

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

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## Motivation

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## Introduction

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- 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 of these risks crucial to inform policy responses

## This Paper

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- 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

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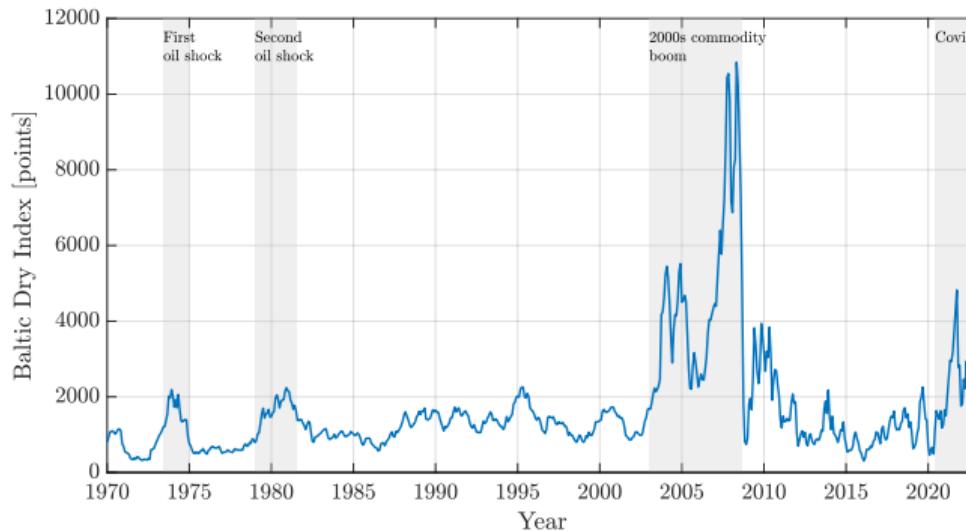
- Adverse supply chain shocks have significant global effects:
  - **Shipping rates increase** significantly and persistently  
Disruptions slow transit, reduce capacity, create bottlenecks, rippling through supply chains
  - Passes through **commodity prices** with some lag
  - In response to scarcity, **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

## Identification Strategy

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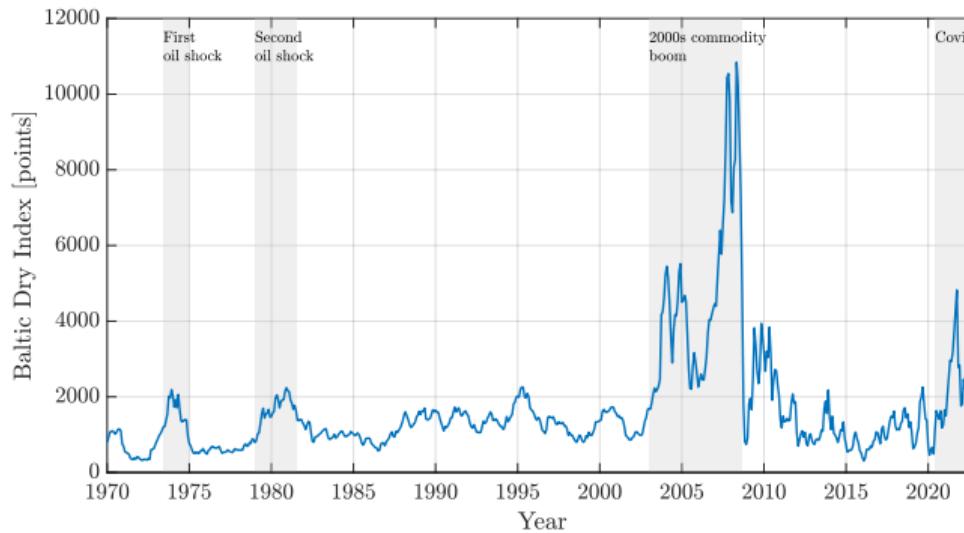
# Identifying Supply Chain Disruptions

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



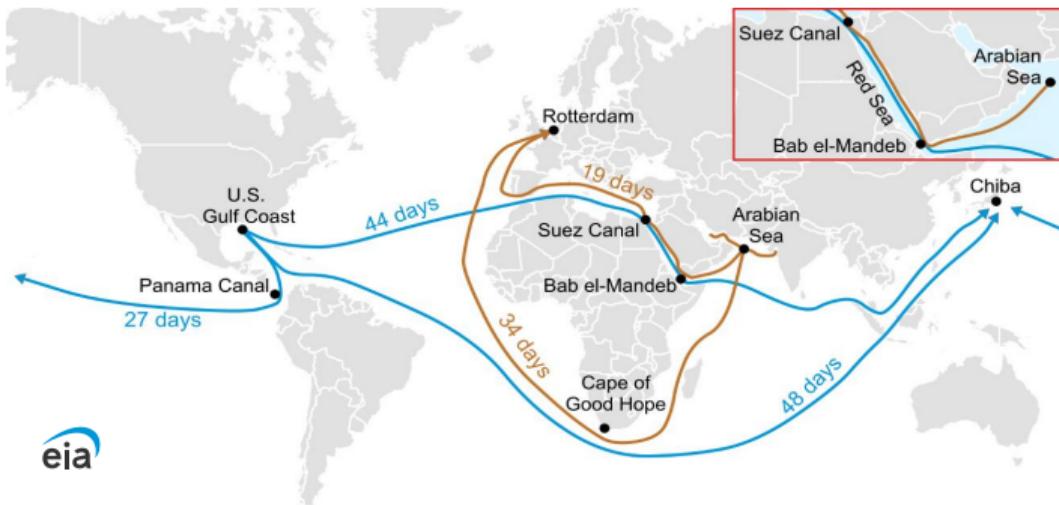
# Identifying Supply Chain Disruptions

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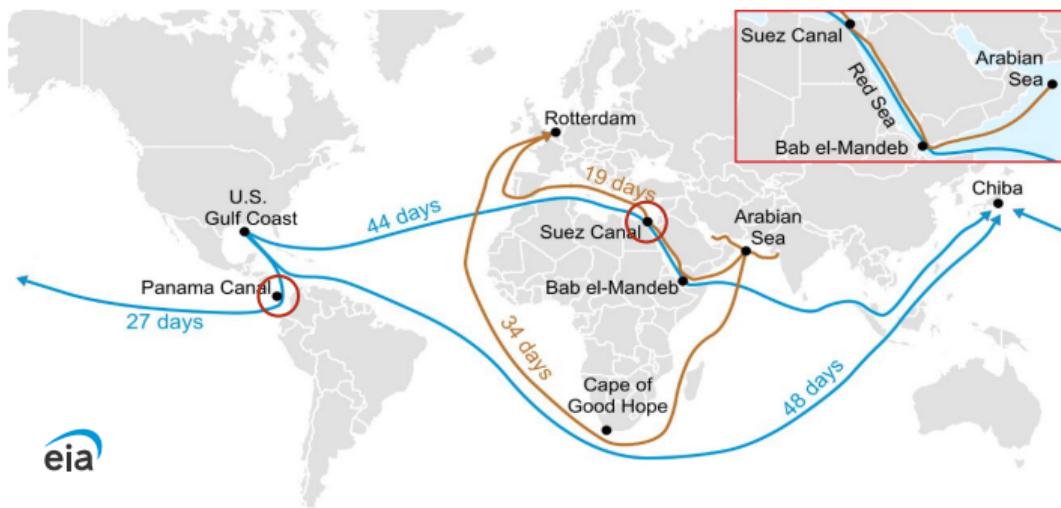
- **Shipping rates** reflect both demand and supply forces
- How can we isolate **exogenous supply chain disruptions**?

# 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

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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 [...]”*

*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

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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

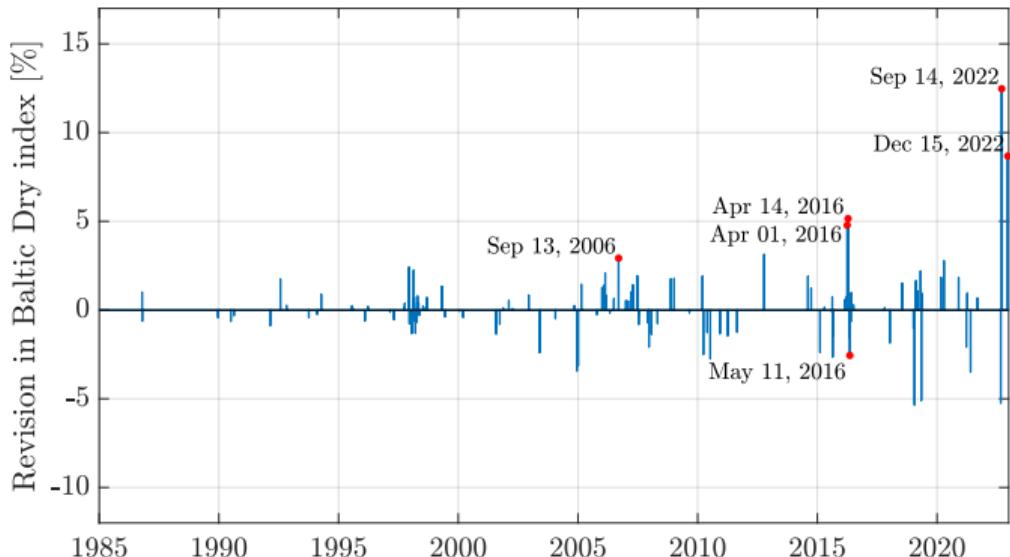
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- Disruptive events along global trade routes closely **monitored by market experts**
- Reporting of these events can lead to significant **market reactions**
- **Idea:** Identify **shipping cost surprise** as the change in shipping rate in a tight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

