What Can Stockouts Tell Us About Inflation? Evidence from Online Micro Data

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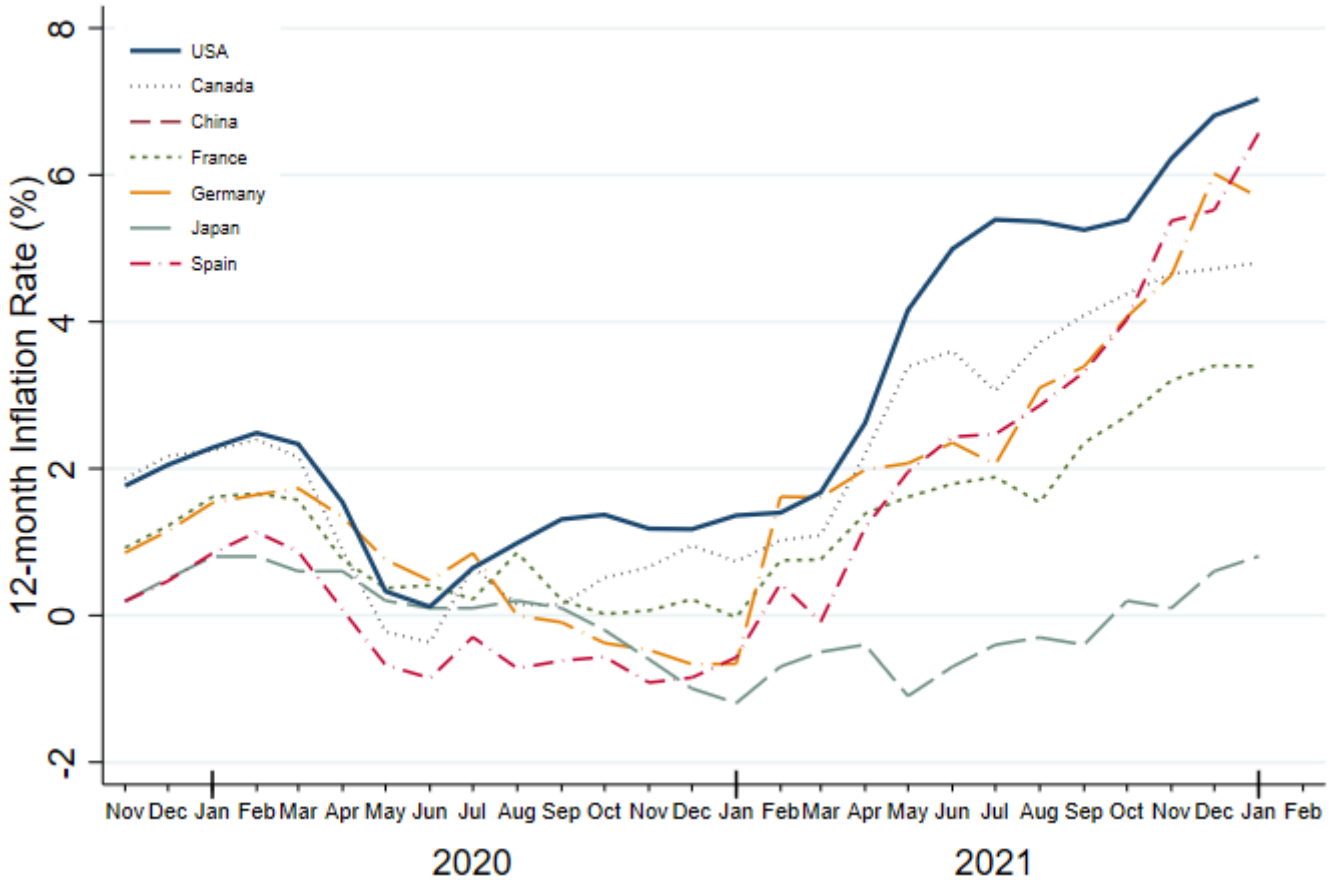
Motivation

- Inflation during Covid: fell, quickly rebounded, reached decades high by end 2021

CPI Inflation Rates



- Did supply disruptions play an important role in these price dynamics?

Paper summary

- Analyze two high-frequency measures of consumer product shortages in 7 countries
  - temporary stockouts, discontinued products
- Widespread multi-fold rise in shortages in nearly all sectors early in the pandemic
- Over time, the composition of shortages evolved from many temporary stockouts to mostly discontinued products, concentrated in fewer sectors

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- Analyze two high-frequency measures of consumer product shortages in 7 countries
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- Widespread multi-fold rise in shortages in nearly all sectors early in the pandemic
- Over time, the composition of shortages evolved from many temporary stockouts to mostly discontinued products, concentrated in fewer sectors
- Are product shortages associated with inflation?
- Do inflationary effects reflect supply-chain disruptions?
- Do retailers pass through rising costs to prices or to shortages?

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  - temporary stockouts, discontinued products
- Widespread multi-fold rise in shortages in nearly all sectors early in the pandemic
- Over time, the composition of shortages evolved from many temporary stockouts to mostly discontinued products, concentrated in fewer sectors
- Are product shortages associated with inflation? YES
- Do inflationary effects reflect supply-chain disruptions? YES
- Do retailers pass through rising costs to prices or to shortages? YES, BOTH

Prices and stockouts micro data

- We use daily product data from The Billion Prices Project, currently collected by PriceStats
- Data scraped from websites of large multi-channel retailers that sell mostly offline

<html>
<product> Leche Condensada </product>
<brand> Nestlé </brand>
<td price> $1.199 Uni </td>

	ID	ID2	PRODUCT	BRAND	SIZE	BULK PRICE	PRICE
1	3429	266235-ST	Leche Condensada	Leche Sur	Lata 395 grs.	xKilo:$1.744	689
2	3422	266231-ST	Leche Condensada	Nestlé	Descremada, Lata 395 grs.	xKilo:$2.023	799
3	995	619436-ST	Leche Condensada	Nestlé	Envase flexible 350 grs.	xKilo:$2.569	899
4	3804	399781-ST	Leche Condensada	Nestlé	Lata 397 grs.	xKilo:$1.761	699
5	11676	668674-ST	Leche Condensada	Nestlé	Pack 3 unidades, Lata 200 grs. c/u	xKilo:$1.998	1.199

Countries and sectors

- We focus on 70 retailers in 7 countries that show “out of stock” information

	Products	Retailers	Coverage of All CPI Weights, (%)	Coverage of Goods CPI Weights, (%)
Canada	194,151	11	27	80
China	49,685	3	38	76
France	372,962	11	32	63
Germany	297,320	13	27	52
Japan	95,313	7	30	68
Spain	171,400	8	31	56
USA	777,554	17	21	62
All	1,958,385	70	29	65

- Sectors: Food & Beverages, Furnishings & Household, Health, Electronics, Other goods

- Not included: Alcohol & Tobacco, Apparel, Cars, Gasoline

Measuring shortages in retail (sector *j*, country *c*, date *t*)

