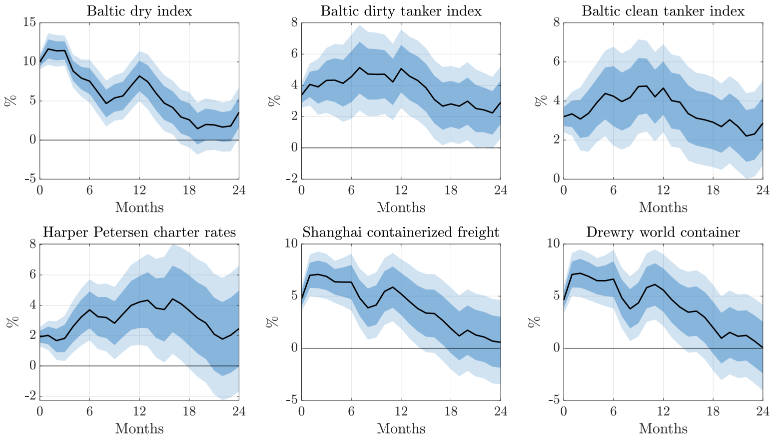


- **Significant increase** in supply chain shortages and supplier delivery times
- No significant effects on trade policy uncertainty or crude oil volatility

More

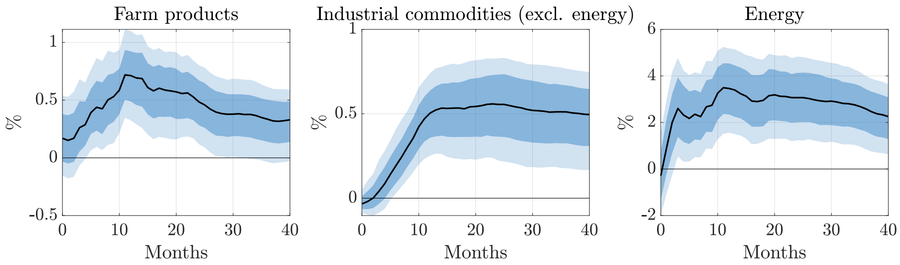
Broad-based Increase in Shipping Costs

▸ Daily event study



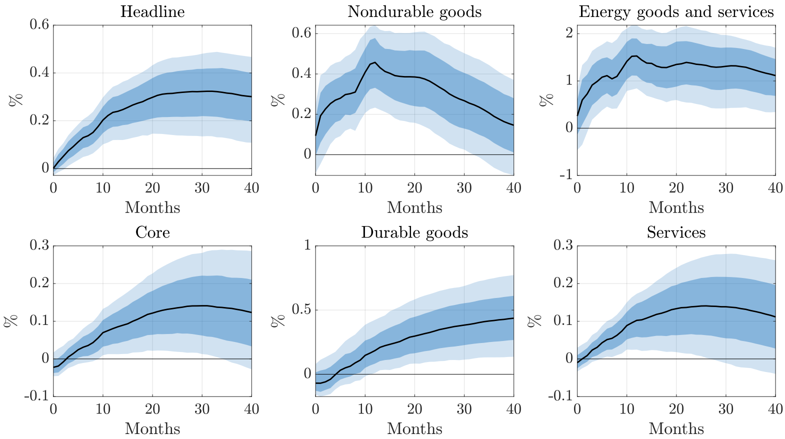
- Shock leads to a broad-based increase in shipping rates
- **Tanker rates**, **charter rates** and **container rates** all increase

Producer Prices



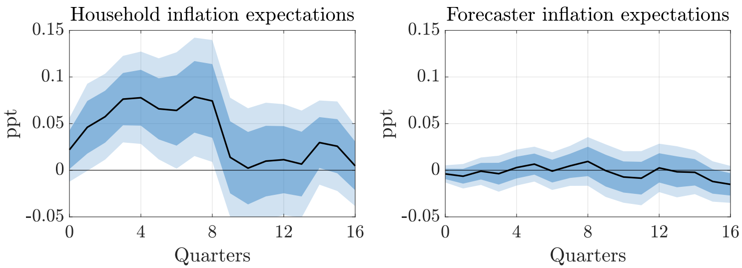
- **Producer prices** increase significantly with some lag
- **Broad-based** increase, most pronounced for energy prices
  - Via delays and disruptions to oil supply and increasing fuel demand due to longer journeys

Consumer Prices



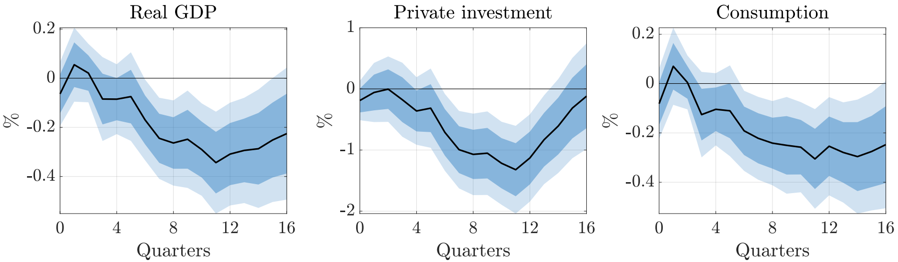
- Significant **pass-through** to consumer prices
- **Fast** for non-durable and energy prices, **slower** for durable and services prices

