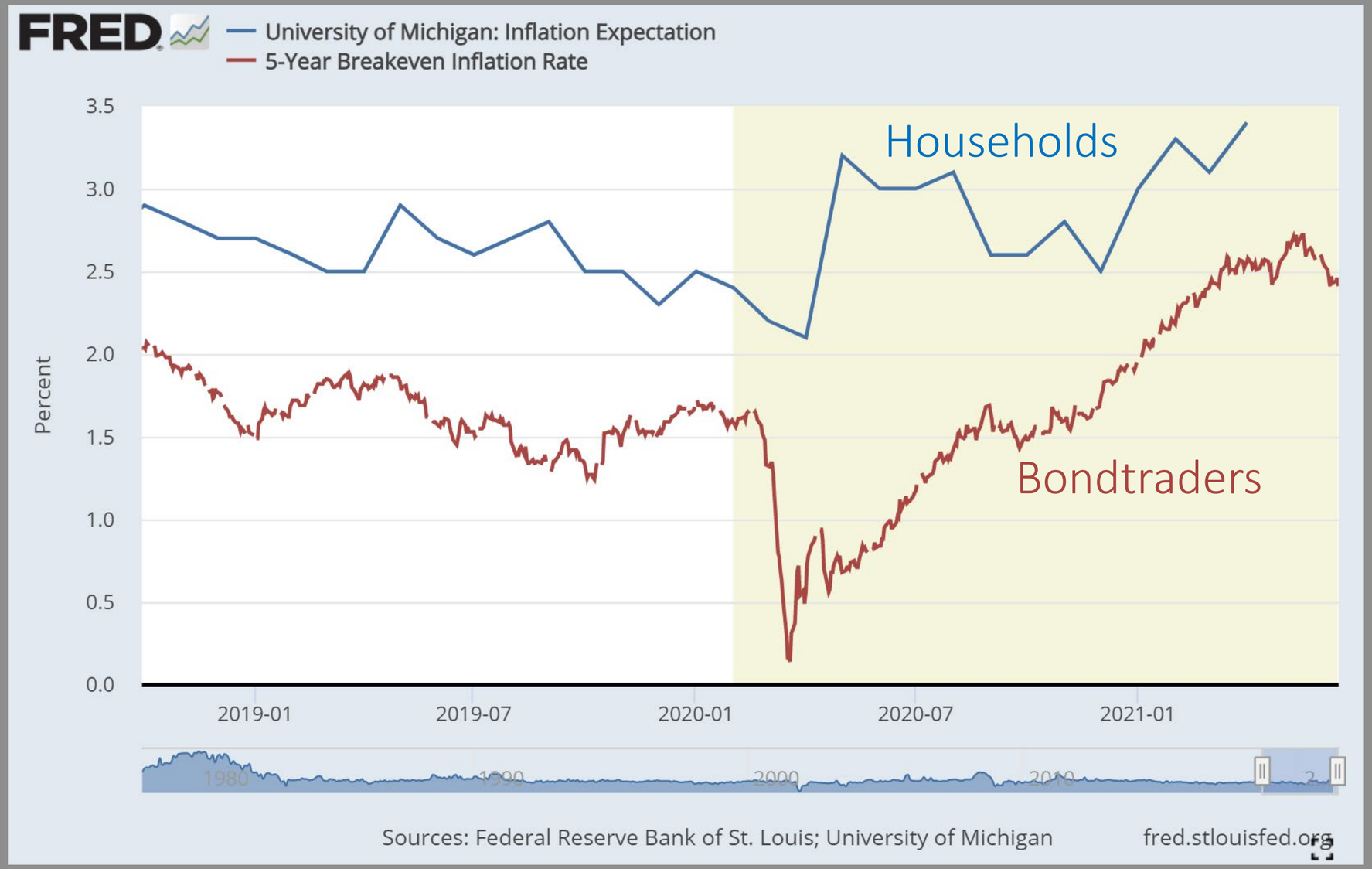
Covid Inflation: Evidence from Real-Time Data