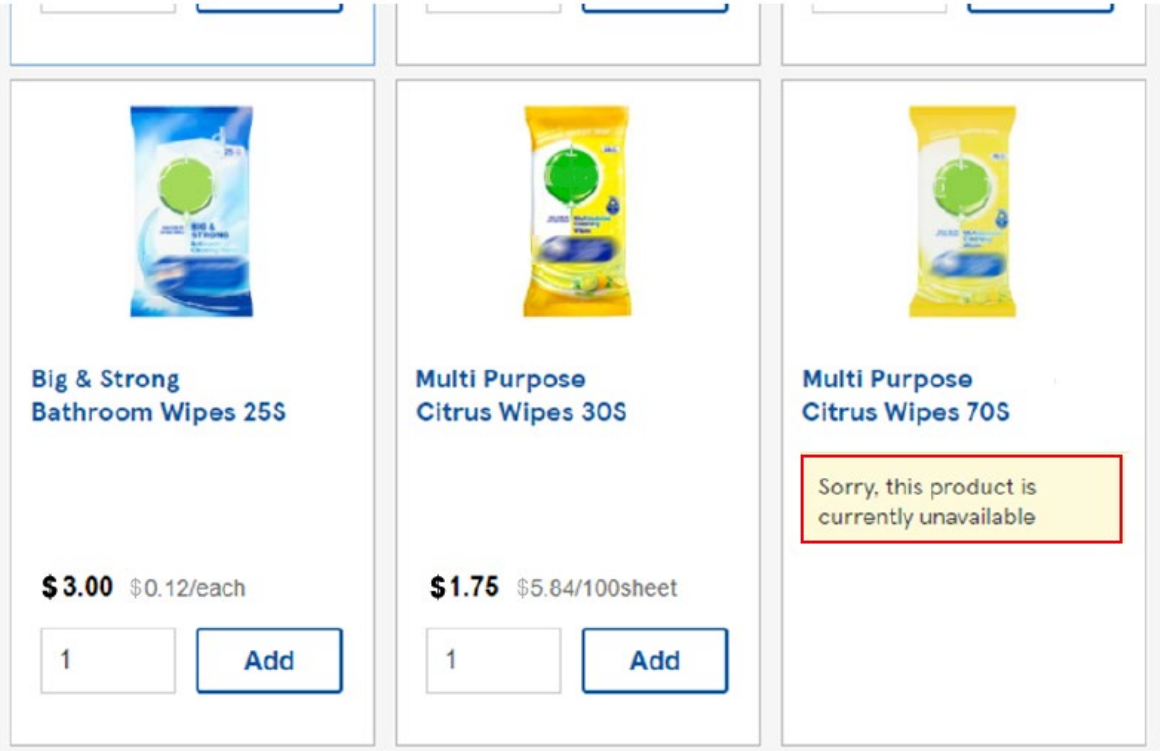

Figure 1: Identifying Stockouts on a Retailer's Website

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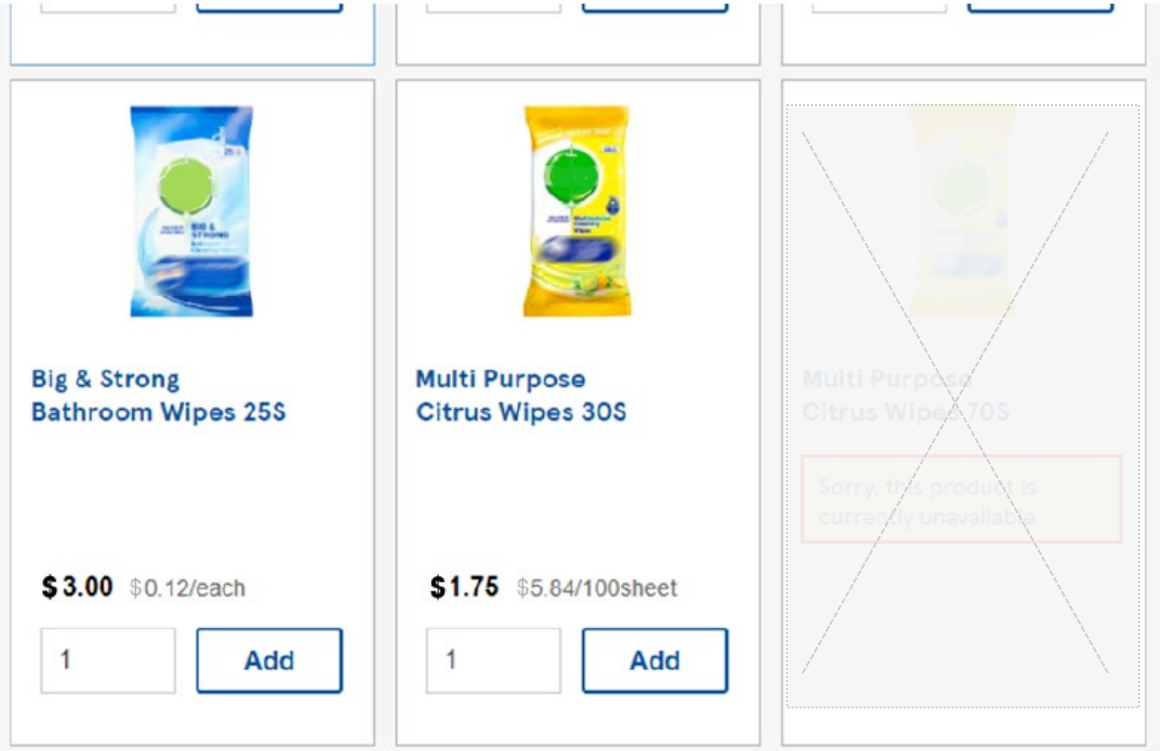

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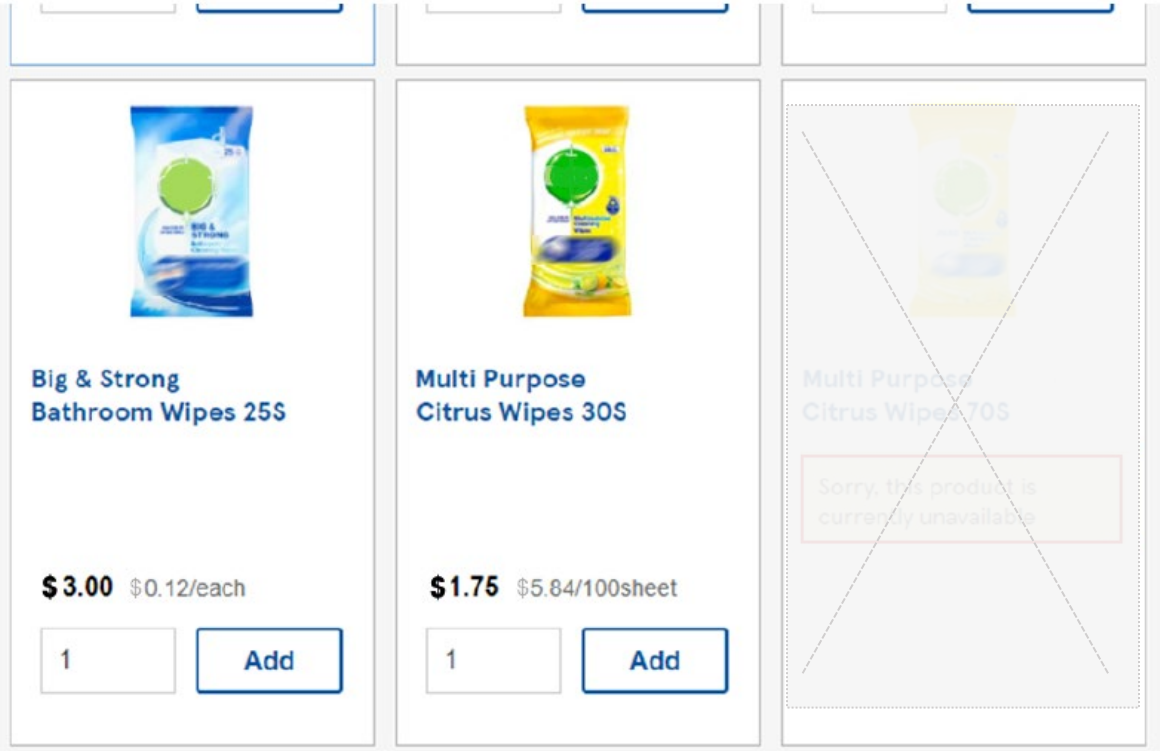