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

- $P_d^{SC}$  is the Baltic Dry Index, a measure of global shipping costs that relies on a composite of dry bulk timecharter averages [▶ More](#)
- $d$  indicates the date of the event

# 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

- 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):

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

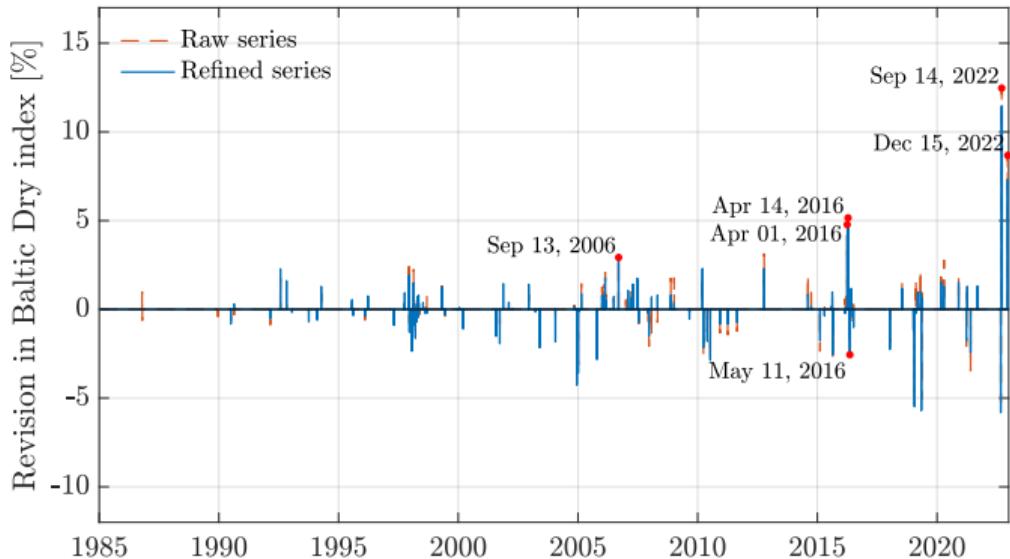
- $X_{d-}$  is a set of predictors known before the event day  $d$   
Macro news, financial variables, commodity prices, geopolitical news, ...

# Predictability

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

## Diagnostic Checks

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- 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)

- Use **shipping cost surprises**,  $z_t$ , as an instrument to identify a **supply chain shock**
- **Identifying assumptions:**

▶ Detail

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

$$\mathbb{E}[z_t \varepsilon_{2:n,t}] = \mathbf{0} \quad (\text{Exogeneity})$$

- **Estimation:** VAR techniques, local projections as robustness

- Sample: 1970 – 2022
  - Specification: 8 variables, 12 lags

▶ Data

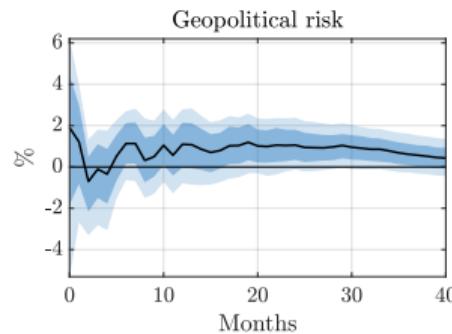
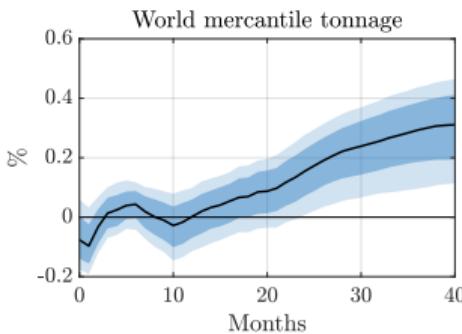
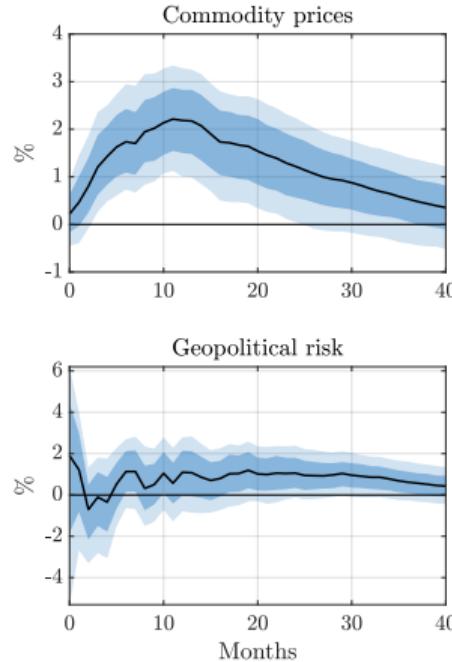
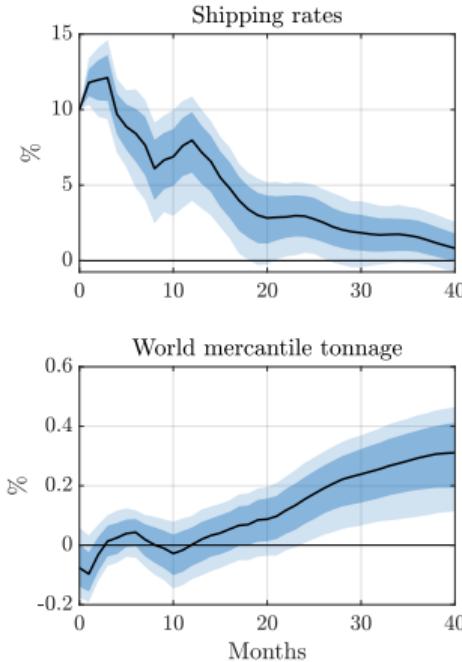
Global shipping: Shipping rates, commodity prices, mercantile tonnage, and geopolitical risk

U.S. economy: U.S. industrial production, consumer prices, 3M treasury yield, real effective FX rate

## Aggregate Results

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# The Causal Effects of Supply Chain Shocks



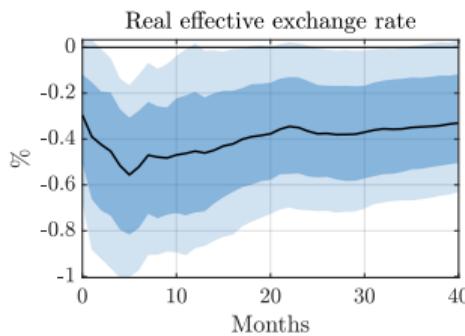
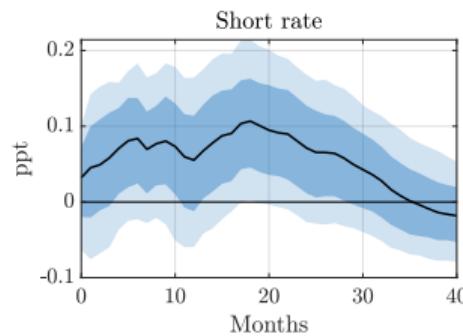
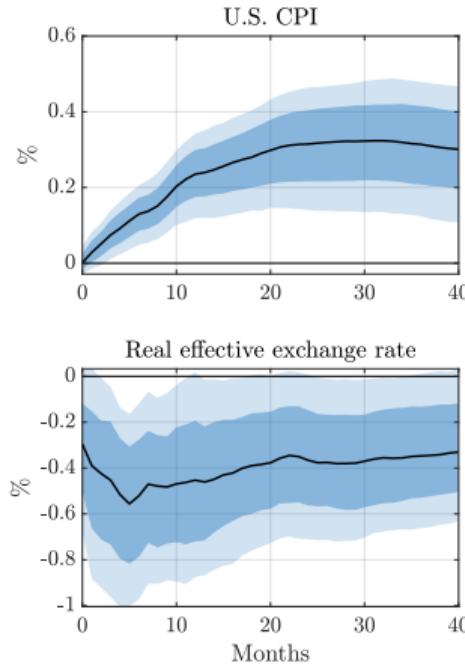
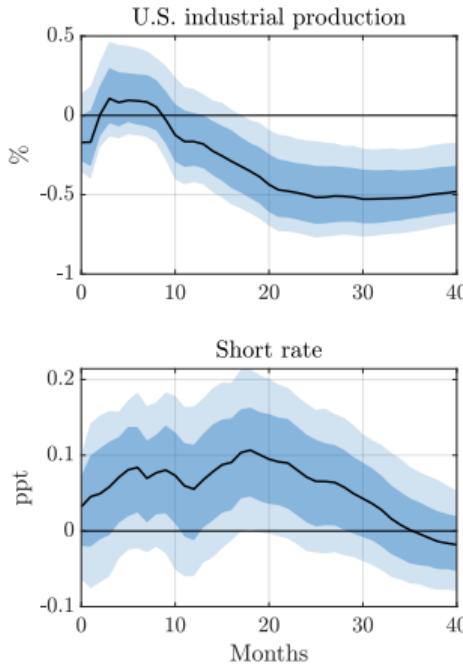
First stage: Robust F-statistic: 24.44,  $R^2$ : 4.18%, Adjusted  $R^2$ : 4.03%