Alberto Cavallo
Harvard Business School

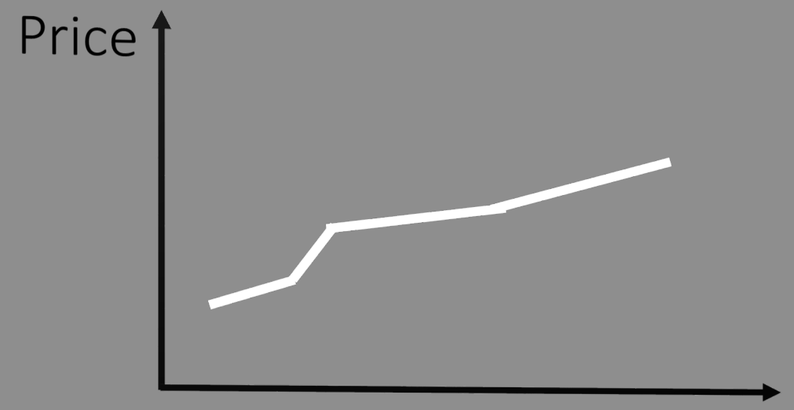
17. June 2021 Markus Brunnermeier

Inflation whipsaw

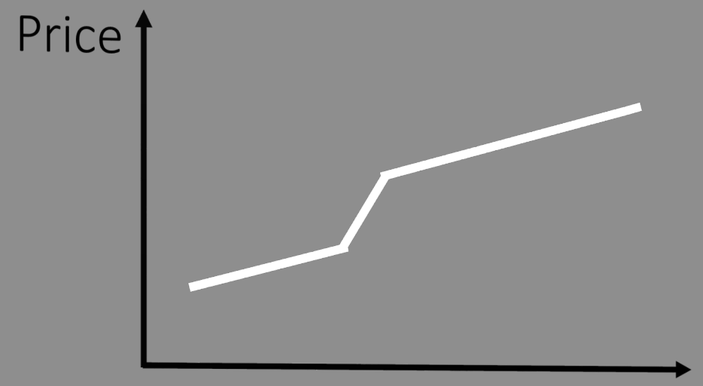


Inflation Scenarios

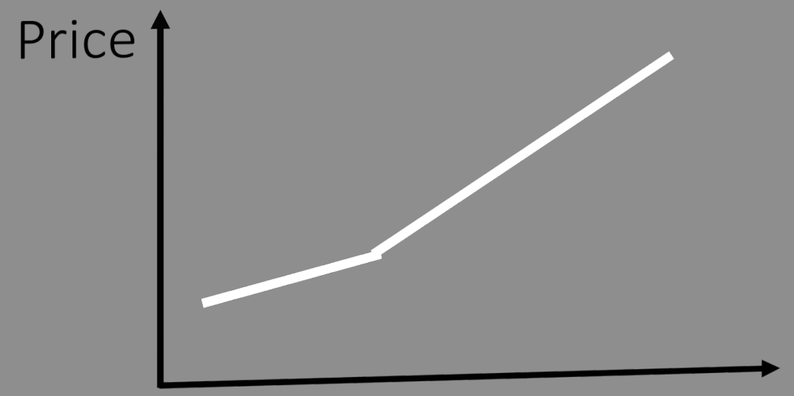
- Inflation above-below-normal



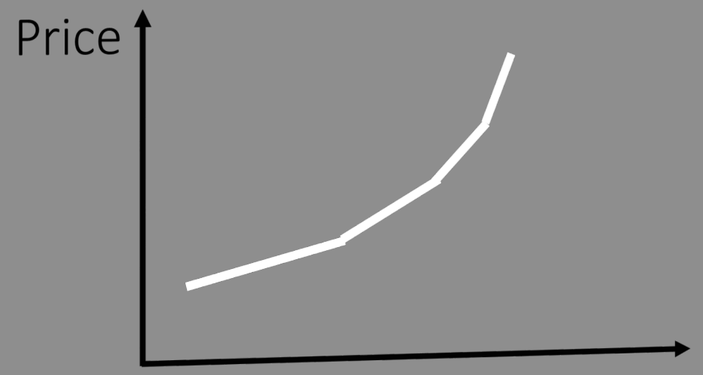
- Temporary inflation hike



- Permanent inflation increase