Inflation Expectations



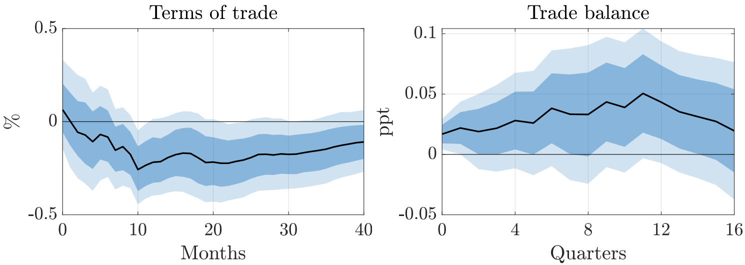
- Very persistent rise in **core CPI**
- Also reflected in the persistent rise in **household** inflation expectations
- **But: professional forecasters** do not respond
  - They may perceive shock as transitory and look through it

Economic Activity: Broader Impacts



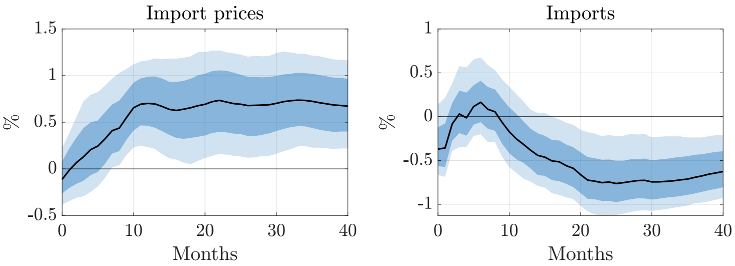
- Translates into **broad-based economic effects**
- Significant fall in **GDP and components**

Trade



- **Terms of trade** fall significantly
- However, **trade balance** improves
  $\Rightarrow$ Consistent with FX response

Imports

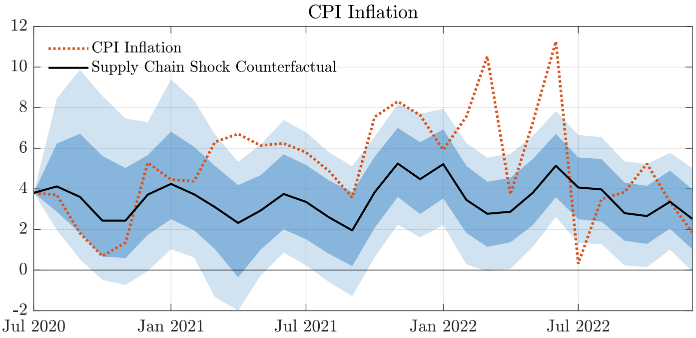


- **Import prices** increase with a lag, in line with the commodity prices
- Improvement in trade balance driven by a sharp contraction in **imports**
- Reflects **weaker domestic demand** and/or **import substitution**

Revisiting the Recent Inflation Surge

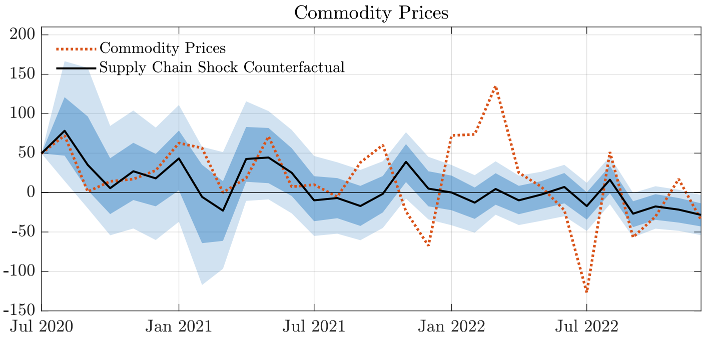
Supply Chain Shocks and the Recent Inflation Surge

- How important are supply chain shocks in the **recent inflationary episode**?
  - Simulate the economy under supply chain shocks alone



- Supply chain stress **contributes meaningfully** to **variations in inflation**
- But cannot account for big inflation spike

Supply Chain Shocks and the Recent Inflation Surge



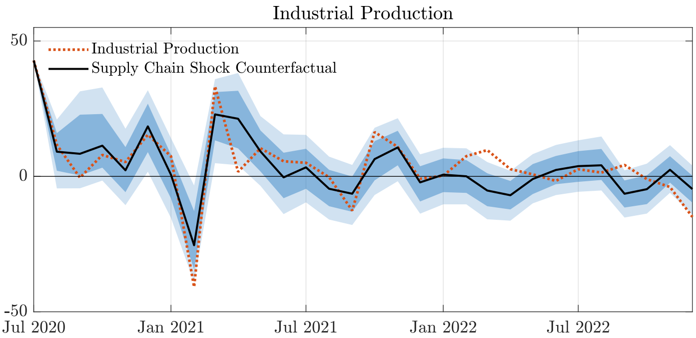
- Shock contributes strongly to **fluctuations in commodity prices** through 2021
- But cannot account for huge surge following Russian invasion of Ukraine