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**

# Impact on the U.S. Economy



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

Results are robust to **potentially restrictive** VAR assumptions:

- 1. Robust to invertibility**

Results similar when using invertibility-robust internal IV [▶ More](#)

- 2. Robust to lag truncation bias**

Results robust to using local projections on VAR shock [▶ More](#)

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

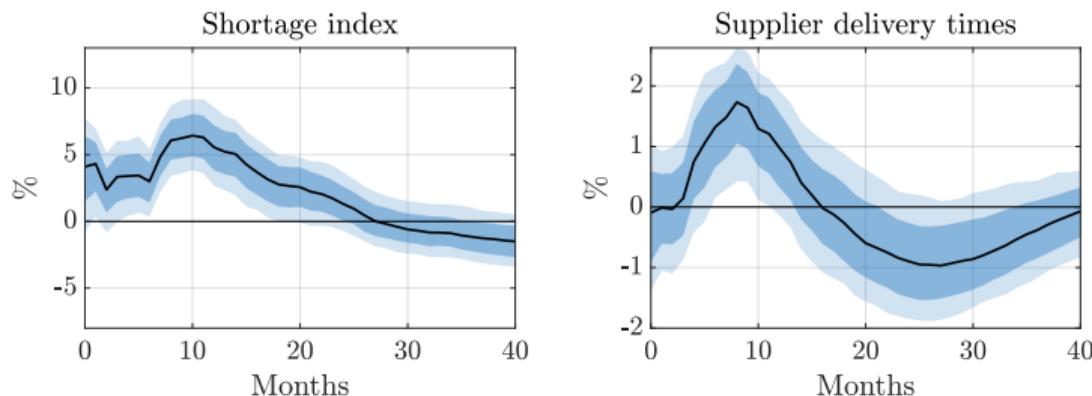
▶ More
5. Could potentially **unaccounted predictability** affect results?
  - Robust to keeping only first events which are less predictable
  - Robust to not removing predictability

▶ More

# 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

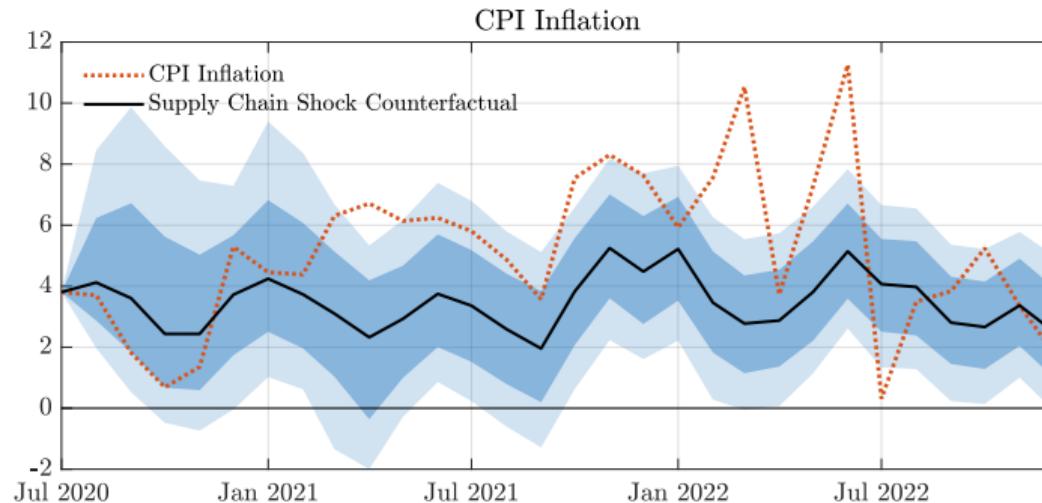
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## Revisiting the Recent Inflation Surge

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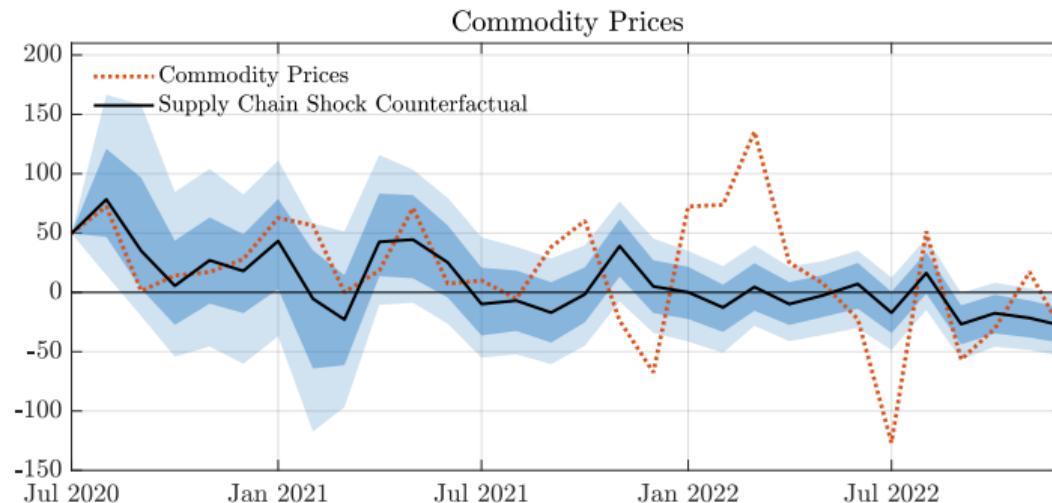
# Supply Chain Shocks and the Recent Inflation Surge

- 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

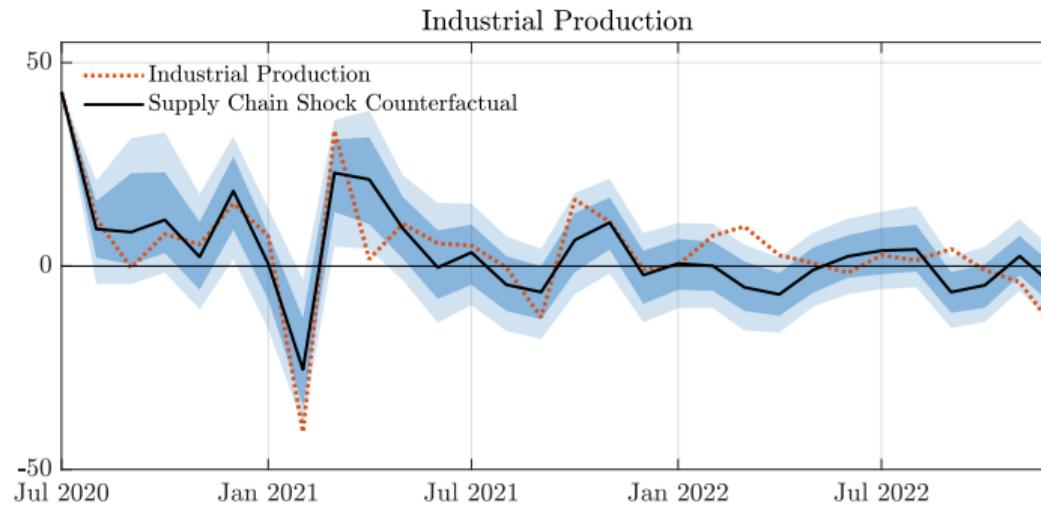
# Supply Chain Shocks and the Recent Inflation Surge

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- **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

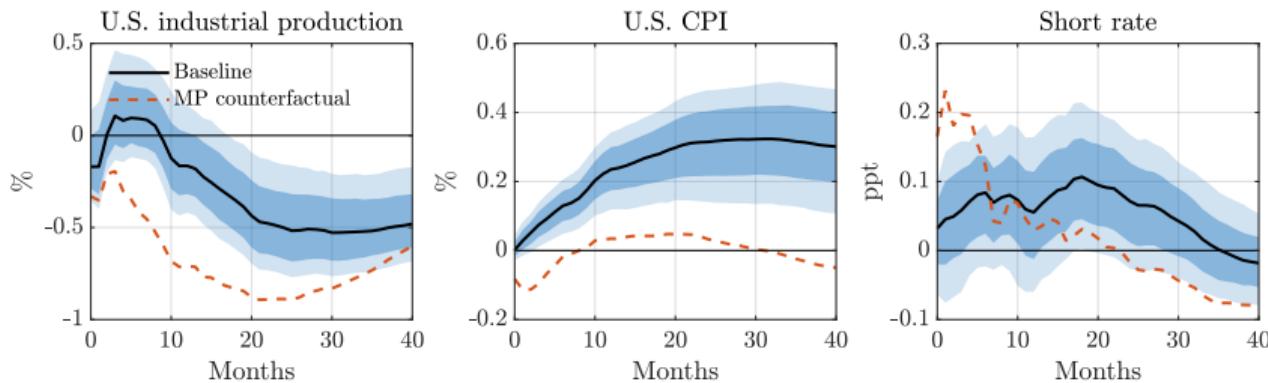


# The Role of Monetary Policy

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- 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  
⇒ Robust to Lucas critique
  - Use shocks from Bauer and Swanson (2023) & Miranda-Agrrippino 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

## Conclusion

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## Conclusion

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- 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

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# Related Literature

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- **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**

Baqae 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 Bhattacharai (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); Käñzig (2021, 2023)