- Accelerating inflation

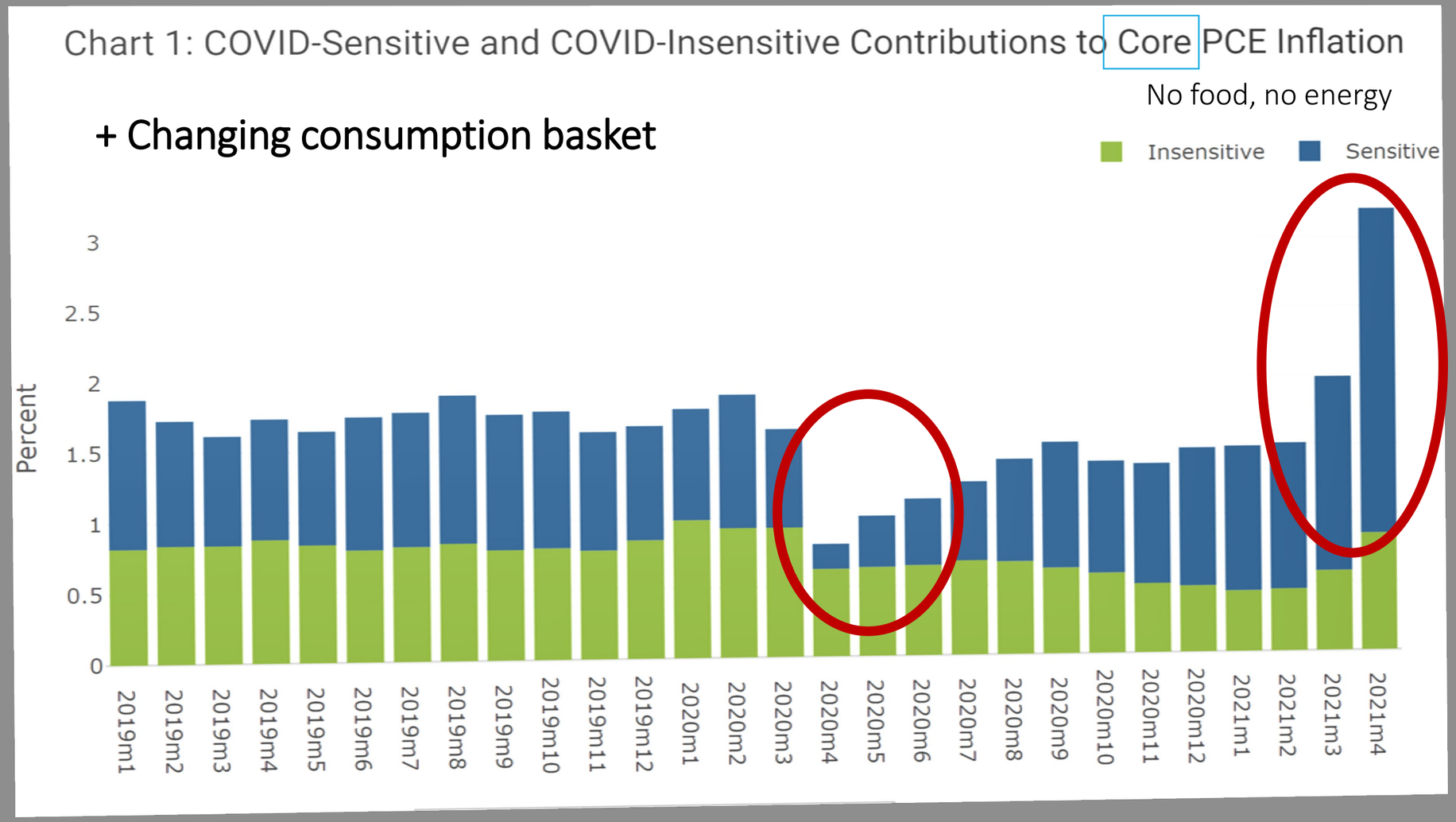


Relative Price Changes

- Inflation is not about relative price changes
  - Signal of scarcity – Hayek

- … but also signal about spike/permanent?

Simply “undoing Covid lowflation”



+ Changing consumption basket

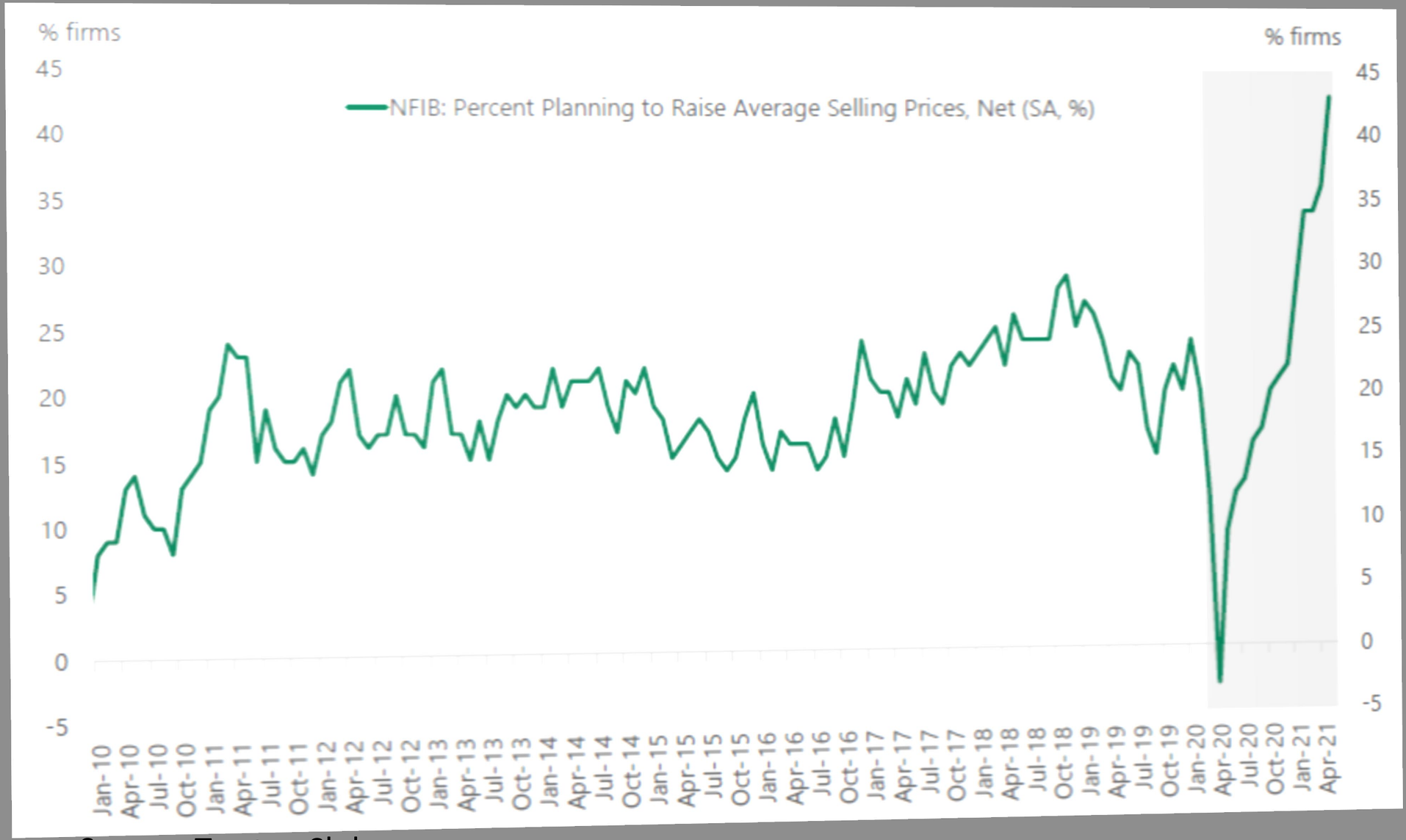
- Francisco Fed (2021San)

Temporary one-off spike or permanent?