Supply Chain Shocks and the Recent Inflation Surge

- **Moderate role** of supply chain shocks for recent inflationary episode
- **In line with evidence** pointing to demand and commodity price shocks
  - Expansionary fiscal policy and loose monetary policy (Giannone and Primiceri, 2024)
  - Commodity price shocks (oil, food, ...) (Gagliardone and Gertler, 2023)

Supply Chain Shocks and the Recent Inflation Surge

- But, important driver for **industrial production**
- Especially through 2021 when supply chain stress was high

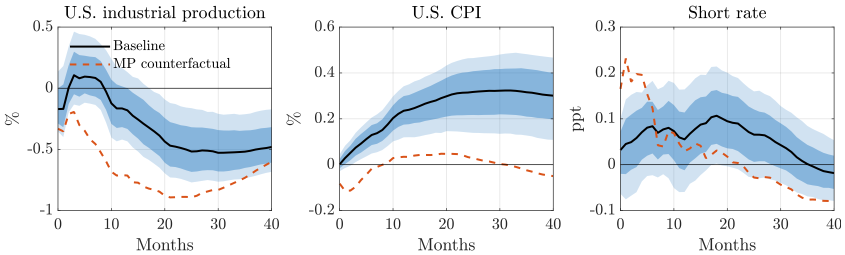


▸ Historical decompositions

The Role of Monetary Policy

- How important is **monetary policy** for transmission of supply chain shocks?
- Perform a **counterfactual exercise** using McKay and Wolf (2023) approach
  - **Idea**: Use combination of time-t monetary policy shocks to condition new rule
    $\Rightarrow$ Robust to Lucas critique
  - Use shocks from Bauer and Swanson (2023) & Miranda-Agrippino and Ricco (2021)
- Assess how costly it would have been if monetary policy **prevented the inflationary rise**

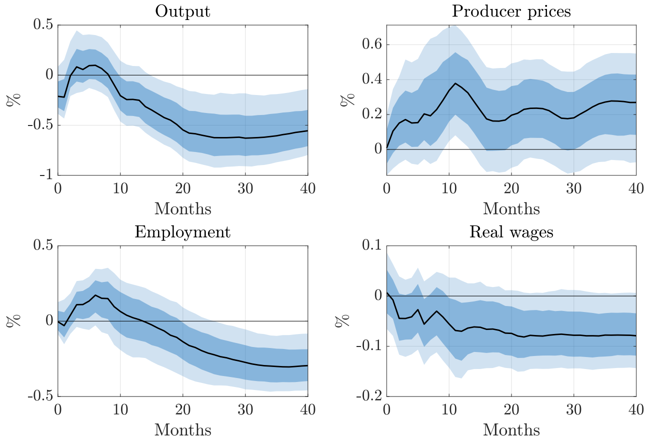
Could Monetary Policy Have Prevented the Inflationary Rise?



- Monetary policy can **stabilize inflation** by aggressively raising rates
- But: Comes at the cost of **significantly lower output**
- Confirms important role of monetary policy in recent inflationary episode

Sectoral Impacts

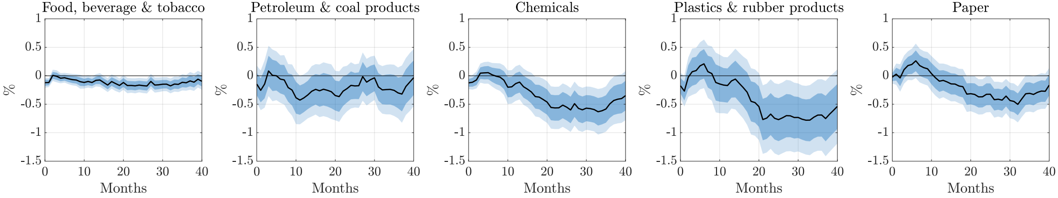
Economic Activity: Manufacturing



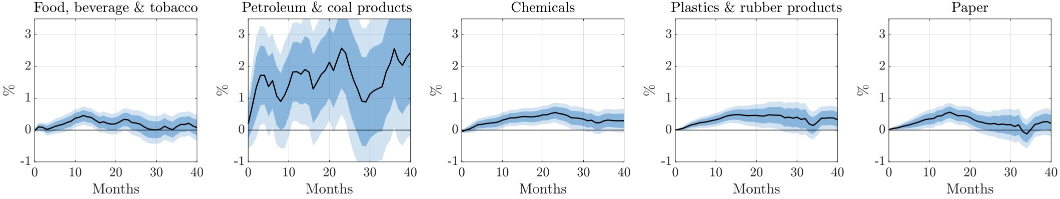
- Disruptions **delay transport of industrial materials**, raising costs
- **Manufacturing output** falls substantially, **employment** somewhat less
- **Real wages** also fall