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

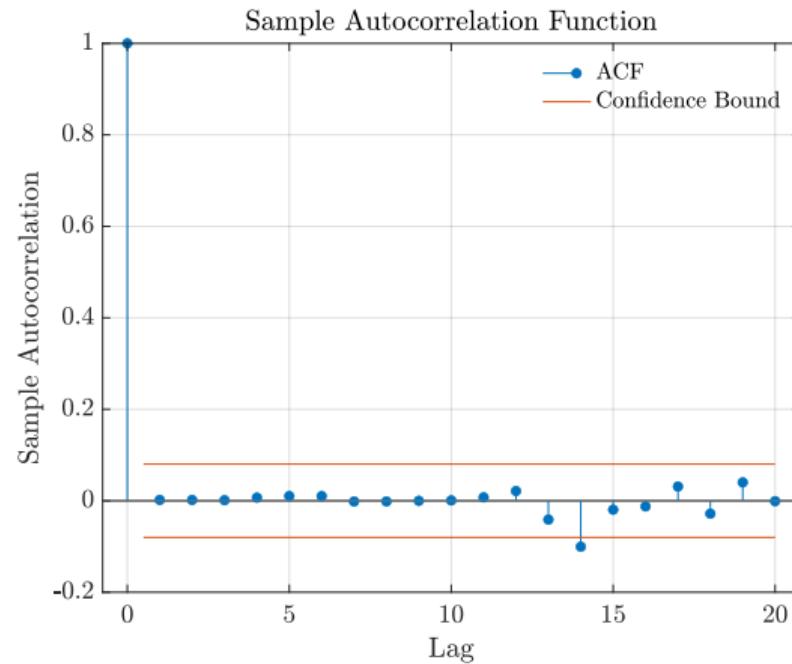
## Measuring Changes in Shipping Cost

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- 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

# Autocorrelation

## Autocorrelation Function of the Shipping Cost Surprise Series



# Forecastability

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## 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	$\rho$	p-value	<i>n</i>	Sample
<i>Panel A: Oil shocks</i>					
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	Kängig (2021)	-0.01	0.83	456	1985M01-2022M12
<i>Panel B: Productivity Shocks</i>					
Productivity	Basu, Fernald, and Kimball (2006)	-0.04	0.71	108	1985Q1-2011Q4
	Smets and Wouters (2007)	-0.05	0.63	80	1985Q1-2004Q4
<i>Panel C: News shocks</i>					
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	$\rho$	p-value	<i>n</i>	Sample
<i>Panel D: Monetary policy</i>					
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
<i>Panel E: Uncertainty shocks</i>					
Uncertainty	Bloom (2009)	-0.04	0.39	396	1985M01-2017M12
	Baker, Bloom, and Davis (2016)	-0.05	0.30	390	1985M07-2017M12
<i>Panel F: Financial shocks</i>					
Financial	Gilchrist and Zakrajšek (2012)	-0.04	0.48	372	1985M01-2015M12
	Bassett et al. (2014)	-0.08	0.48	76	1992Q1-2010Q4
<i>Panel G: Fiscal policy shocks</i>					
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

## External Instrument Approach

- Structural VAR:

$$\mathbf{y}_t = \mathbf{b} + \mathbf{B}_1 \mathbf{y}_{t-1} + \cdots + \mathbf{B}_p \mathbf{y}_{t-p} + \mathbf{S} \boldsymbol{\varepsilon}_t, \quad \boldsymbol{\varepsilon}_t \sim N(0, \boldsymbol{\Omega})$$

- **External instrument:** Variable  $z_t$  correlated with the **shock of interest** but *not* with the **other shocks**
- **Identifying assumptions:**

$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_{1,t}] = \alpha \neq 0 \quad (\text{Relevance})$$

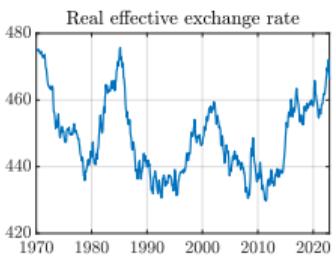
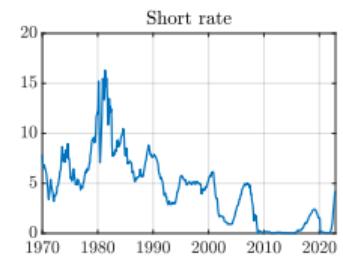
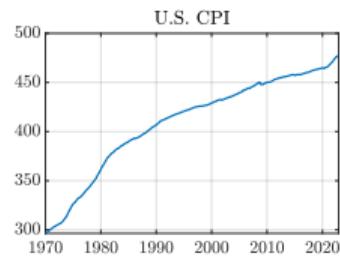
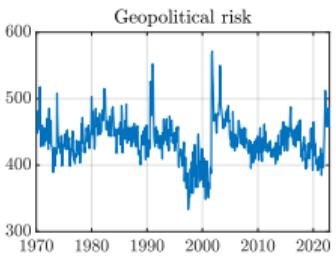
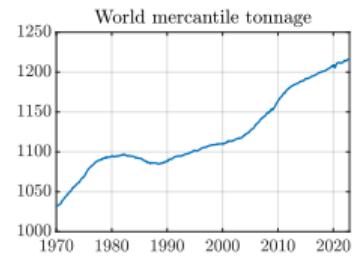
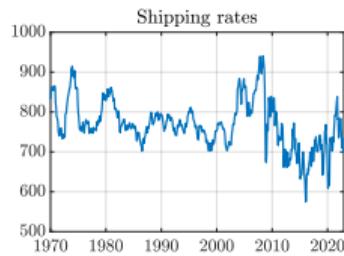
$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_{2:n,t}] = \mathbf{0} \quad (\text{Exogeneity})$$

$$\mathbf{u}_t = \mathbf{S} \boldsymbol{\varepsilon}_t \quad (\text{Invertibility})$$

- Use **shipping cost surprise series** as an *external instrument* for **shipping costs**