- 1970s US inflation
  - Fed chair Arthur Burns had a mistaken theory:
    price and wage controls would control the wage-push effect
- Second round effects
  - Increase in inflation expectations
  - Wage increases beyond productivity gains
- Strength of the inflation anchor – what's a measure?
  - Media attention
  - How easy to coordinate on price increases
    - Warren Buffett on inflation triggered others to increase prices

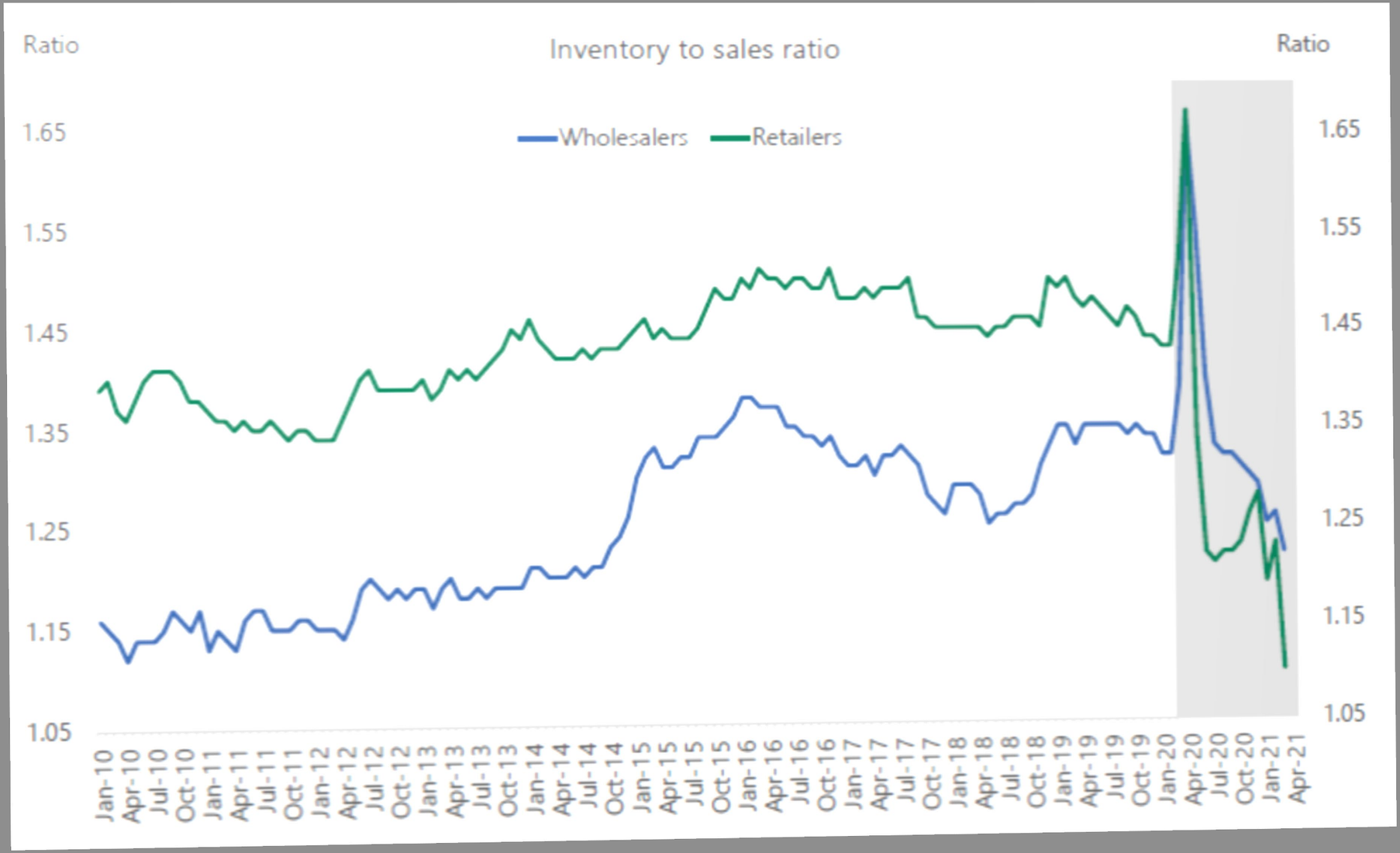
Theory & Measurement interaction

Fraction of Firms Planning to Raise Price



Source: Torsten Slok

Inventory to Sales Ratio in US



Source: Census Bureau, Torsten Slok

Poll

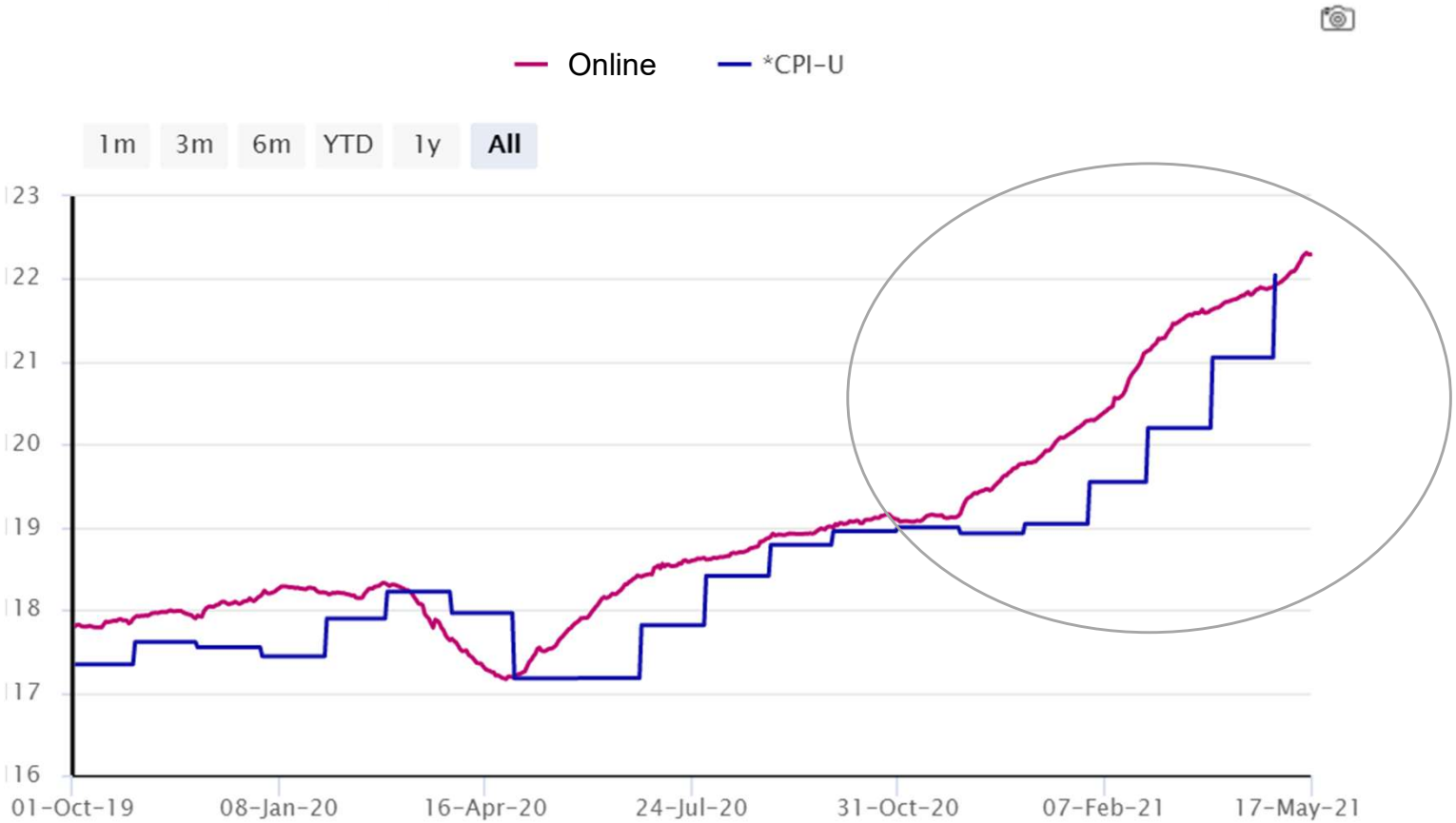
1. What is the main advantage of having private sector data for economic statistics?
   a. speed,
   b. high-frequency,
   c. details
   d. other
2. During Covid, did you personally experience …. inflation to the one measured by the CPI?
   a. Higher than measured
   b. Lower
   c. similar
3. Were you surprised with the rapid increase in US inflation?
   a. Yes
   b. No
4. Do you believe that the increase in inflation is mostly temporary?
   a. Yes
   b. No

Covid Inflation: Evidence from Real-Time Data

Alberto Cavallo
Harvard Business School, NBER

Markus' Academy – June 17th 2021

US Price Index



Source: PriceStas - State Street, BLS

Roadmap for today

- Online Price Indices
  - Main characteristics
  - Current inflation trends

- What is driving US Inflation?
  - Measurement distortions (Basket Weights)
  - Supply disruptions (Stockouts)
  - Pent-up Demand (Sales Behavior)

Inflation Measurement with Online Data

- History:
  - 2007: Argentina Lies – “Inflacion Verdadera”

“Web Scraping”