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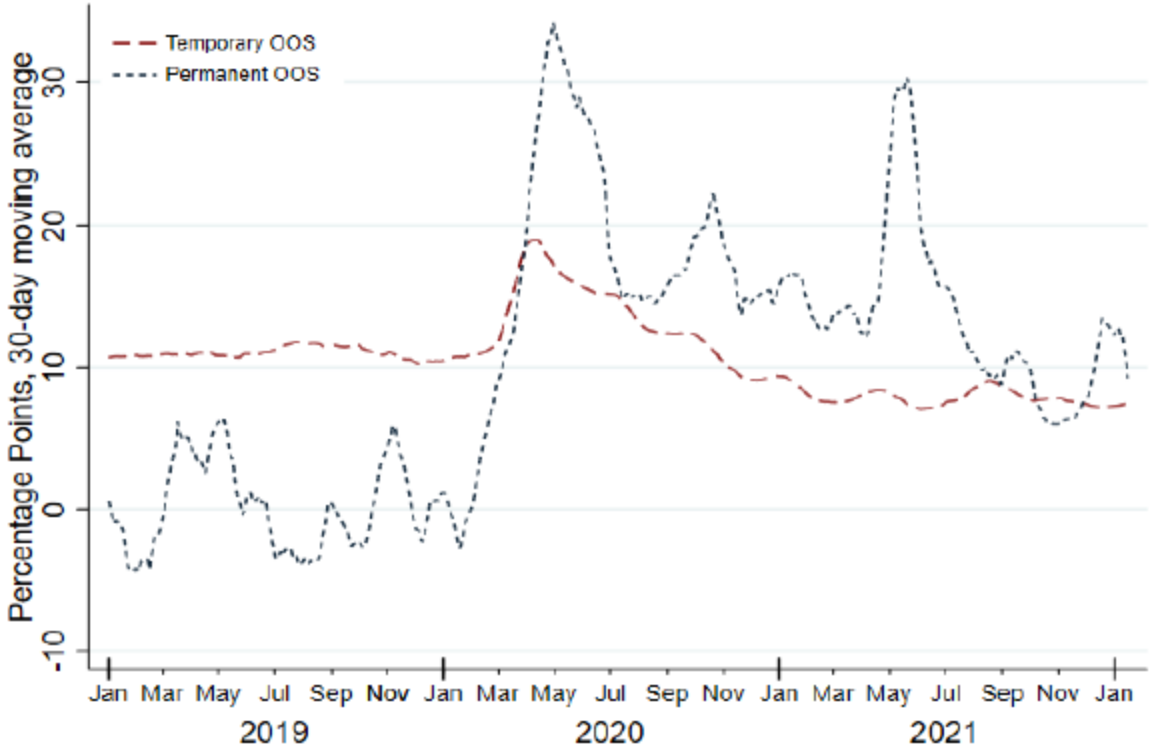
- All Stockouts = $TOOS_{jc,t} + POOS_{jc,t}$