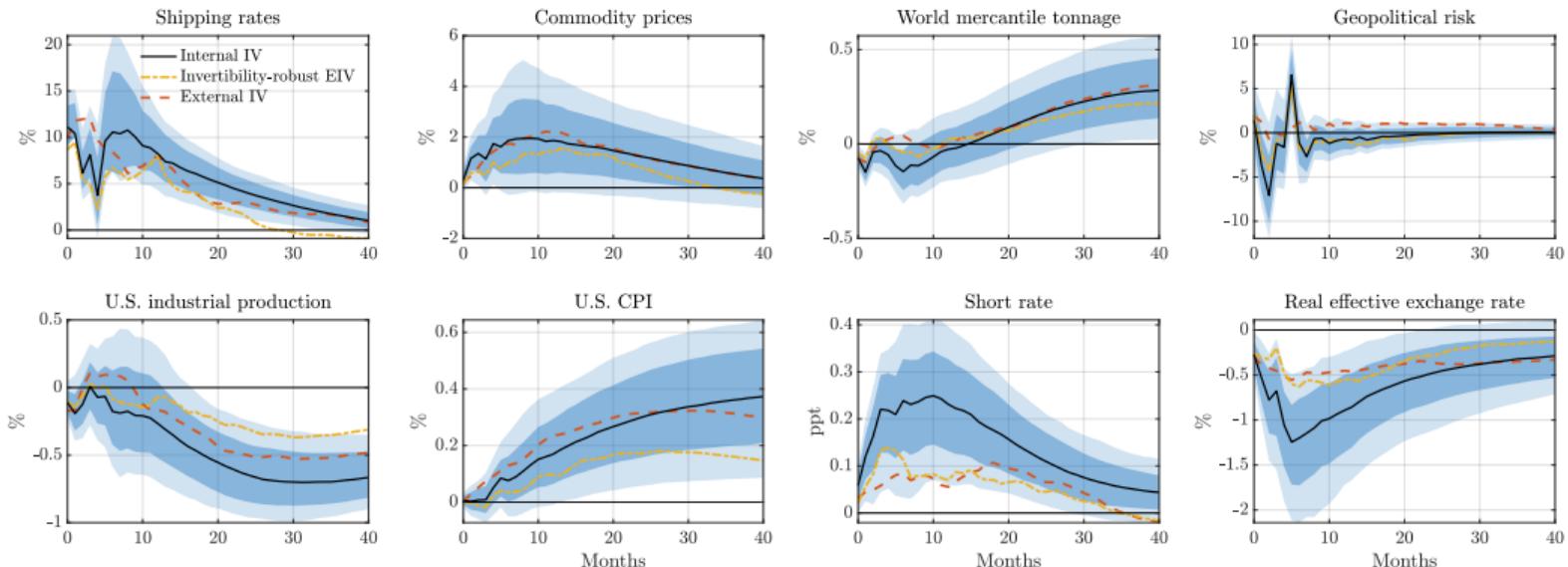
# Data

## Transformed Data Series



# Internal Instruments VAR

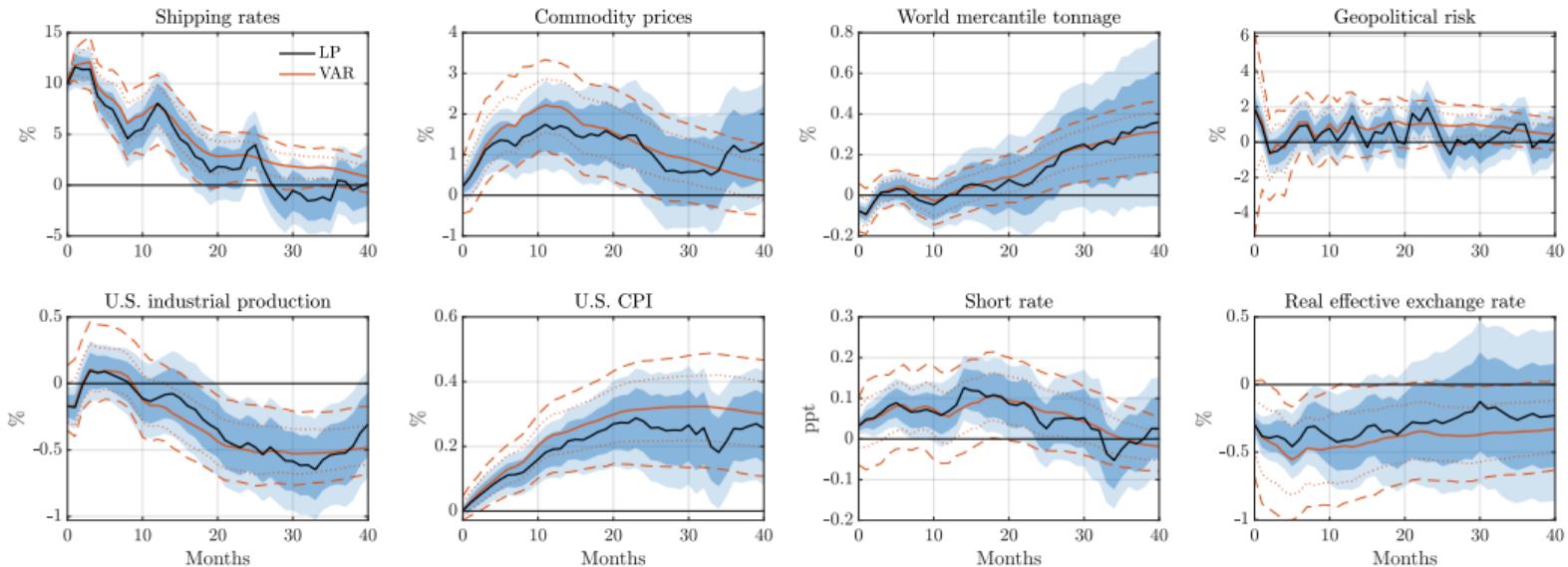
## Impulse Responses to a Supply Chain Shock



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

# Local Projections

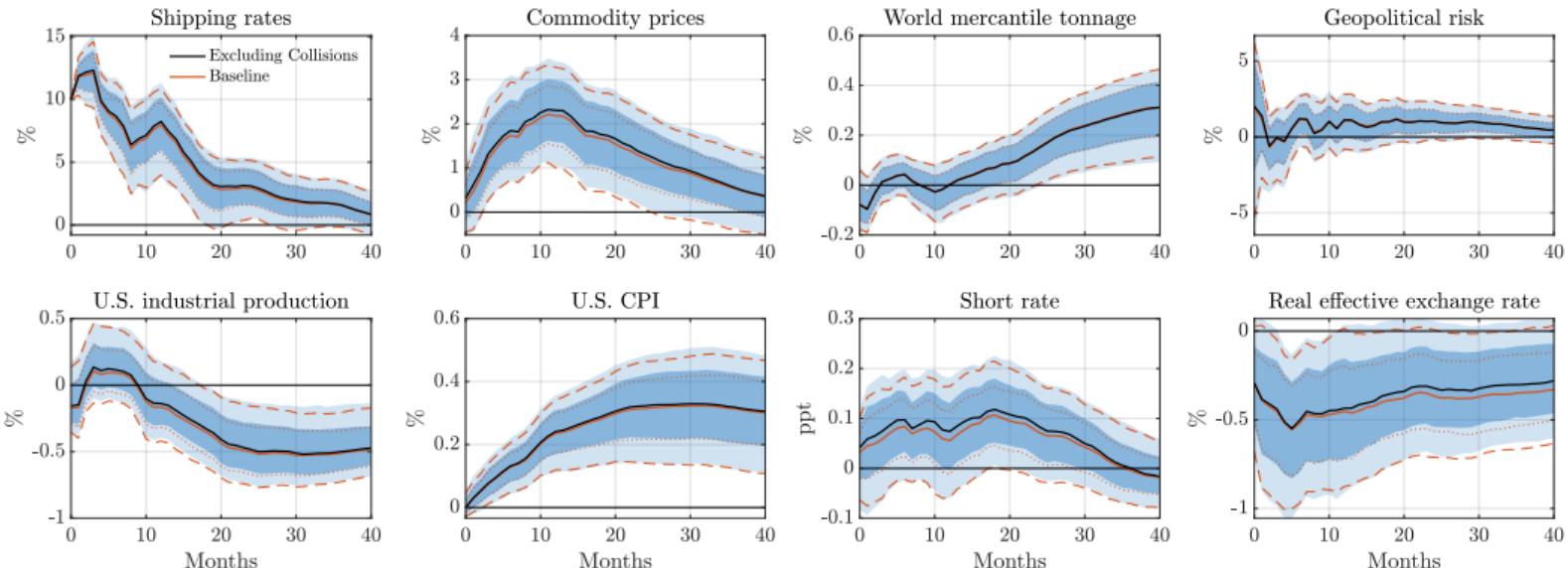
## Impulse Responses to a Supply Chain Shock



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

# Excluding Collisions

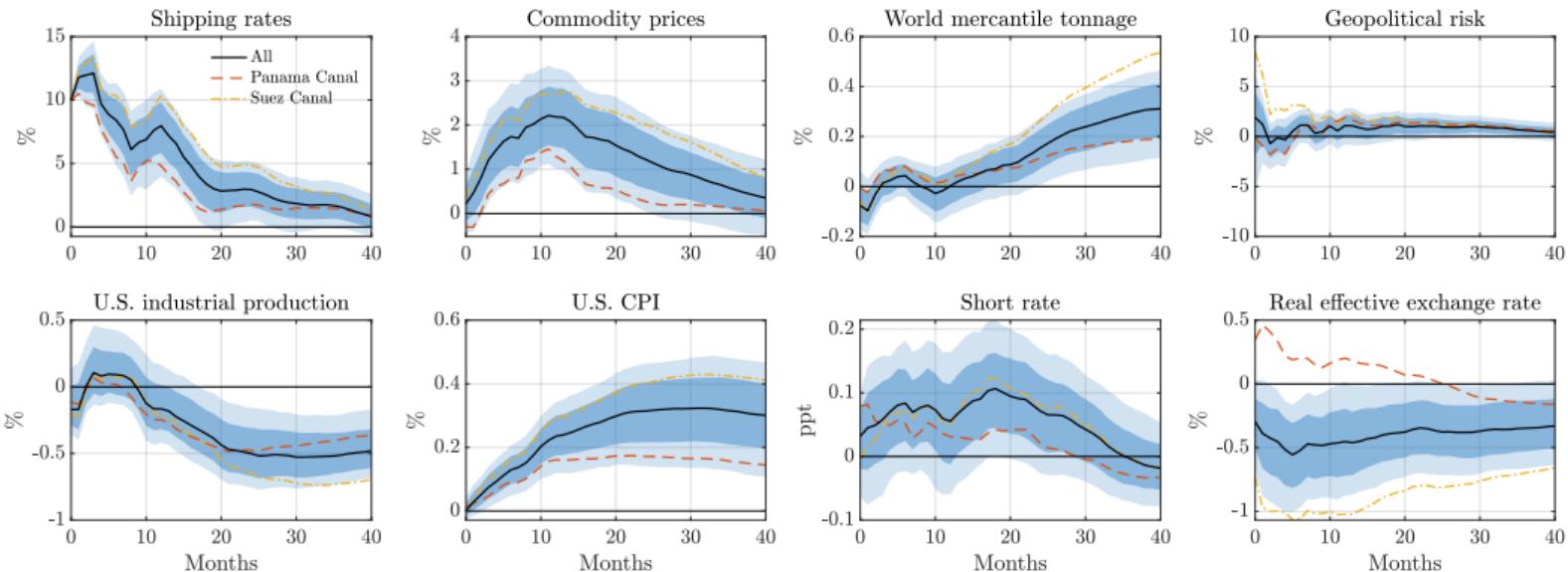
## Impulse Responses to a Supply Chain Shock