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

Online and official price indexes: Measuring Argentina’s inflation

Alberto Cavallo

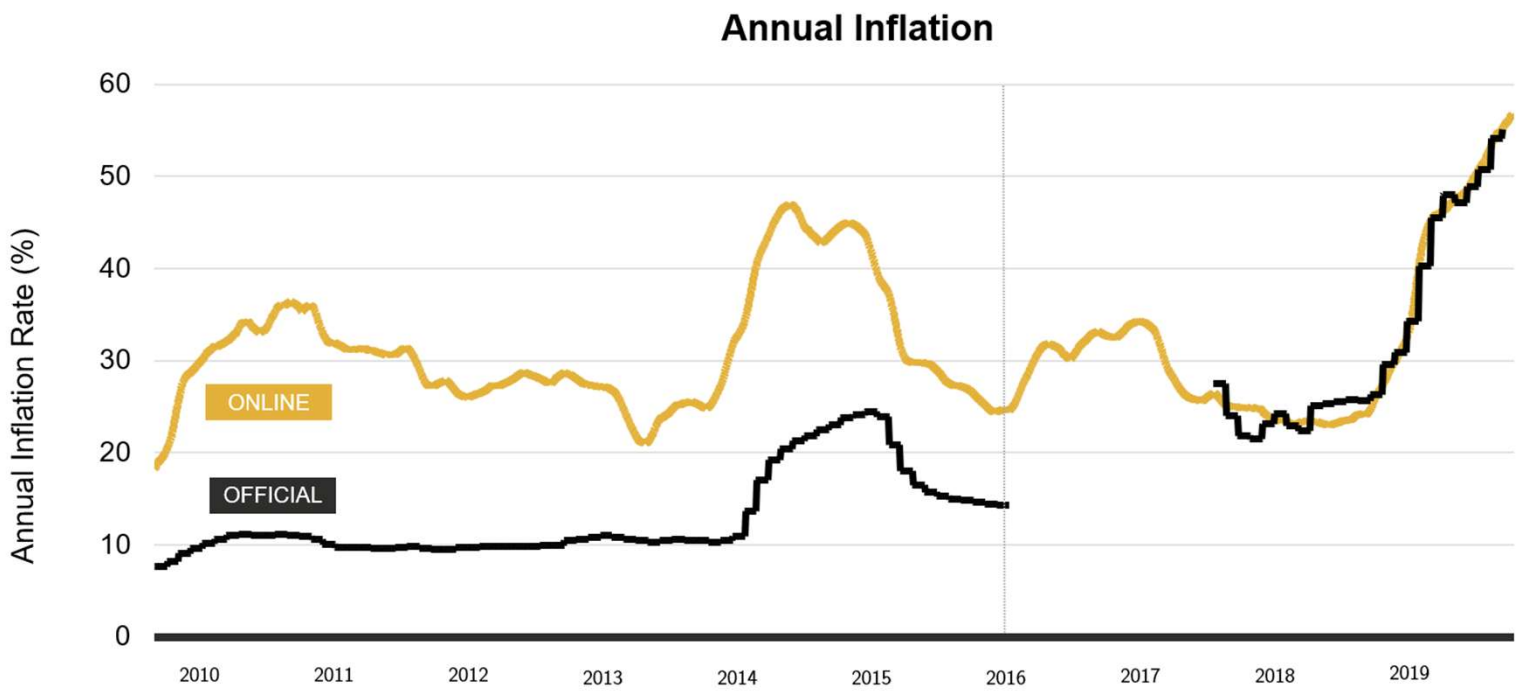
Journal of Monetary Economics, May 2013, Vol. 60 (2)

Download Paper | Download Data

Prices collected from online retailers can be used to construct daily price indexes that complement official statistics. This paper studies their ability to match official inflation estimates in five Latin American countries, with a focus on Argentina, where official statistics have been heavily criticized in recent years. The data were collected between October 2007 and March 2011 from the largest supermarket in each country. In Brazil, Chile, Colombia, and Venezuela, online price indexes approximate both the level and main dynamics of official inflation. By contrast, Argentina’s online inflation rate is nearly three times higher than the official estimate.

Inflation Measurement with Online Data

- History:
  - 2007: Argentina Lies – “Inflacion Verdadera”



Source: PriceStats, INDEC, The Billion Prices Project

Inflation Measurement with Online Data

- History:
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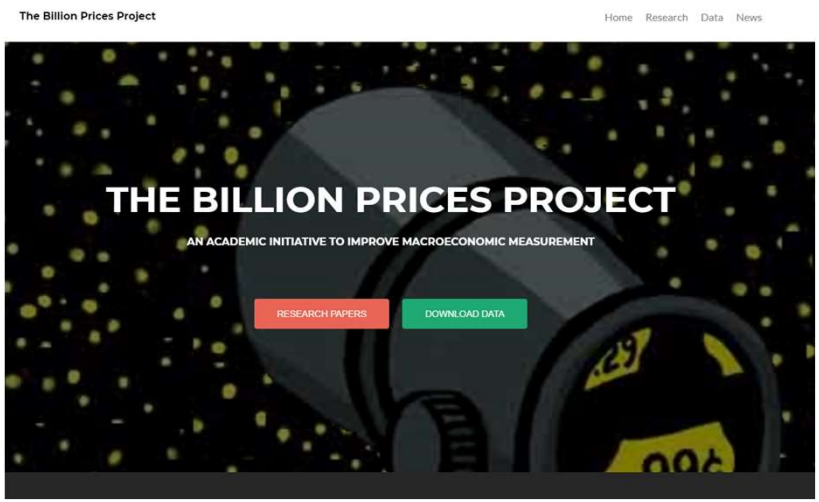


The Billion Prices Project: Using Online Prices for Measurement and Research

Alberto Cavallo and Roberto Rigobon

Journal of Economic Perspectives , Spring 2016, Vol 30(2): 151-78

Download Paper| Download Data

New data-gathering techniques, often referred to as “Big Data,” have the potential to improve statistics and empirical research in economics. This paper presents one example of how this can be achieved by using the vast number of online prices displayed on the web. We describe our work with the Billion Prices Project at MIT, and emphasize key lessons that can be used for both inflation measurement and some fundamental research questions in macro and international economics. In particular, we show how online prices can be used to construct daily price indexes in multiple countries and to avoid measurement biases that distort evidence of price stickiness and international relative prices.

Inflation Measurement with Online Data

- History:
  - 2007: Argentina Lies – “Inflacion Verdadera”
  - 2008: The Billion Prices Project
  - 2010: PriceStats (www.pricestats.com)
    - Real-time inflation in 22 countries
      - Daily data collected online
      - Over 1000 large retailers
    - PPP indicators in 8 countries
    - Data shared with Central Banks, policymakers, NSOs, and researchers

Online Data vs CPI

- Speed – Real-time (3-day lag)
- High frequency – Daily
- Low cost per observation (vs traditional survey method)
- Full price history for all goods in each retailer (micro analysis)
- Same methodology in every country & over time (comparisons)
- Official basket weights and main CPI methods
- But no hedonics, seasonal adjustments, or other special index methods
- Limited Coverage
  - Retailers: multi-channel (online and offline)
  - Sectors: Most goods, but few services and no housing