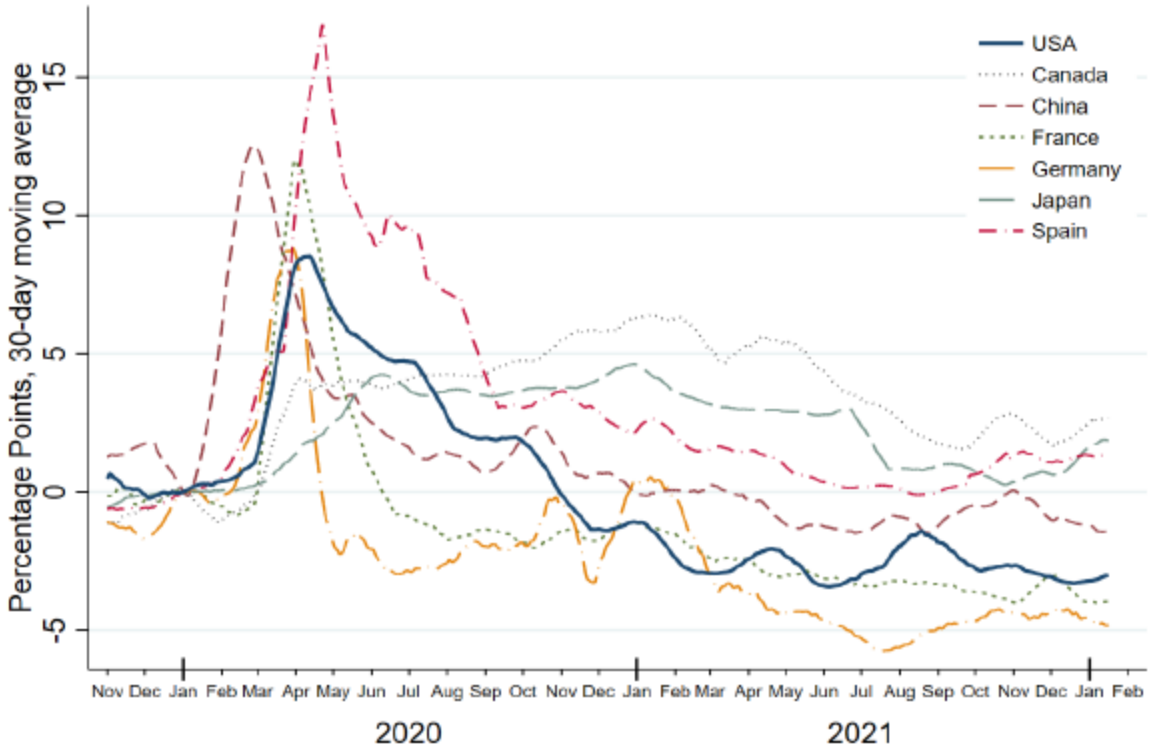
Stockout dynamics in the United States

(a) All Stockouts

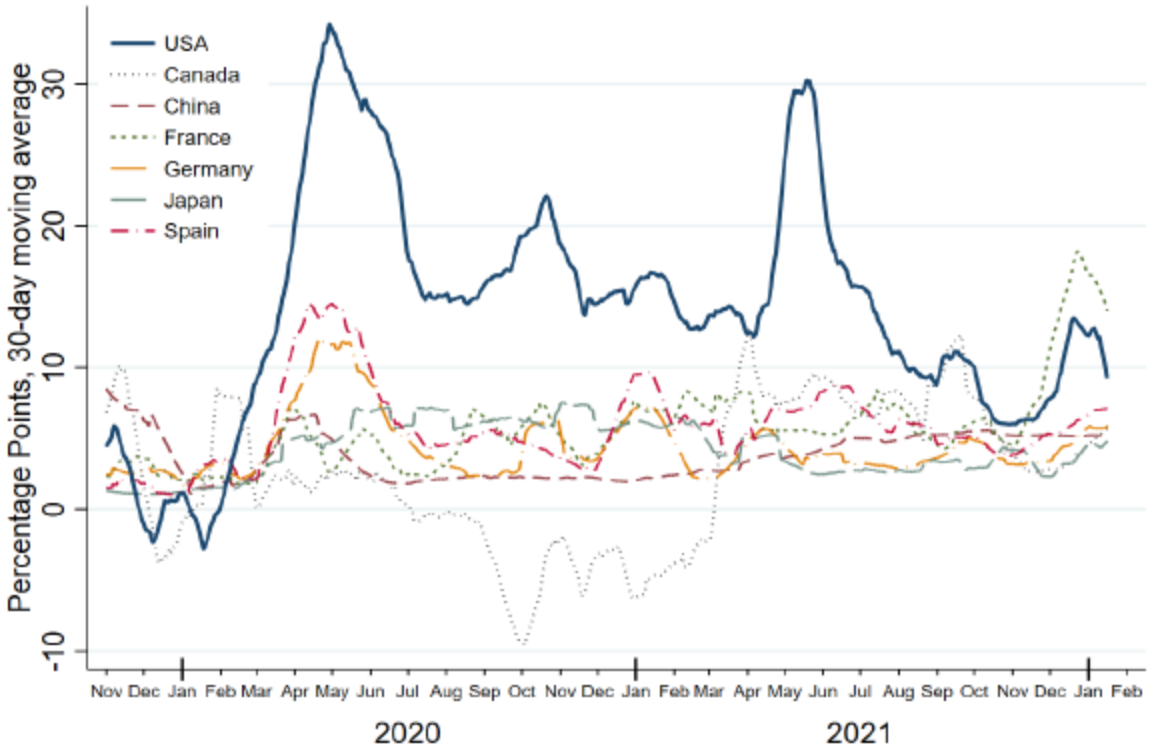


(b) Temporary and Permanent Stockouts

Stockout dynamics in 7 countries

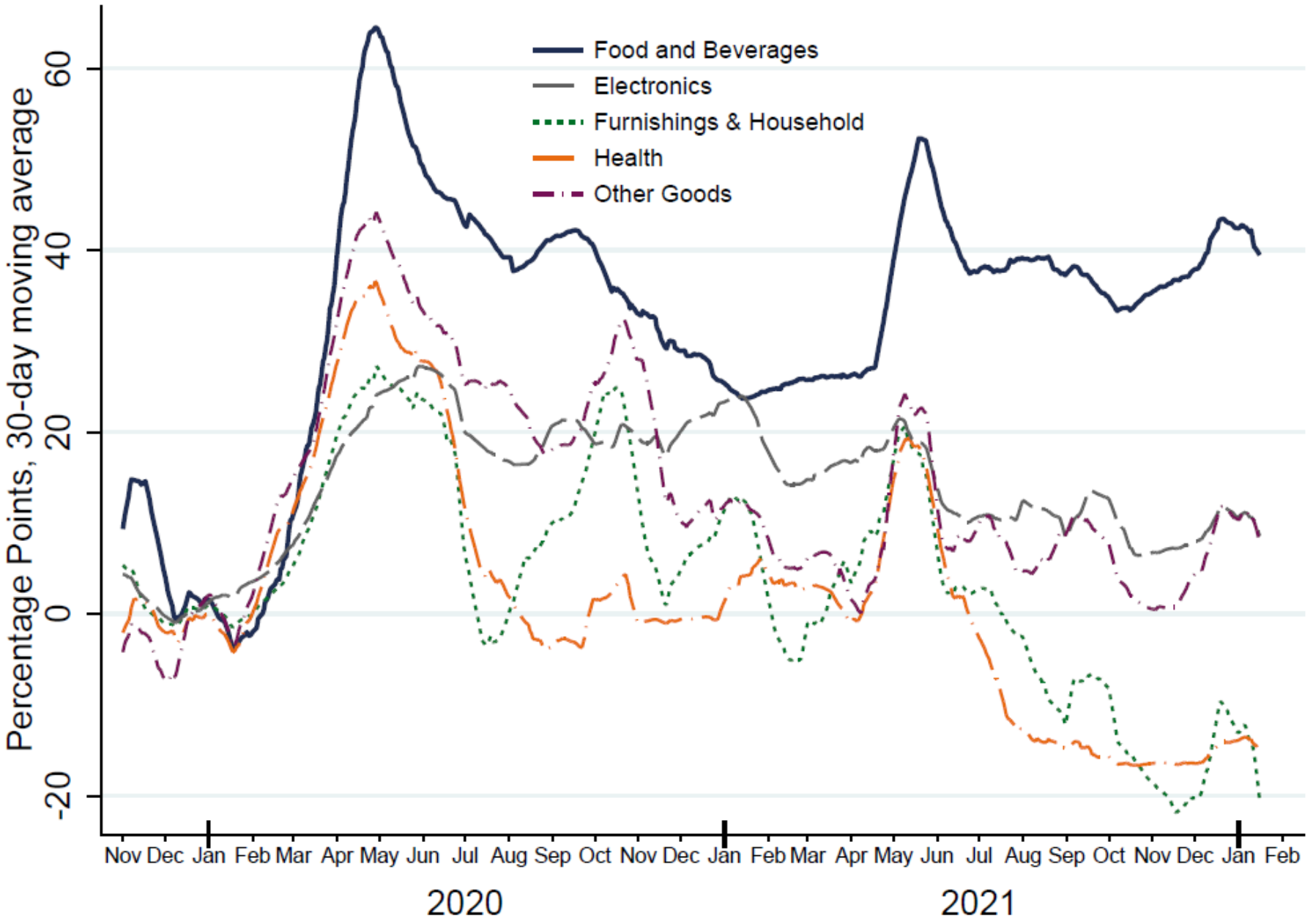


(a) Temporary Stockouts

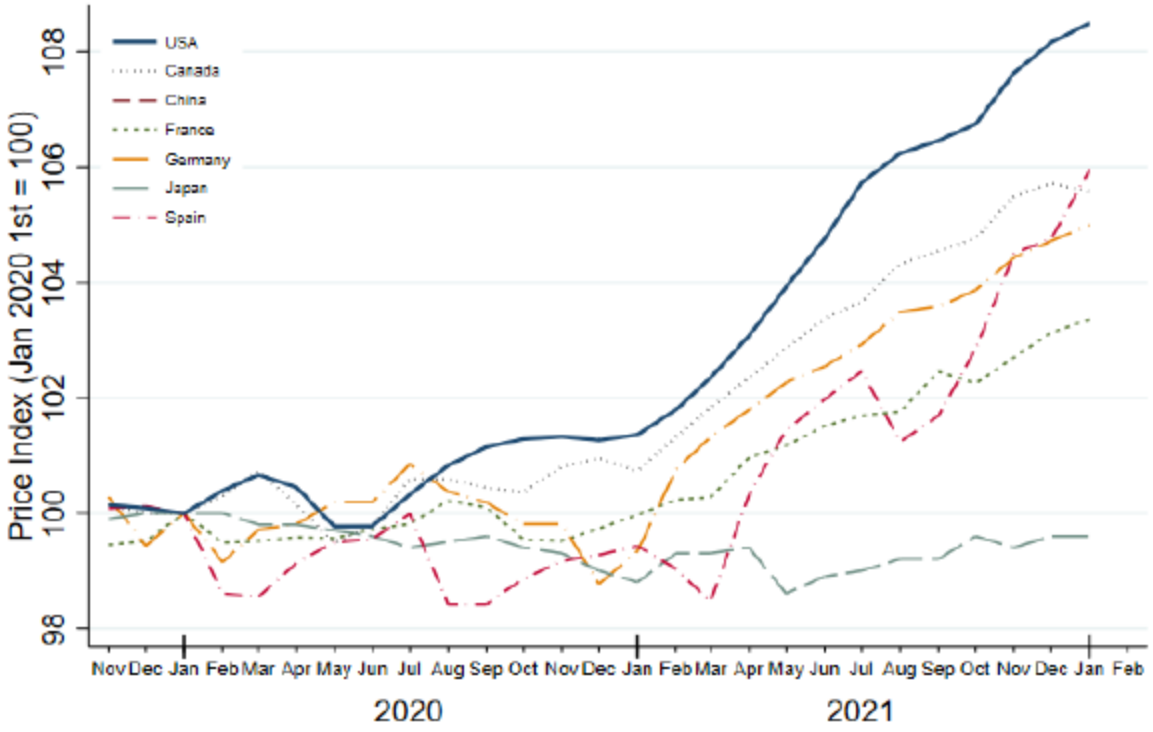


(b) Permanent Stockouts

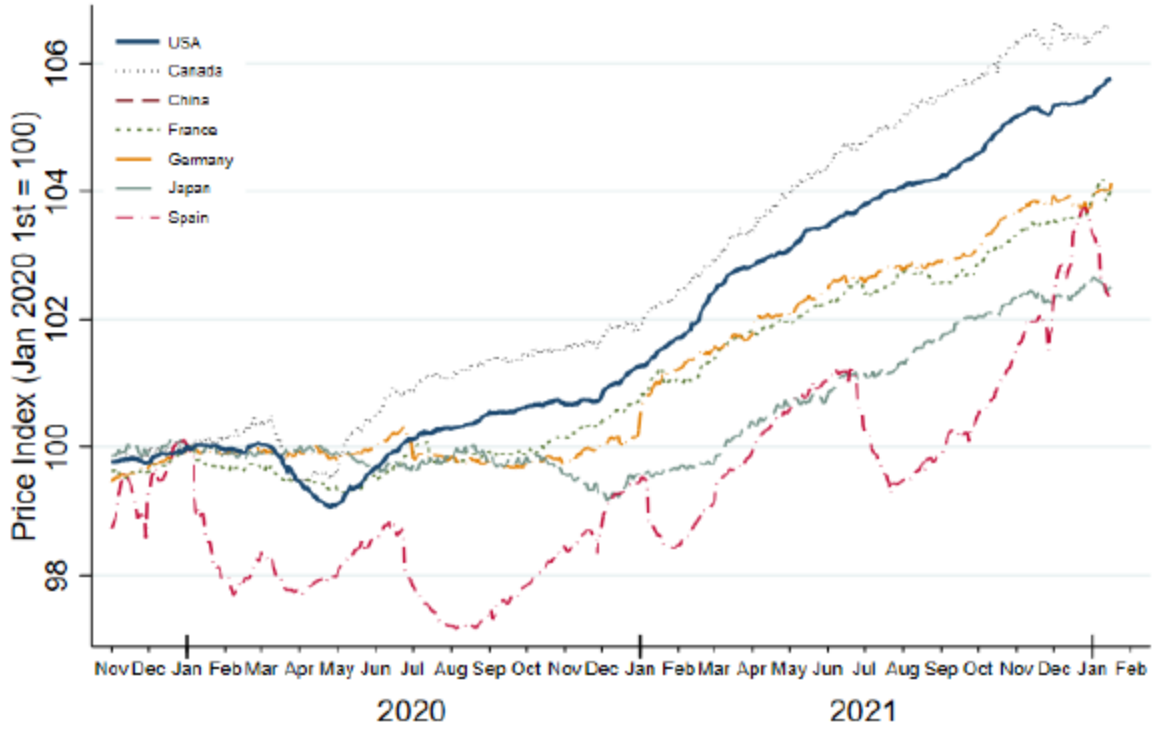
In the United States, stockouts are more persistent in Food and Electronics



Are product shortages associated with inflation?