Non-Durable Goods Production

Industrial Production

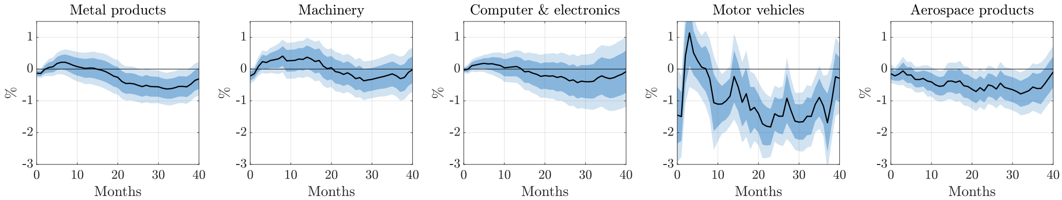


Producer Prices

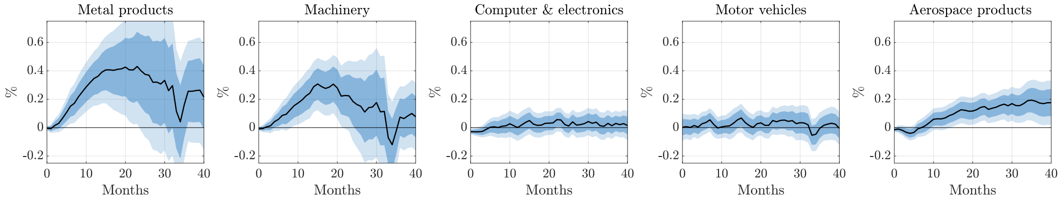


Durable Goods Production

Industrial Production



Producer Prices



Implications for Network Models

- Consider CES framework with sectors $i = 1, \dots N$:

$$Y_{it} = \left(\left[A_{it} K_{it}^{\alpha} L_{it}^{1-\alpha} \right]^{\frac{\zeta_i - 1}{\zeta_i}} + \left(B_{it} M_{it} \right)^{\frac{\zeta_i - 1}{\zeta_i}} \right)^{\frac{\zeta_i}{\zeta_i - 1}}, \quad \text{with } M_i = \left(\sum_j \omega_{ij}^{\frac{1}{\eta_i}} Y_{ij}^{\frac{\eta_i - 1}{\eta_i}} \right)^{\frac{\eta_i}{\eta_i - 1}}$$

- **Elasticity of substitution:**

$$\zeta_{it} = \frac{\partial \ln \left(L_{it} / M_{it} \right)}{\partial \ln \left(P_{it}^{M} / W_t \right)}$$

- Can use **sectoral IRFs** to estimate elasticities of substitution

Conclusion

Conclusion

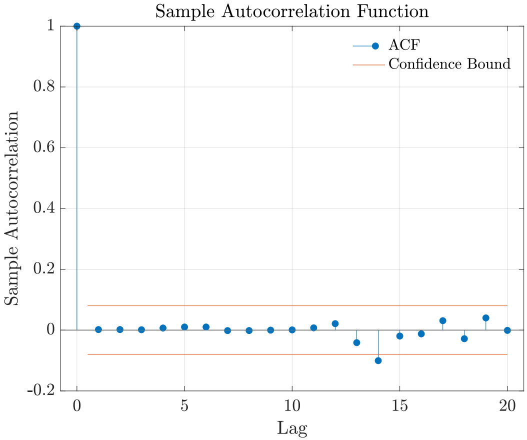
- New evidence on macroeconomic implications of **supply chain disruptions**
  - Leverage **plausibly exogenous** disruptive events at key trade **choke points** and **high-frequency** financial data
- Pervasive **economic effects**:
  - Persistent increases in shipping rates, commodity prices, and consumer prices
  - Fall in industrial production and significant depreciation of the dollar
- Results highlight the **fragility of global supply chains**
  - Heightened by climate change, geopolitical tensions, tariffs . . .
  - Stagflationary pressures underscore challenges for monetary policy

Thank you!

Appendix

Autocorrelation

Autocorrelation Function of the Shipping Cost Surprise Series



Forecastability

Granger Causality Tests

Variable	p-value
Instrument	0.9906
Shipping rates	0.2474
Commodity prices	0.8855
World mercantile tonnage	0.8975
Geopolitical risk	0.7192
U.S. industrial production	0.5380
U.S. CPI	0.5932
Short rate	0.9182
Real effective exchange rate	0.5079
Oil price	0.6678
Shortage index	0.6106
Joint	0.8571

Orthogonality

Correlation With Other Shock Measures

Shock	Source	ρ	p-value	n	Sample
Panel A: Oil shocks					
Oil price	Hamilton (2003)	0.03	0.56	396	1985M01-2017M12
Oil supply	Kilian (2008)	-0.10	0.12	237	1985M01-2004M09
	Caldara, Cavallo, and Iacoviello (2019)	-0.06	0.29	372	1985M01-2015M12
	Baumeister and Hamilton (2019)	0.00	0.95	456	1985M01-2022M12
	Kilian (2009)	-0.08	0.17	276	1985M01-2007M12
Global demand	Kilian (2009)	0.10	0.11	276	1985M01-2007M12
Oil-specific demand	Kilian (2009)	-0.03	0.60	276	1985M01-2007M12
Oil supply news	Känzig (2021)	-0.01	0.83	456	1985M01-2022M12
Panel B: Productivity Shocks					
Productivity	Basu, Fernald, and Kimball (2006)	-0.04	0.71	108	1985Q1-2011Q4
	Smets and Wouters (2007)	-0.05	0.63	80	1985Q1-2004Q4
Panel C: News shocks					
News	Barsky and Sims (2011)	-0.20	0.06	91	1985Q1-2007Q3
	Kurmann and Otrok (2013)	0.15	0.19	82	1985Q1-2005Q2
	Beaudry and Portier (2014)	0.01	0.90	111	1985Q1-2012Q3

Orthogonality (cont.)