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

# Panama Canal or Suez Canal Only

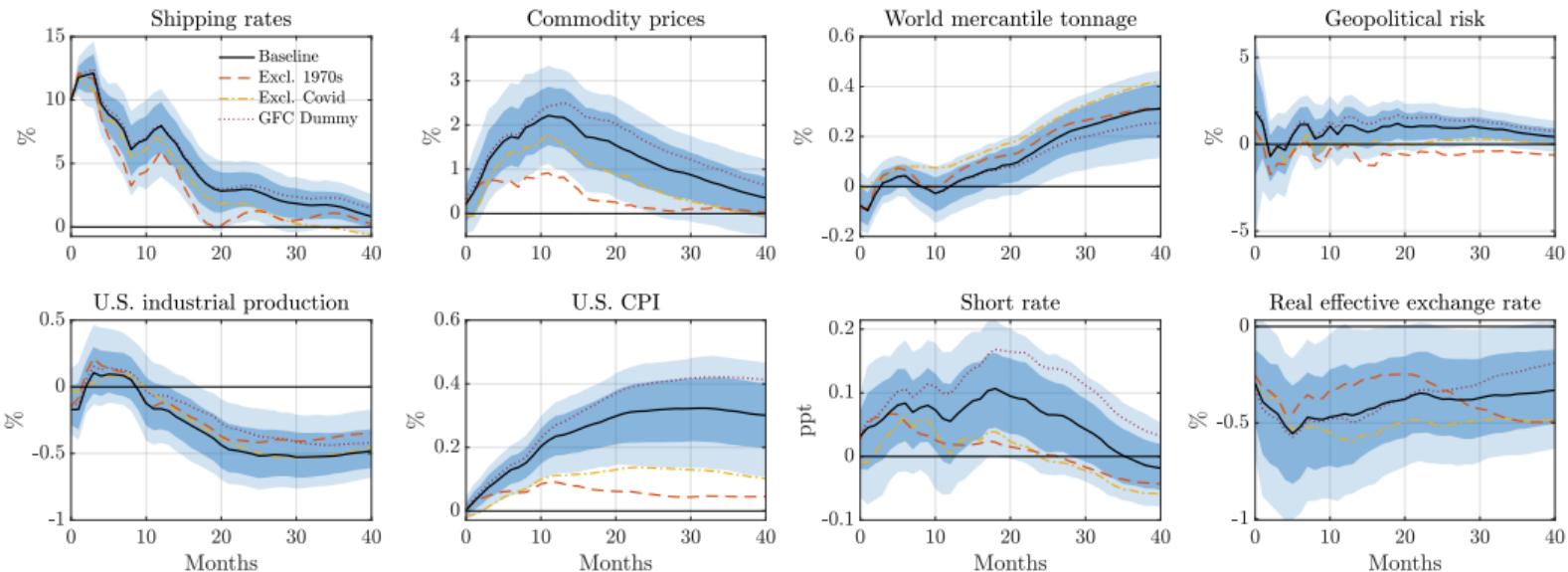
## Impulse Responses to a Supply Chain Shock



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

# Robustness Across Sample Periods

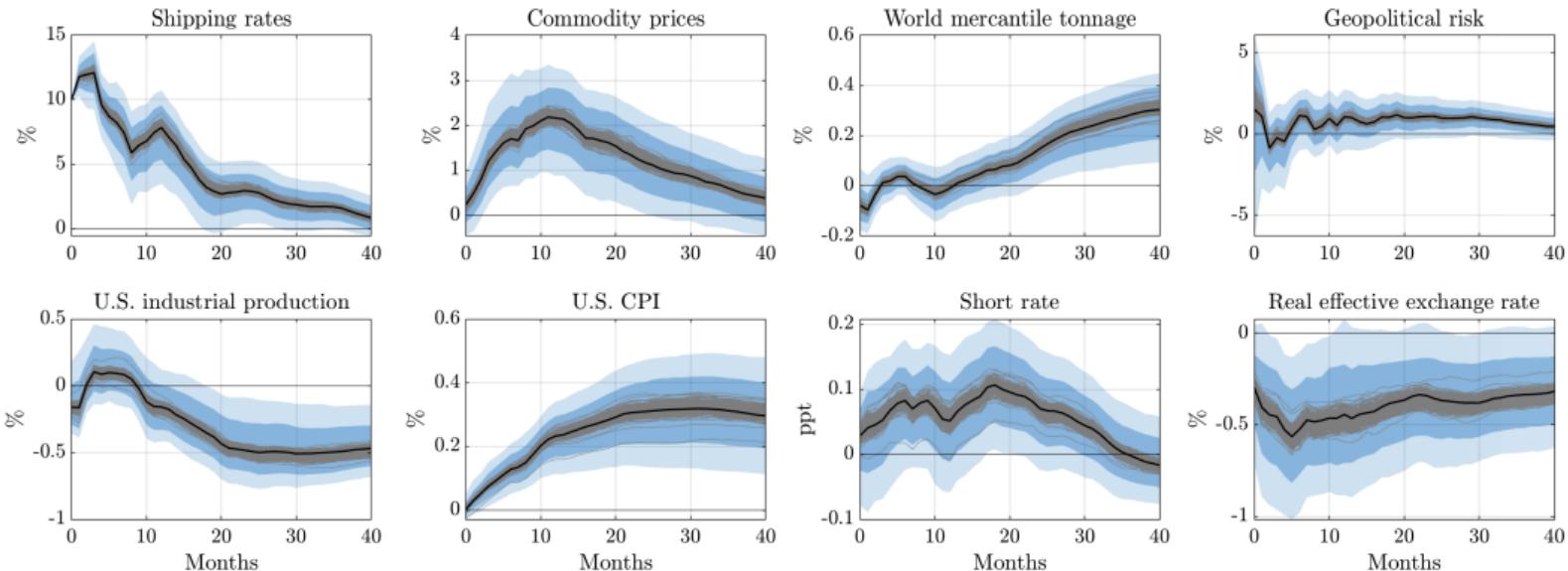
## Impulse Responses to a Supply Chain Shock



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

# Jackknife Exercise

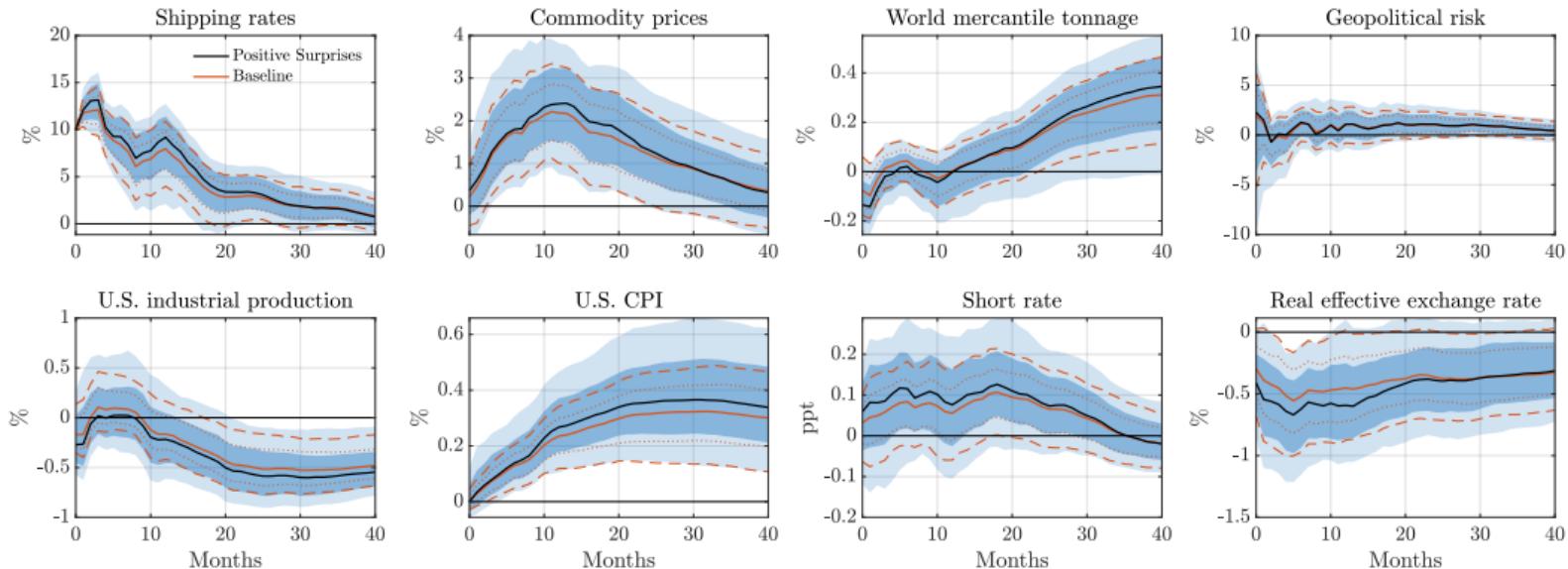
## Impulse Responses to a Supply Chain Shock