(a) Official CPIs



(b) Online Price Indices

Estimation of responses to stockouts shocks, 235 sectors in 7 countries

- Estimate the response of inflation to an exogenous stockout disturbance at the 3-digit level

- Stockout shock: residual of an AR(1) process for the weekly stockout rate in sector *j* country *c*

$$OOS_{cj,t} = c_{cj} + \beta_{cj} OOS_{cj,t-1} + \epsilon_{cj,t}$$

- Estimate impulse responses to the stockout shock using linear projections (Jordà, 2005):

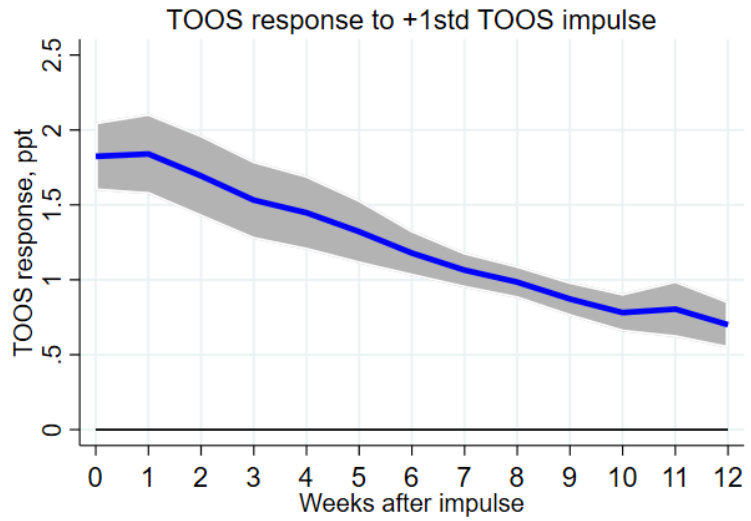
$$X_{cj,t+h} - X_{cj,t-1} = c^{(h)} + \sum_{l=0}^{L} \beta_l^{(h)} \epsilon_{cj,t-l} + \sum_{n=1}^{N} \delta_n^{(h)} X_{cj,t-n} + D_{cj} + error_{cj,t}^{(h)}$$

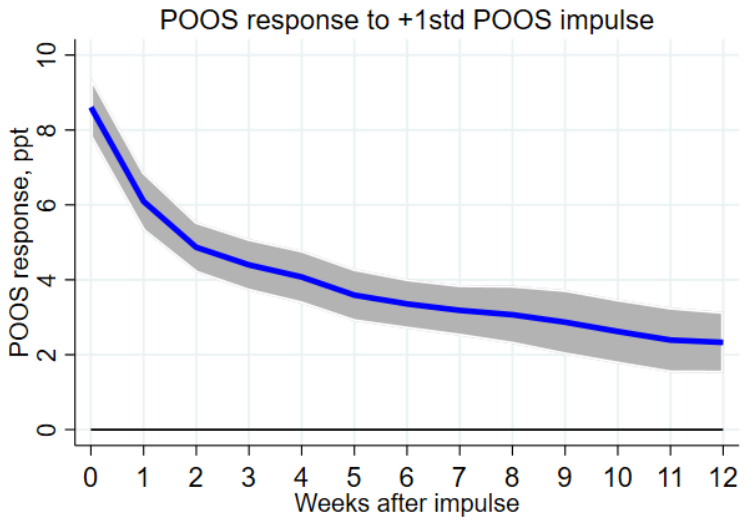
$X_{cj,t}$ is monthly inflation rate or stockout rate (*TOOS* or *POOS*)

D_{cj} are sector-country fixed effects

$\widehat{\beta}_l^{(h)}$ provide the estimated impulse response at horizon *h*

Responses to +1std OOS impulse





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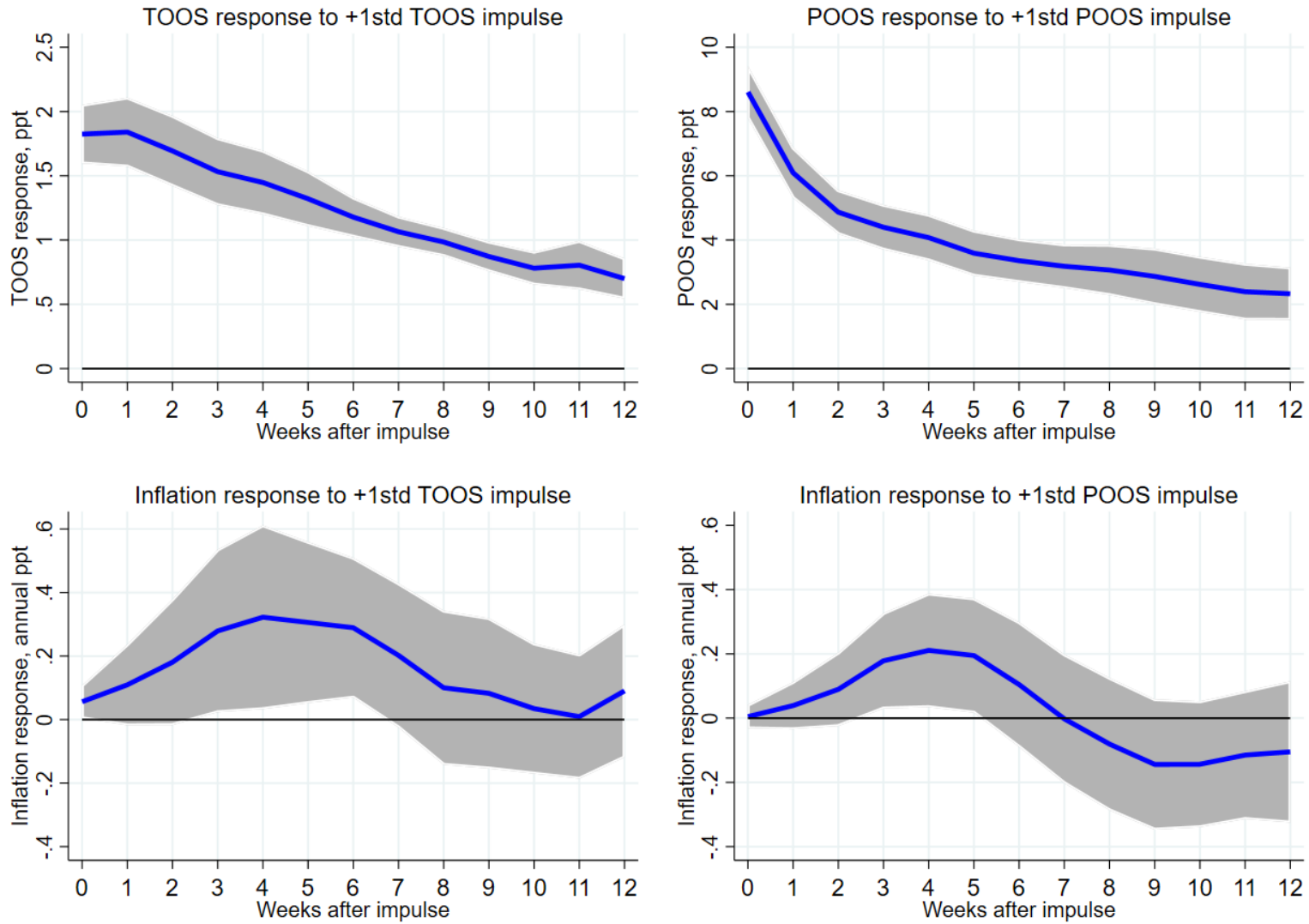

- Doubling stockouts from 10% to 20% increases sector inflation by 1.6 ppt (annualized rate)

Do inflationary effects reflect supply-chain disruptions?