Are Online and Offline Prices Similar? Evidence from Large Multi-Channel Retailers

Alberto Cavallo

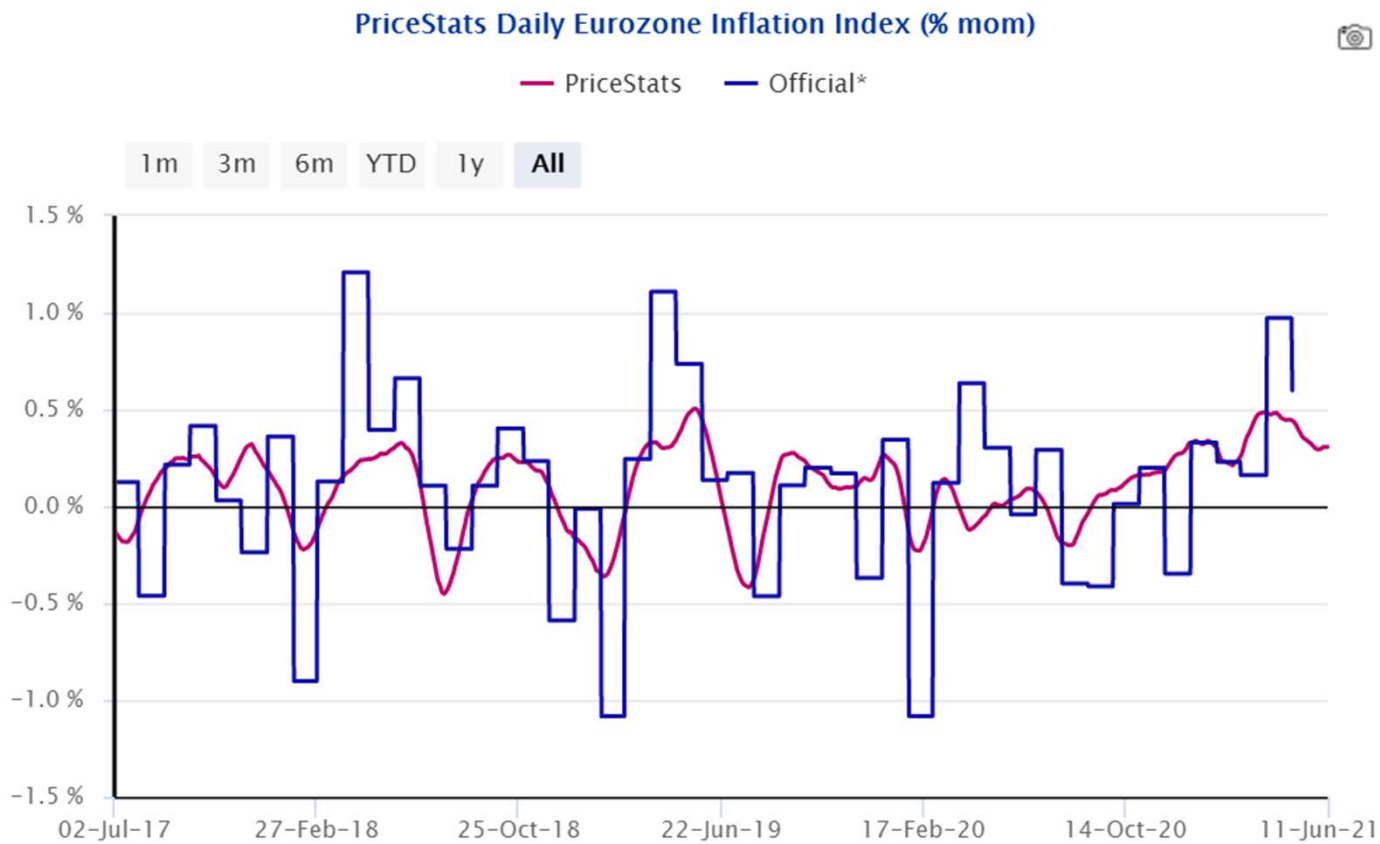
American Economic Review, January 2017, Vol 107 (1)

Download Paper | Download Data

Online prices are increasingly used for measurement and research applications, yet little is known about their relation to prices in physical stores, where most retail transactions occur. I conduct the first large-scale comparison of prices simultaneously collected from the websites and physical stores of 56 large multi-channel retailers in 10 countries. I find that price levels are identical about 72 percent of the time. Price changes are not synchronized but have similar frequencies and average sizes. These results have implications for national statistical offices, researchers using online data, and anyone interested in the effect of the Internet on retail prices.

What are online price indices useful for?