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

# Positive Surprises Only

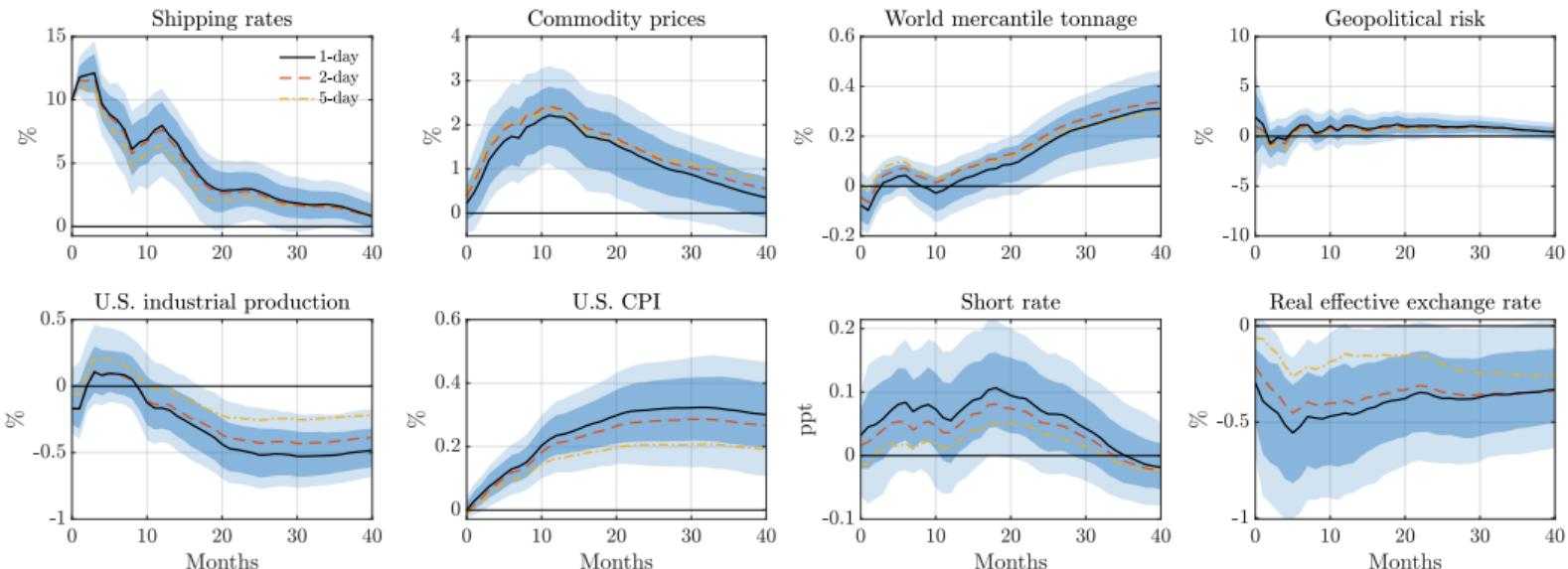
## Impulse Responses to a Supply Chain Shock



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

# Different Event Windows

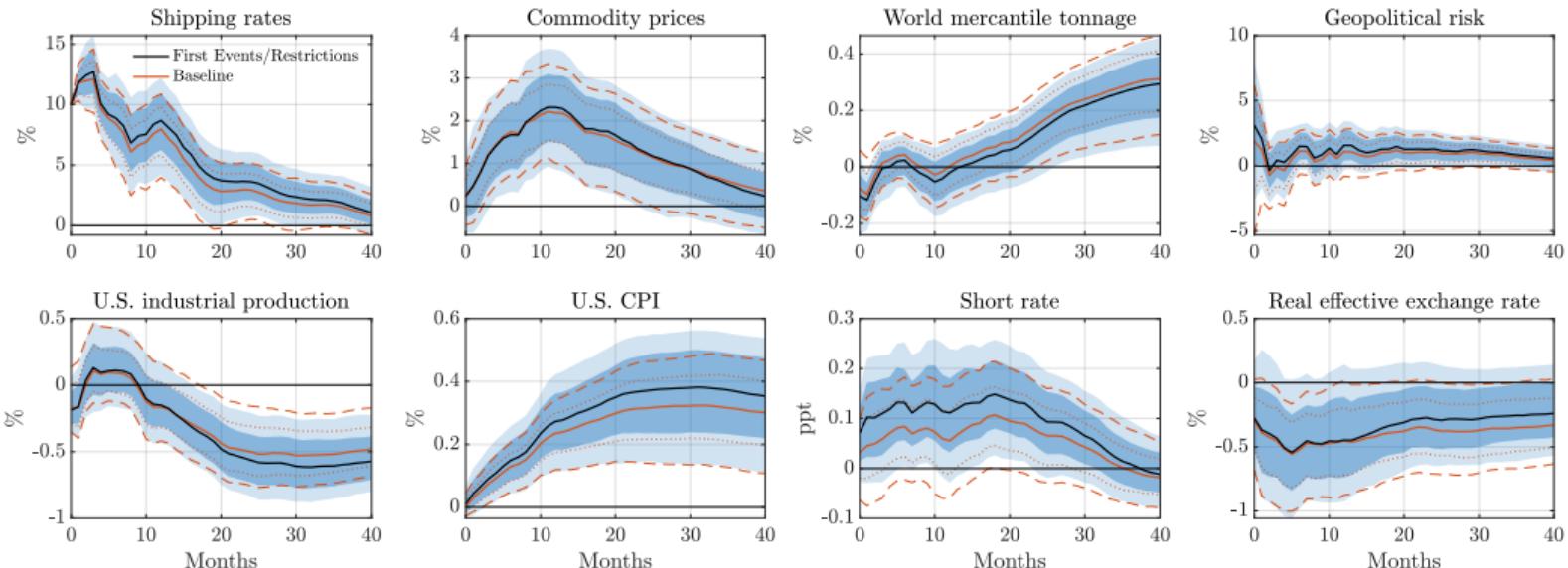
## Impulse Responses to a Supply Chain Shock



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

# First Events Only

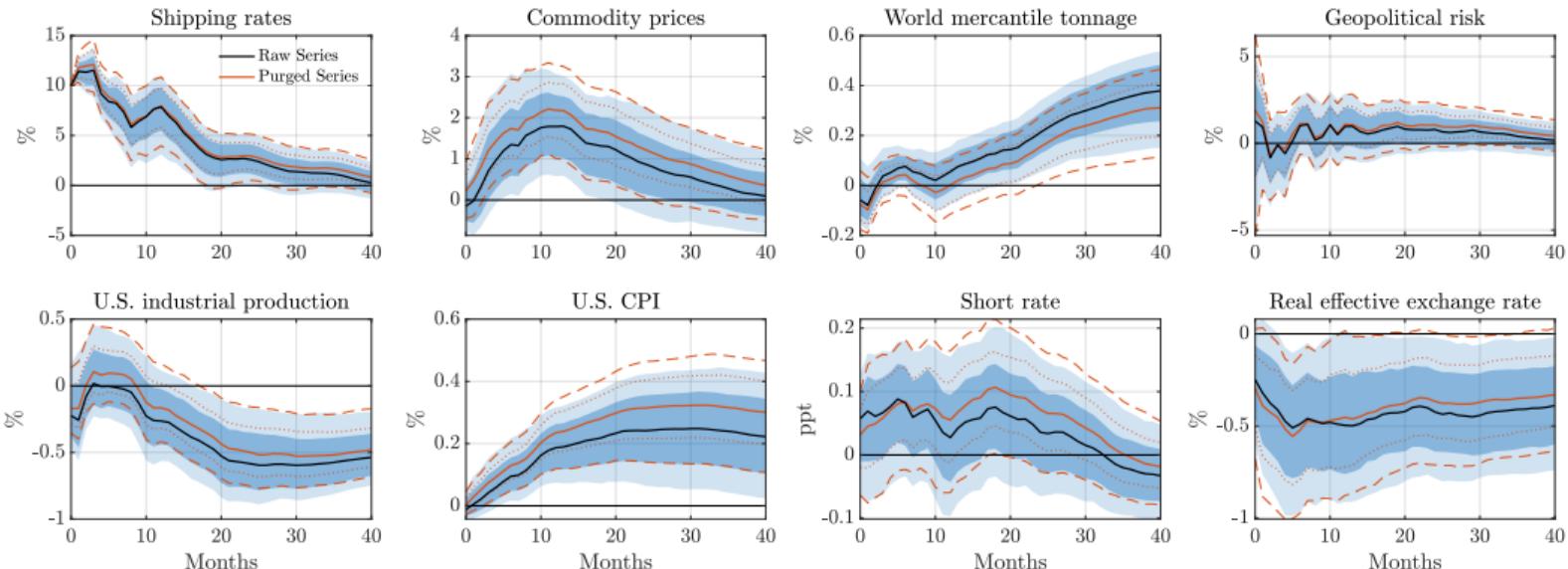
## Impulse Responses to a Supply Chain Shock