Shock	Source	ρ	p-value	n	Sample
Panel D: Monetary policy					
Monetary policy	Bauer and Swanson (2023)	0.01	0.89	383	1988M02-2019M12
	Gertler and Karadi (2015)	0.01	0.87	324	1990M01-2016M12
	Romer and Romer (2004)	-0.01	0.94	144	1985M01-1996M12
	Smets and Wouters (2007)	-0.09	0.45	80	1985Q1-2004Q4
Panel E: Uncertainty shocks					
Uncertainty	Bloom (2009)	-0.04	0.39	396	1985M01-2017M12
	Baker, Bloom, and Davis (2016)	-0.05	0.30	390	1985M07-2017M12
Panel F: Financial shocks					
Financial	Gilchrist and Zakrajšek (2012)	-0.04	0.48	372	1985M01-2015M12
	Bassett et al. (2014)	-0.08	0.48	76	1992Q1-2010Q4
Panel G: Fiscal policy shocks					
Fiscal policy	Romer and Romer (2010)	-0.15	0.17	92	1985Q1-2007Q4
	Ramey (2011)	-0.08	0.41	104	1985Q1-2010Q4
	Fisher and Peters (2010)	0.00	0.97	96	1985Q1-2008Q4

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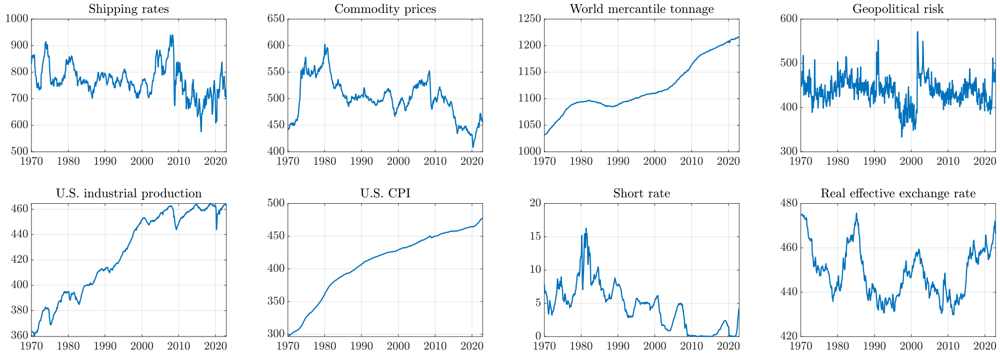
Data

Transformed Data Series



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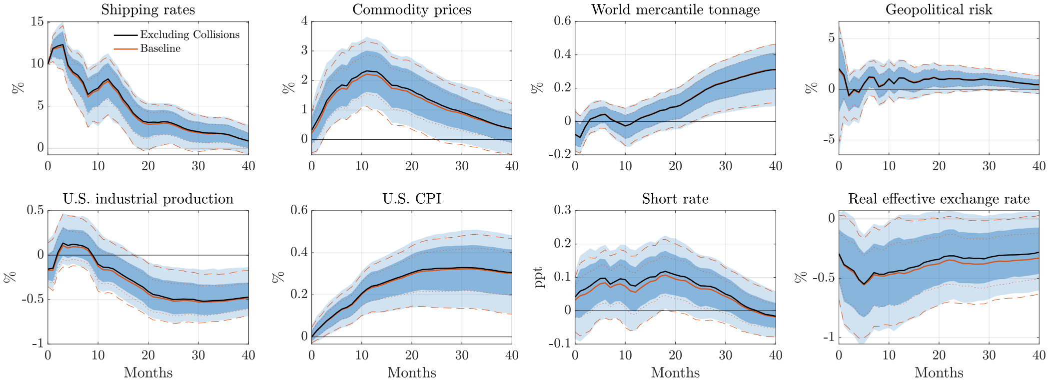
Excluding Collisions

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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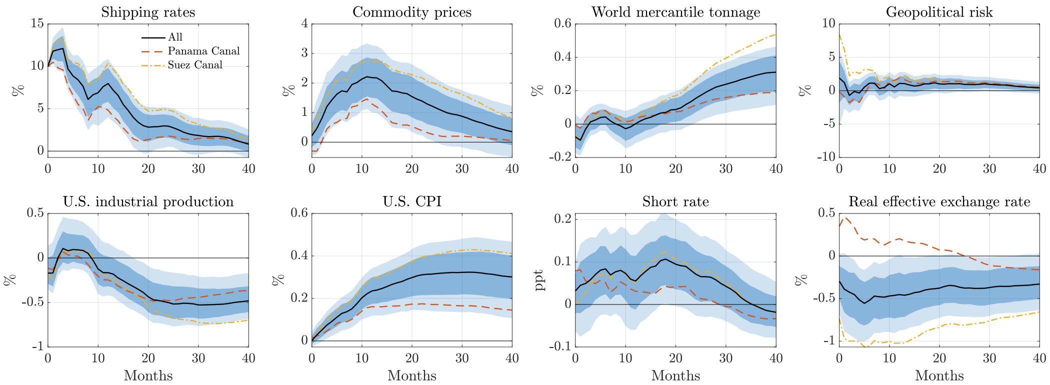
Panama Canal or Suez Canal Only