- Supply disruptions during Covid impacted imported goods more domestically supplied goods:
  - Imported goods held in inventories twice as long (Alessandria, Kaboski, Midrigan, 2010)
  - U.S. Census Small Business Pulse Survey: more frequent/longer delays by foreign suppliers
  - Benigno et al. (2022): evidence from index of global supply chain pressures
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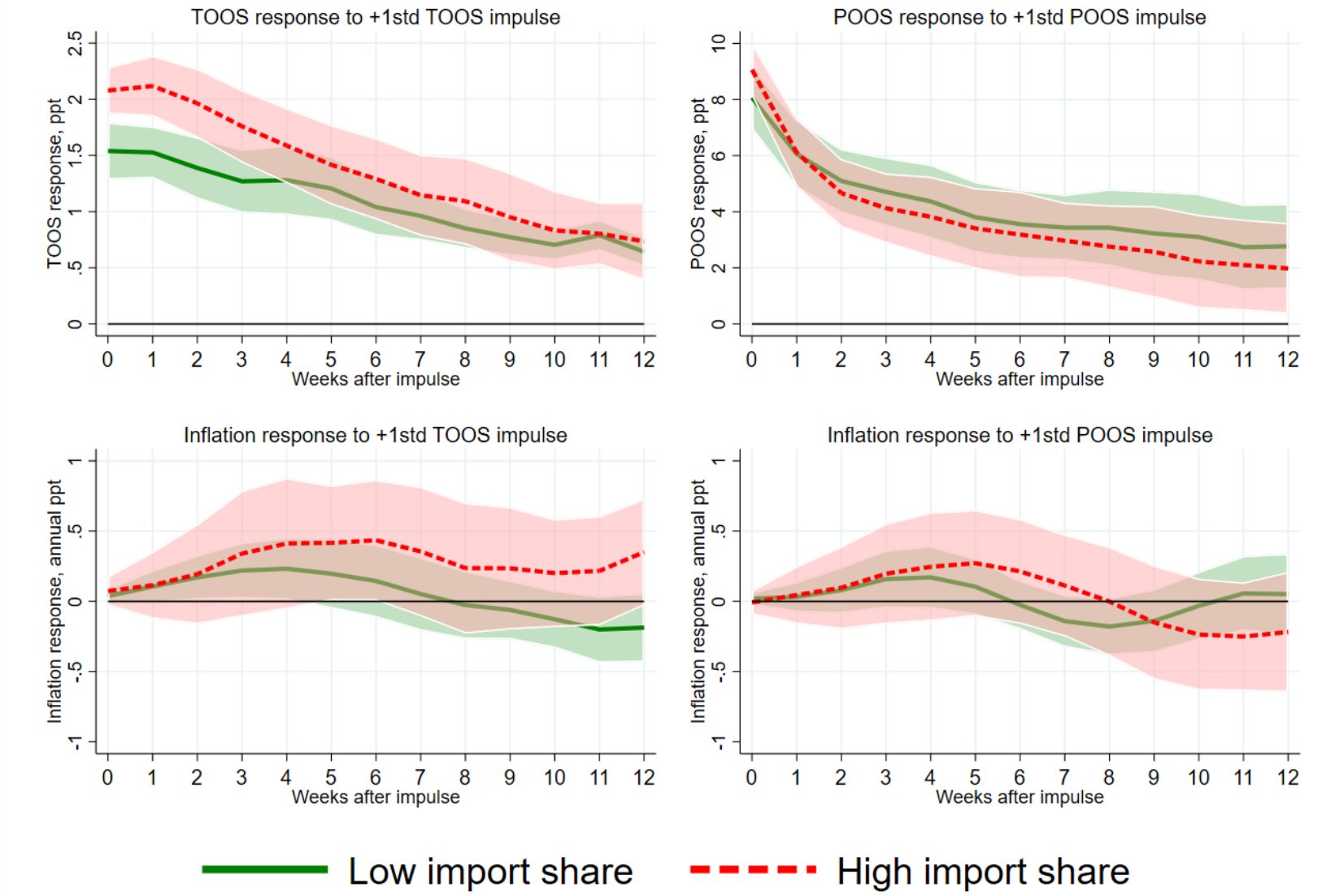
- Differentiate goods by origin:

1. Split 235 sectors (7 countries) into groups below/above weighted median import share (0.24)
   - Low shares: China, Japan, USA; unprocessed food, plants, printed material
   - High shares: Canada, Germany; video/audio equipment, furniture, jewelry and watches
2. Micro evidence from a large U.S. retailer: imported vs domestic products

Responses to +1std OOS impulse: sectors with low/high import share



World Input-Output Database: Import Share in Total Consumption = Imports / (Output + Imports – Exports)

Micro evidence from a large U.S. retailer

	U.S. Retailer
Number of products	16,953
imported	12,275
domestic	4,678
Fraction of stockouts, %	5.6
imported	5.5
domestic	4.1
Stockout duration, days	27.6
imported	26.3
domestic	18.2
Product inflation, ann %	0.86
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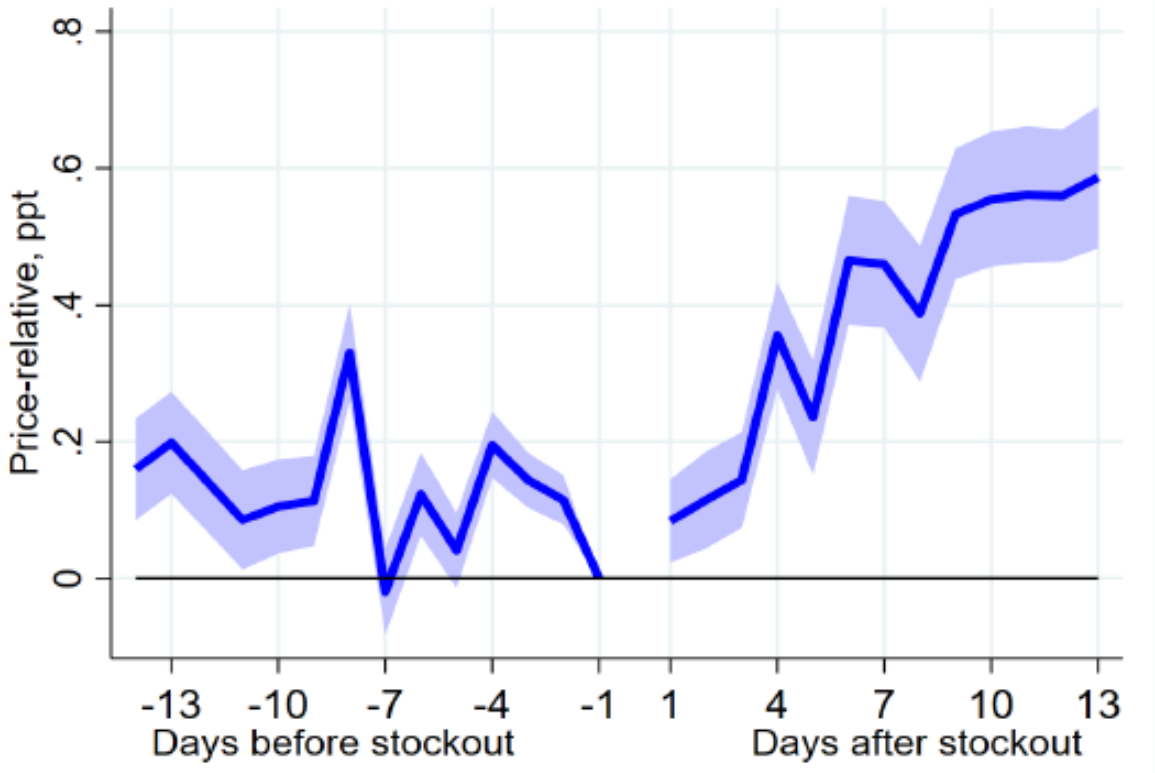
Price levels before/after a stockout



(a) All price changes

Price-relative = cum log p-change *t* days before/after day -1 relative to cum log price change for goods in sector