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

# 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.

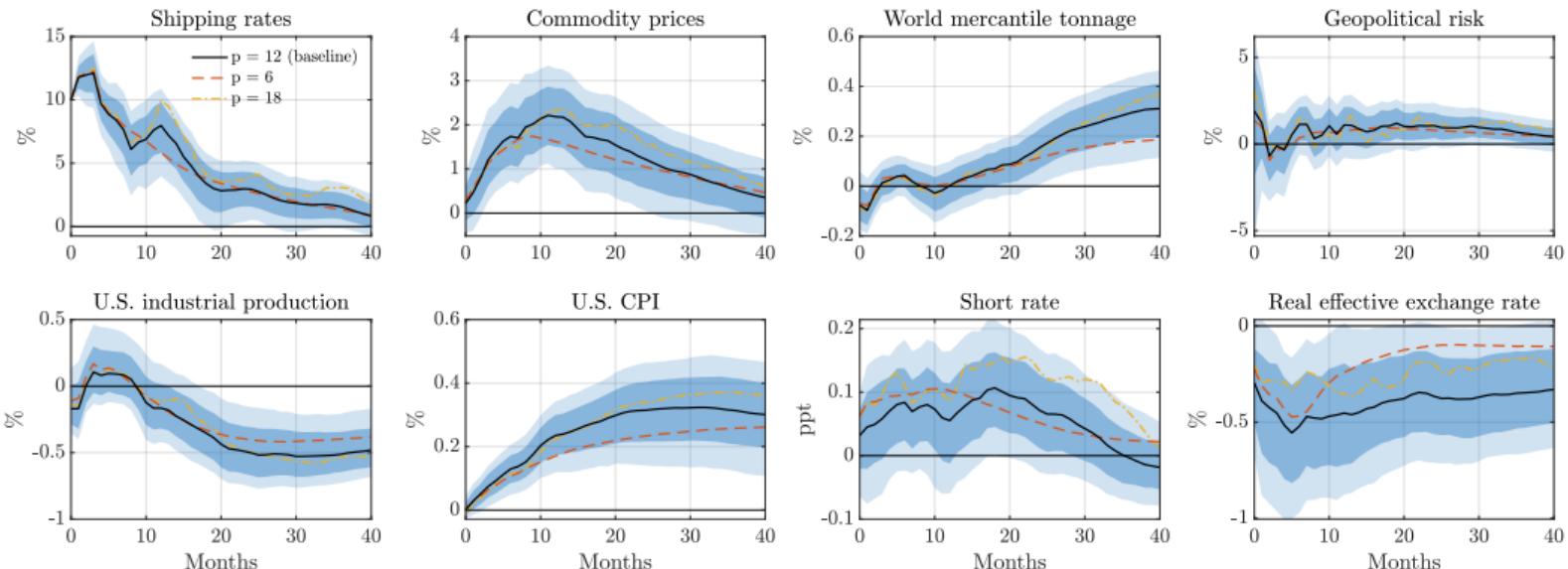
## Additional Sensitivity

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

# Lag Order

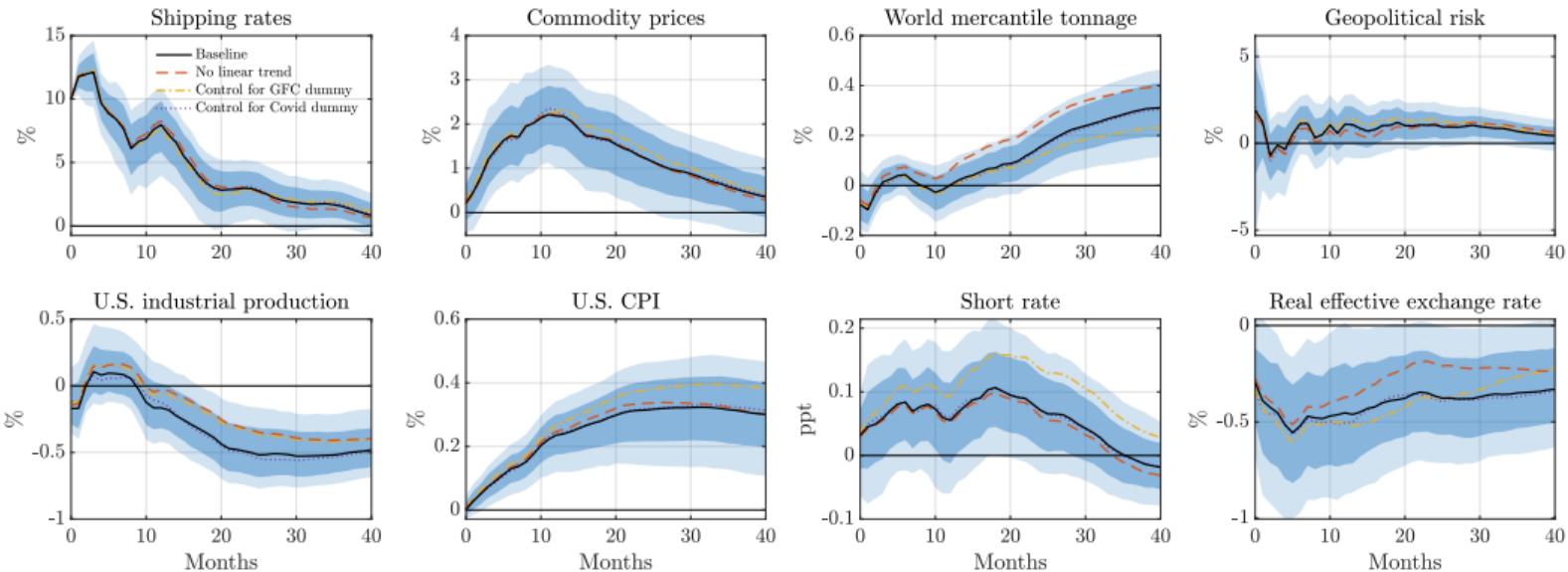
## Impulse Responses to a Supply Chain Shock



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

# Deterministics

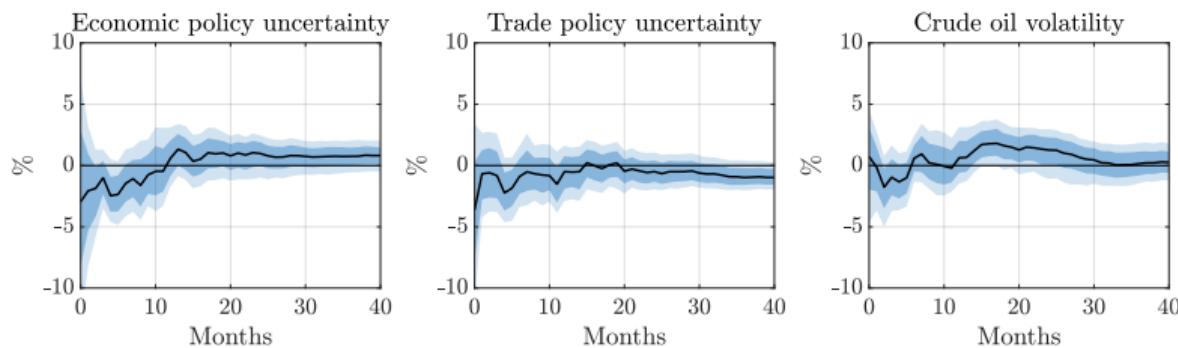
## Impulse Responses to a Supply Chain Shock



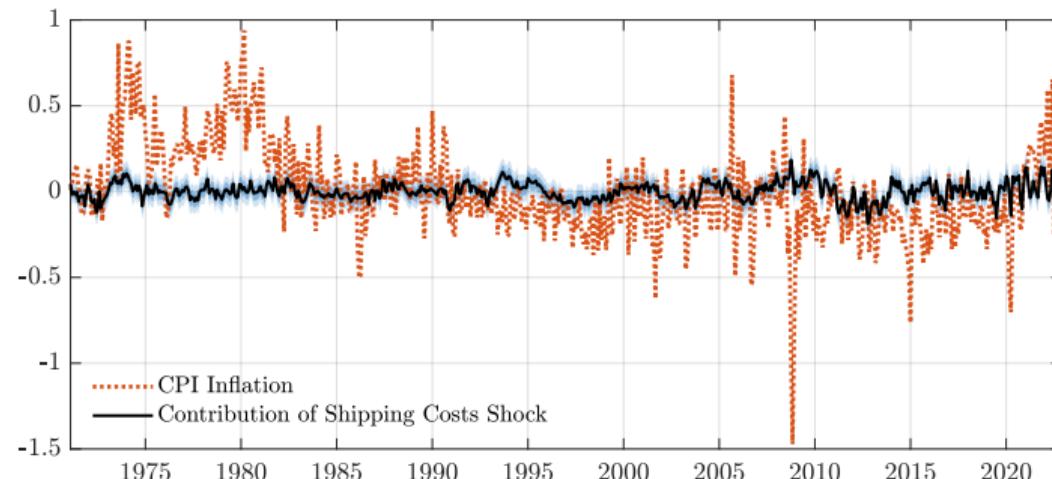
Notes: The solid line is the point estimate and the dark and light shaded areas are 68% and 90% confidence bands.

# Uncertainty

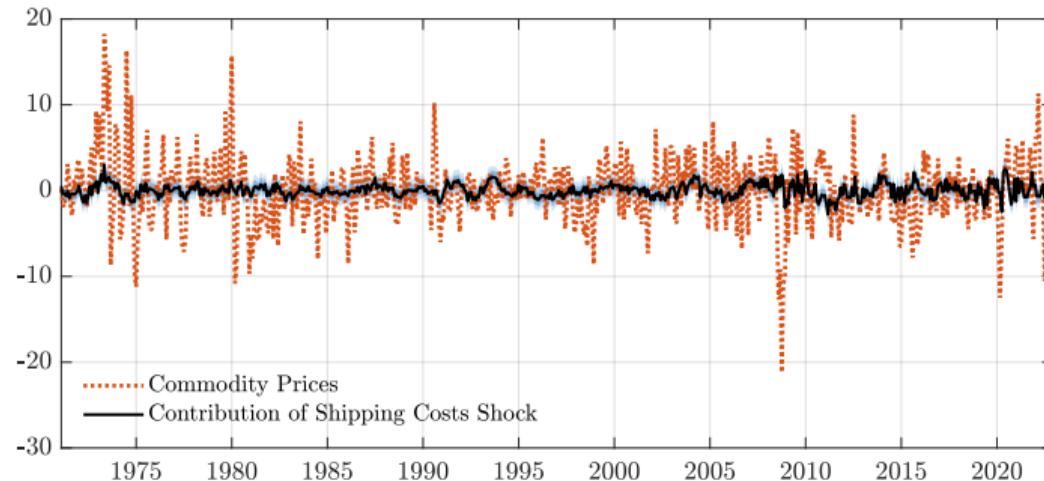
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## Historical Decomposition



## Historical Decomposition



## Historical Decomposition