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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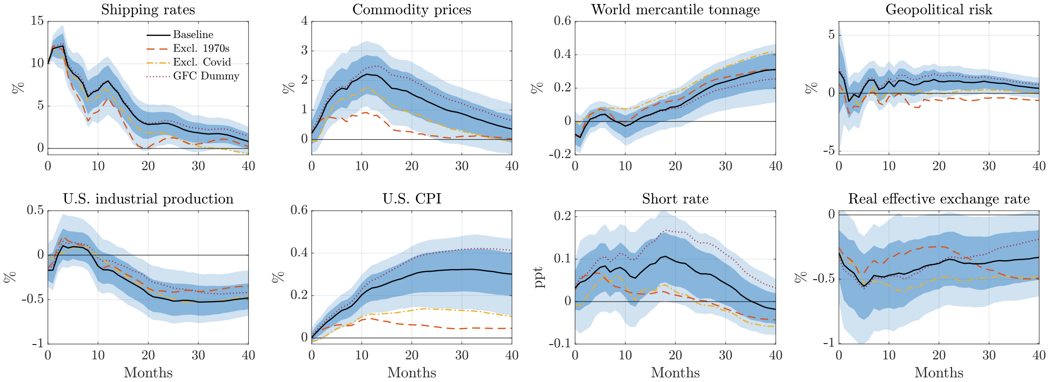
Robustness Across Sample Periods

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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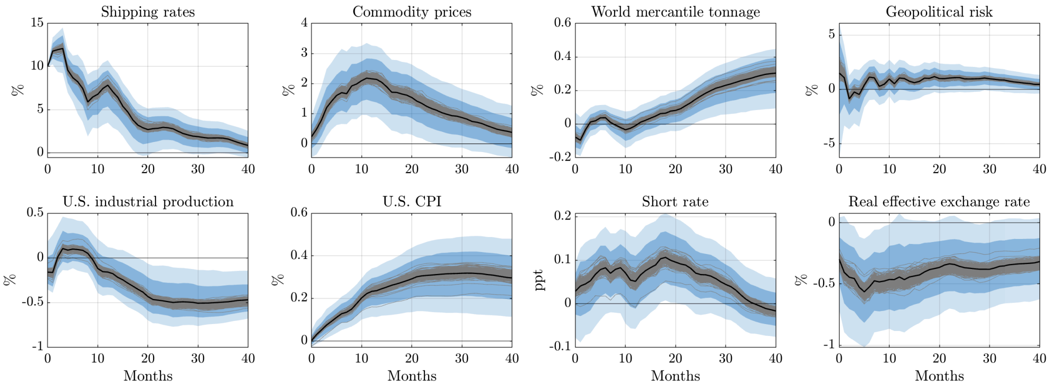
Jackknife Exercise

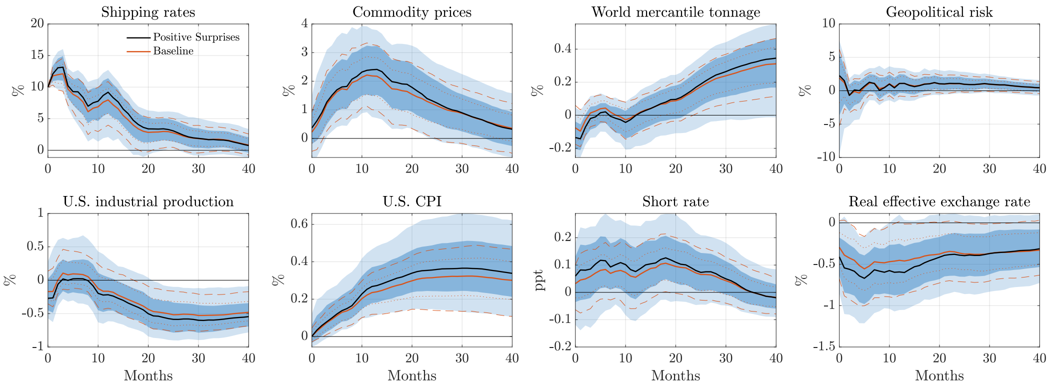
Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