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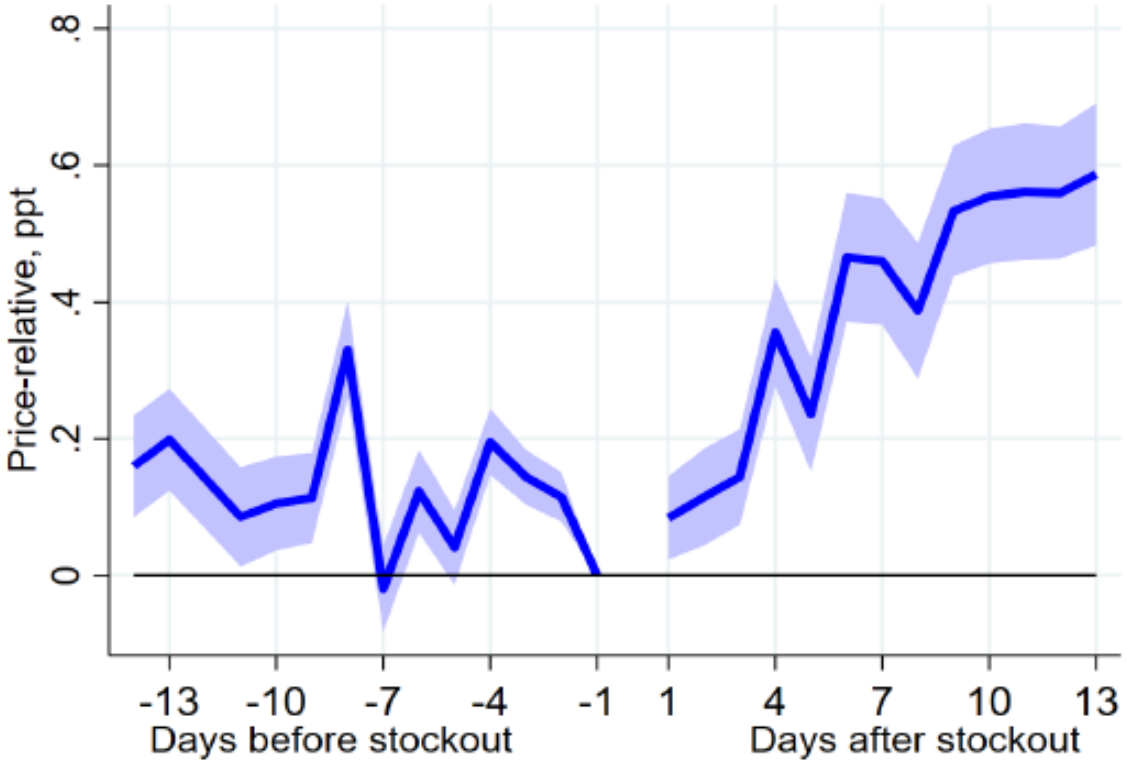

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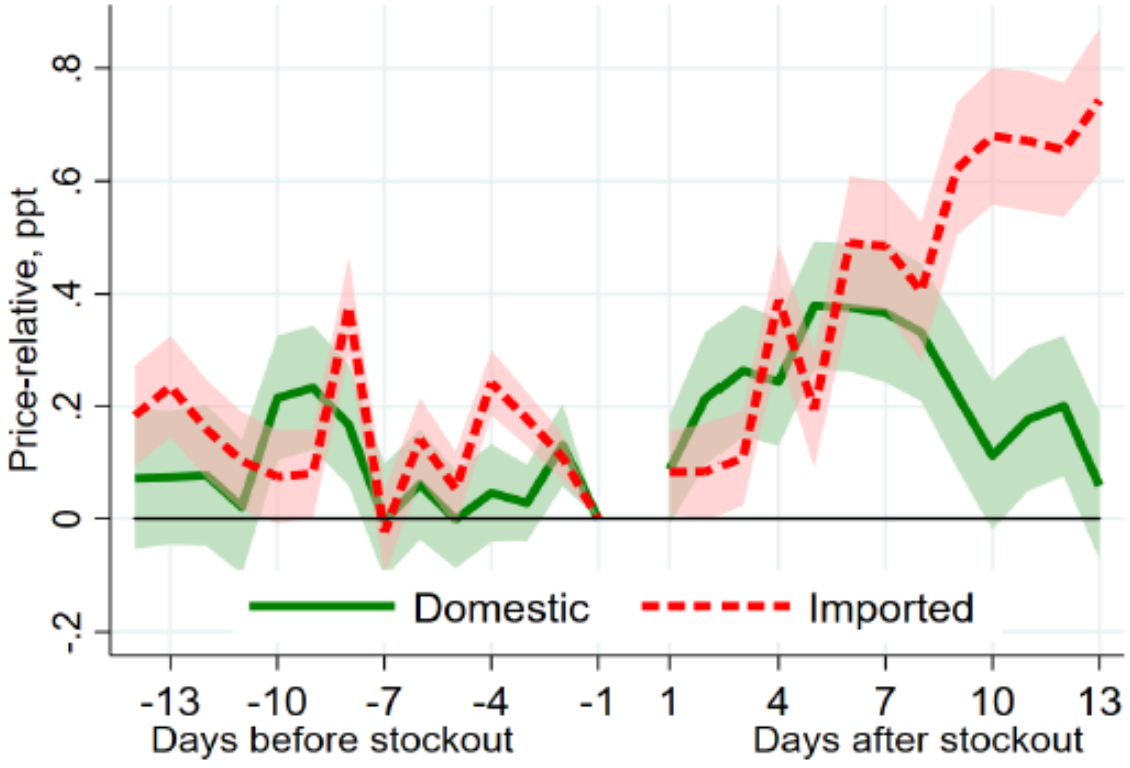

(b) Domestic versus Imported Goods

Price-relative = cum log p-change *t* days before/after day -1 relative to cum log price change for goods in sector

Do retailers pass through rising costs to prices or to shortages?

- Inventories depend on the cost of supplying/replacing goods (also interact with price decisions)

- Model of monopolistic firm with inventories (build on Kryvtsov and Midrigan, 2013)
  - Inventories help firm to manage incidence of stockouts
  - Convex cost of adjusting inventories

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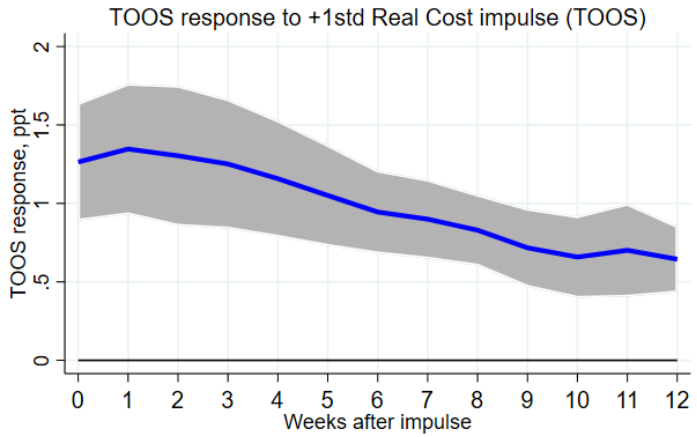
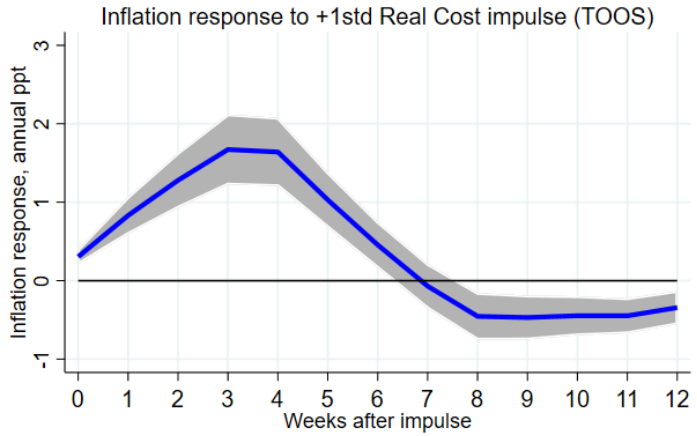
  - Inventories help firm to manage incidence of stockouts
  - Convex cost of adjusting inventories
- Model predicts:
  - Probability of temporary stockout given the firm's price, and current/future replacement cost
  - Past stockouts raise replacement costs
- Easy to aggregate to sector level and eliminate persistent component of replacement costs
- Estimate using weekly panel of TOOS and price data, obtain innovations to replacement costs

Responses to +1std sector real replacement cost impulse





- Retailers pass cost shock through to both prices and stockouts
- Endogenous stockouts → Inflation responses are relatively more volatile but less persistent