Positive Surprises Only

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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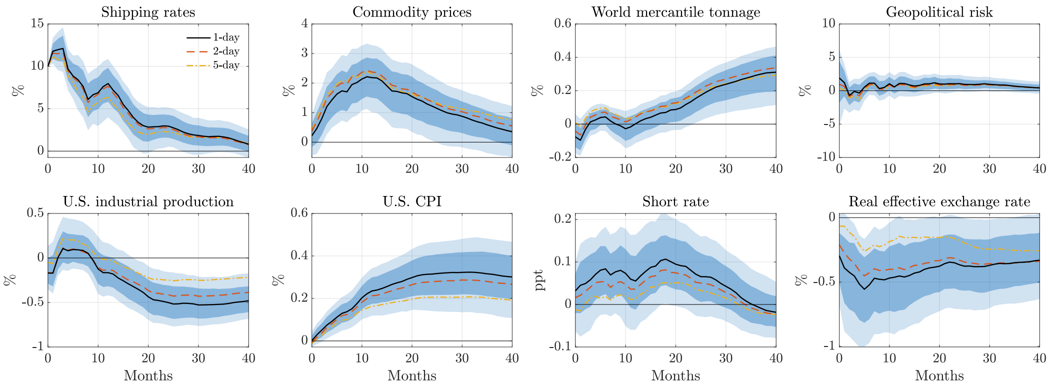
Different Event Windows

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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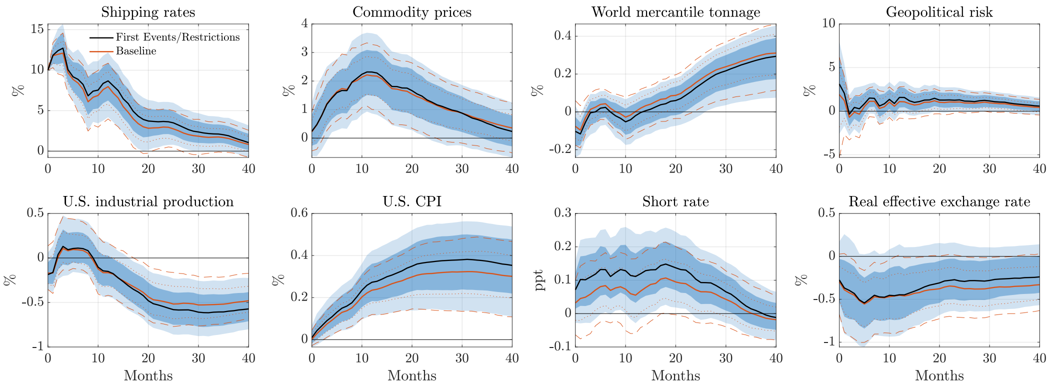
First Events Only

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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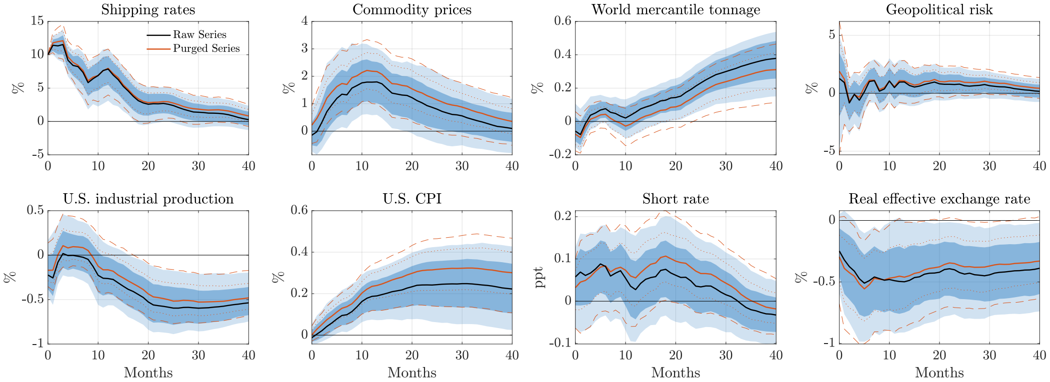
Responses Based on Raw Instrument

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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Additional Sensitivity

- Robust to lag order ▸ More
- Robust to deterministics included ▸ More

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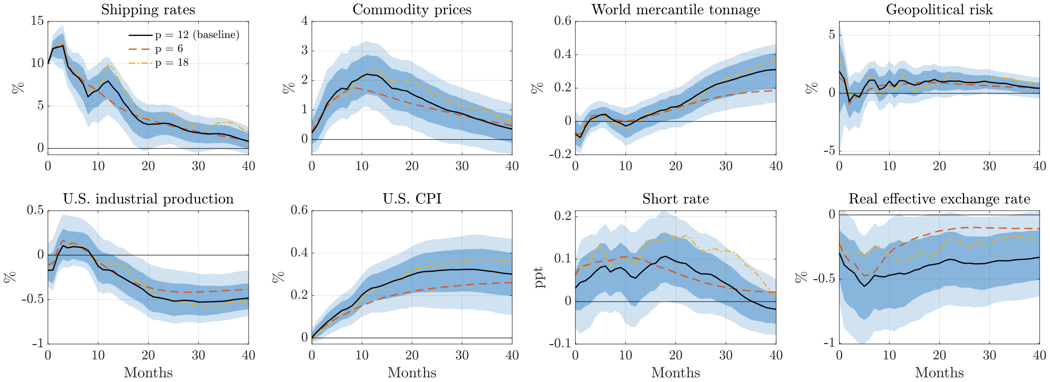
Lag Order