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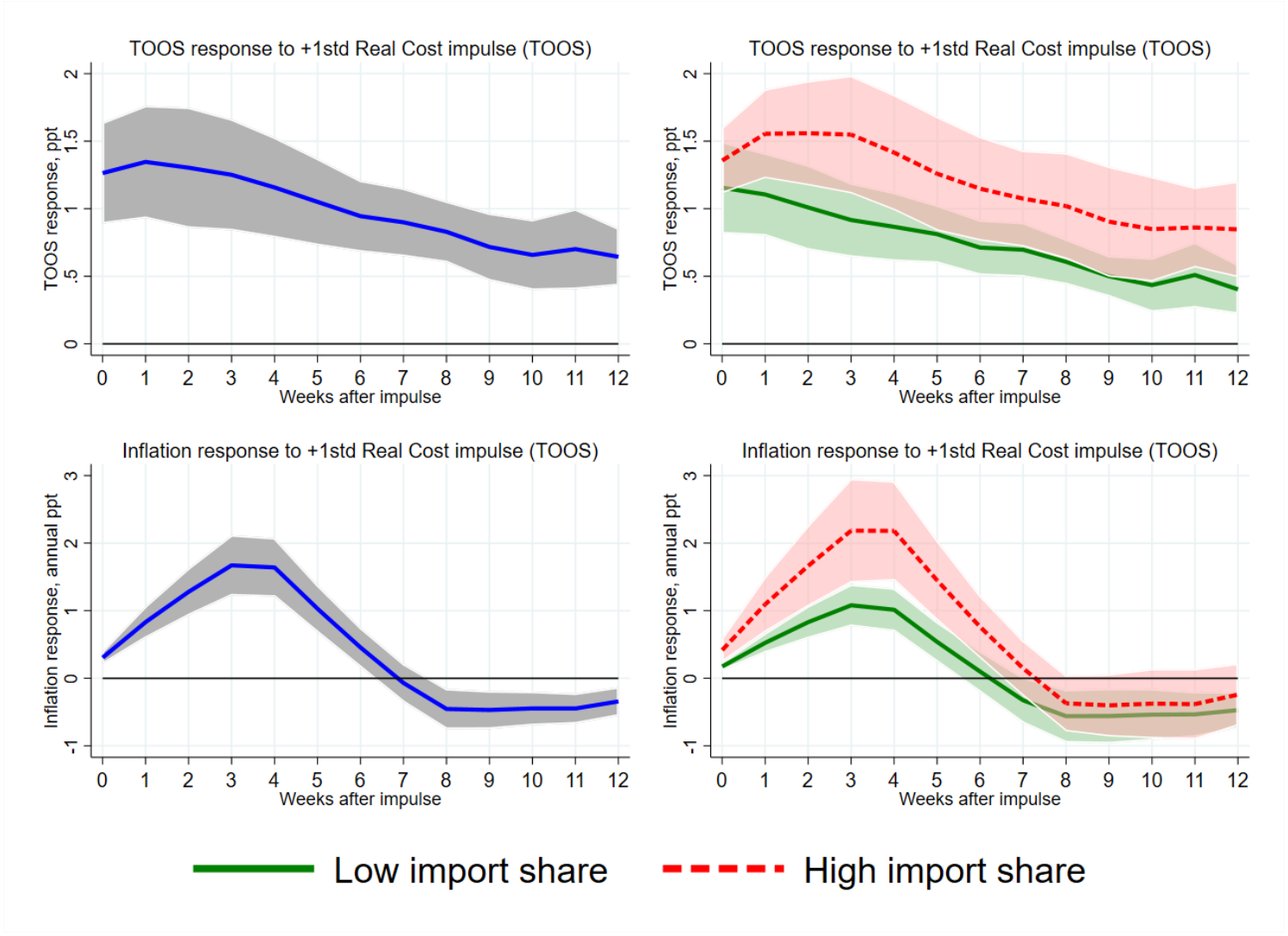

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Key results and takeaways

- Widespread increase in shortages during the pandemic

- The composition and visibility of shortages changes over time → from temporary stockouts affecting nearly all categories to permanently discontinued goods concentrated in fewer sectors

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- Widespread increase in shortages during the pandemic
- The composition and visibility of shortages changes over time → from temporary stockouts affecting nearly all categories to permanently discontinued goods concentrated in fewer sectors
- Are product shortages associated with inflation?

  Yes, product shortages have economically significant inflationary effects, within 1 to 3 months
- Do inflationary effects reflect supply-chain disruptions?

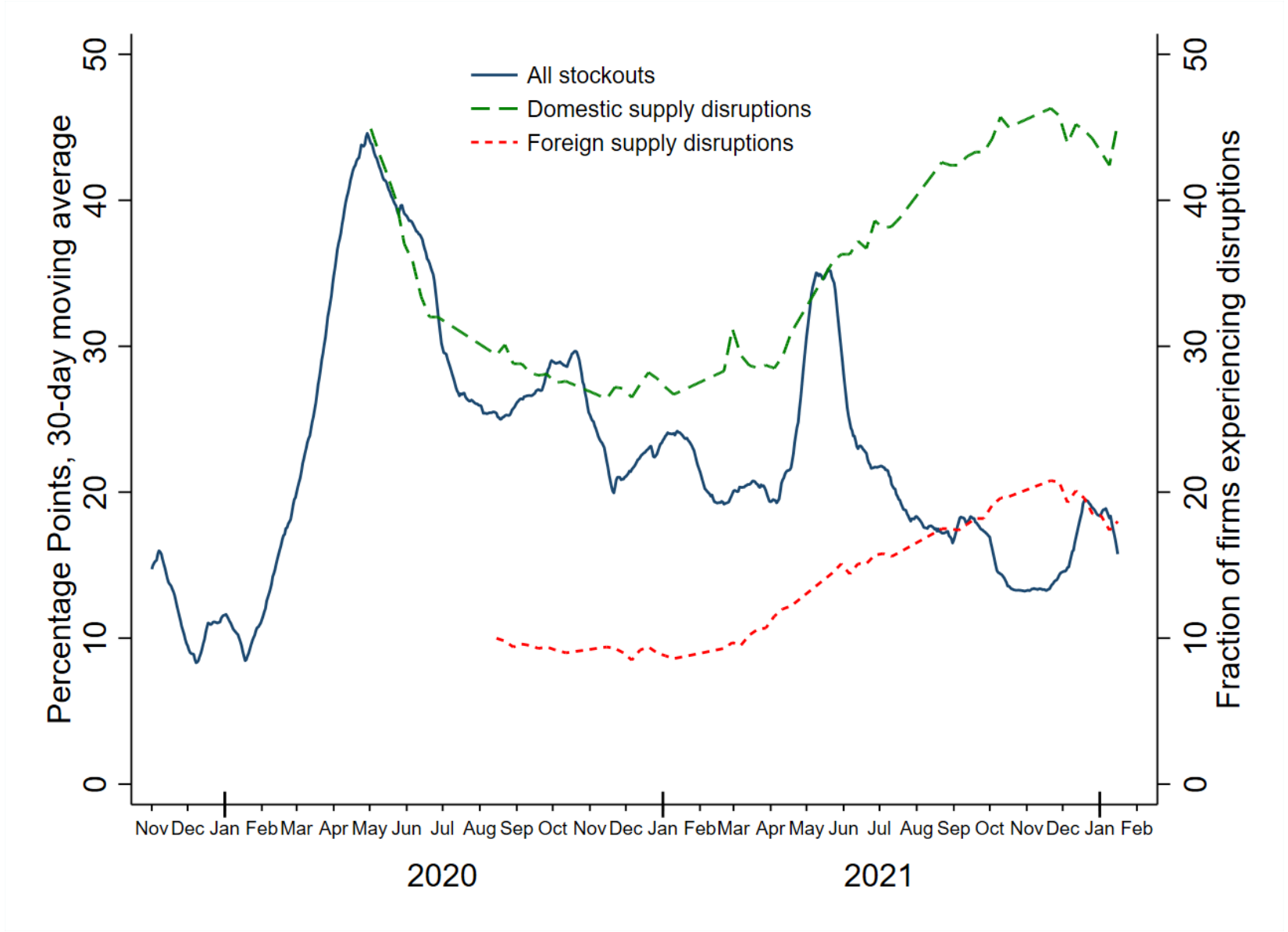
  Yes, effects are larger and more persistent for imported goods and import-intensive sectors
- Do retailers pass through rising costs to prices or to shortages?

  Retailers pass through heightened replacement cost to both prices and stockouts

THANK

YOU

U.S. Census Small Business Pulse Survey



Global Supply Chain Pressures Index (Benigno et al. 2022)