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

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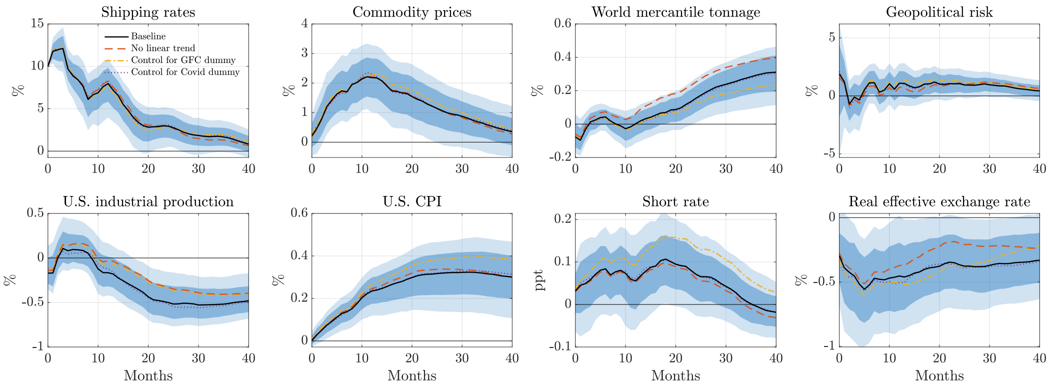
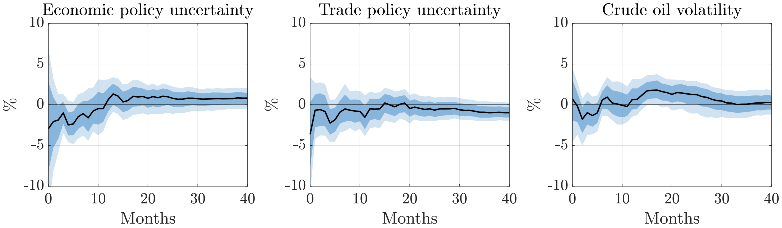
Deterministics

Impulse Responses to a Supply Chain Shock



Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

Uncertainty



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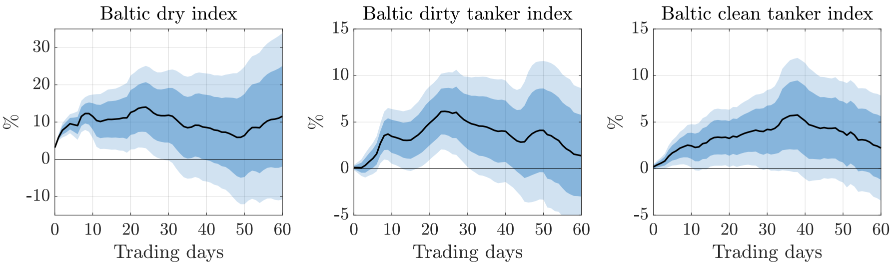
Event Study on Shipping Rates



- Use **daily local projections** of shipping costs on surprises to examine persistence
- Surprises measured using dry bulk also reflect increases in broader **tanker rates**

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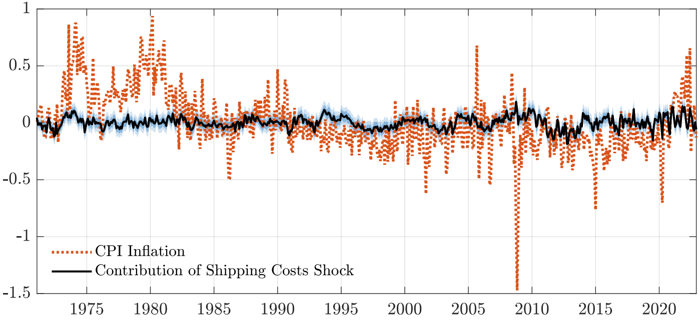
Historical Decomposition



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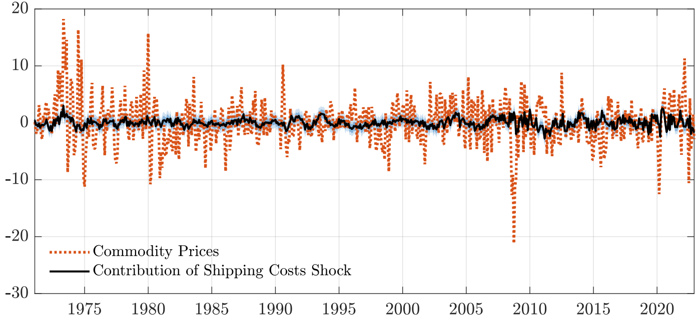
Historical Decomposition



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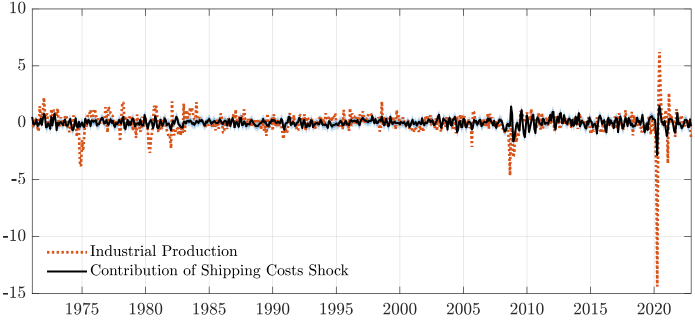
Historical Decomposition



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