- Cannot match the CPI inflation rates every month



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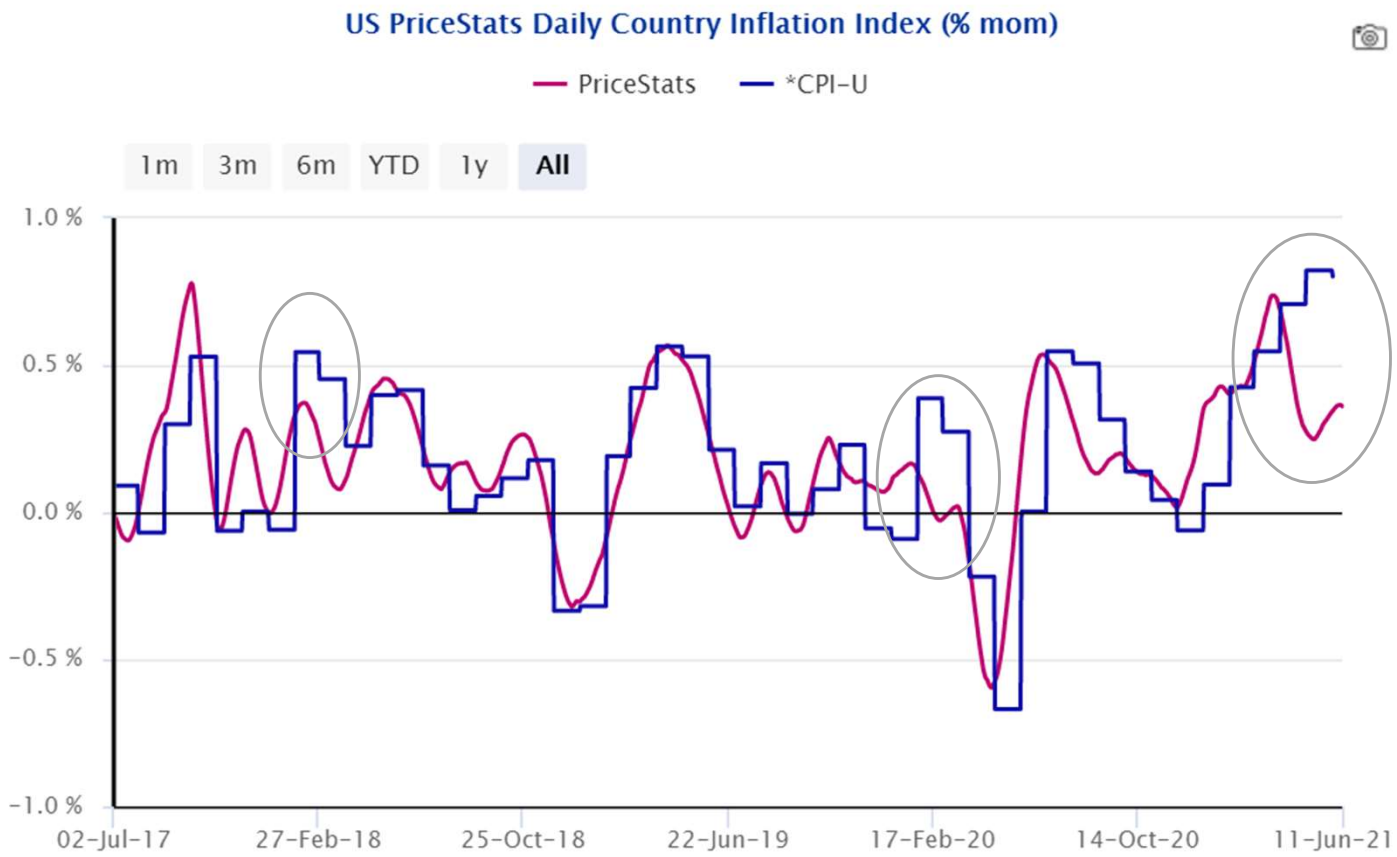
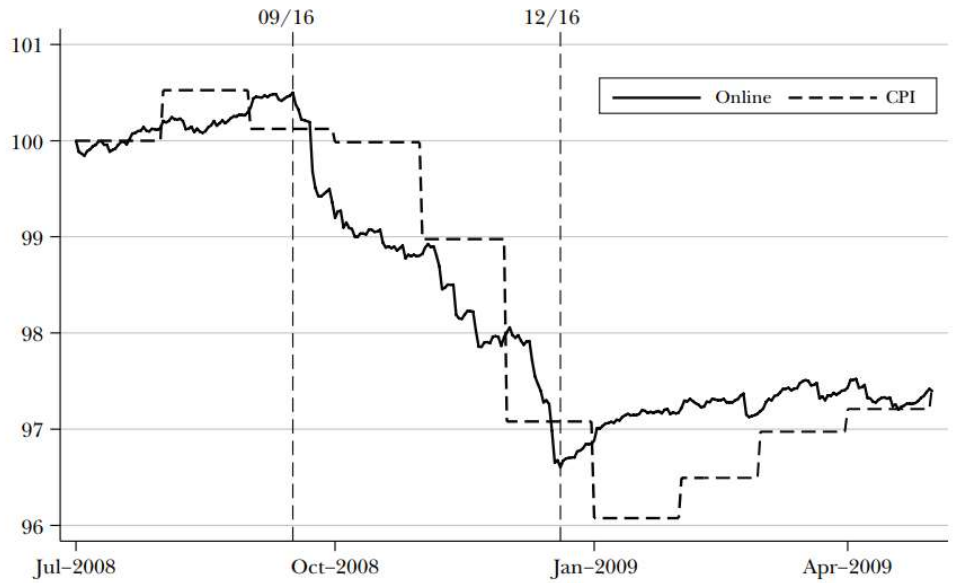


What are online price indices useful for?

- Anticipating changes in inflation trends

Figure 3

US Consumer Price Index around the Bankruptcy of Lehman Brothers



Source: Authors using online price index computed by PriceStats and the Consumer Price Index from the US Bureau of Labor Statistics.
Note: The figure highlights the events around the bankruptcy of Lehman Brothers, the fourth-largest investment bank in the United States, during September 2008.

Source: Cavallo & Rigobon (2016) "The Billion Prices Project", Journal of Economic Perspectives, Spring 2016, Vol 30(2):151-78.

What are online price indices useful for?

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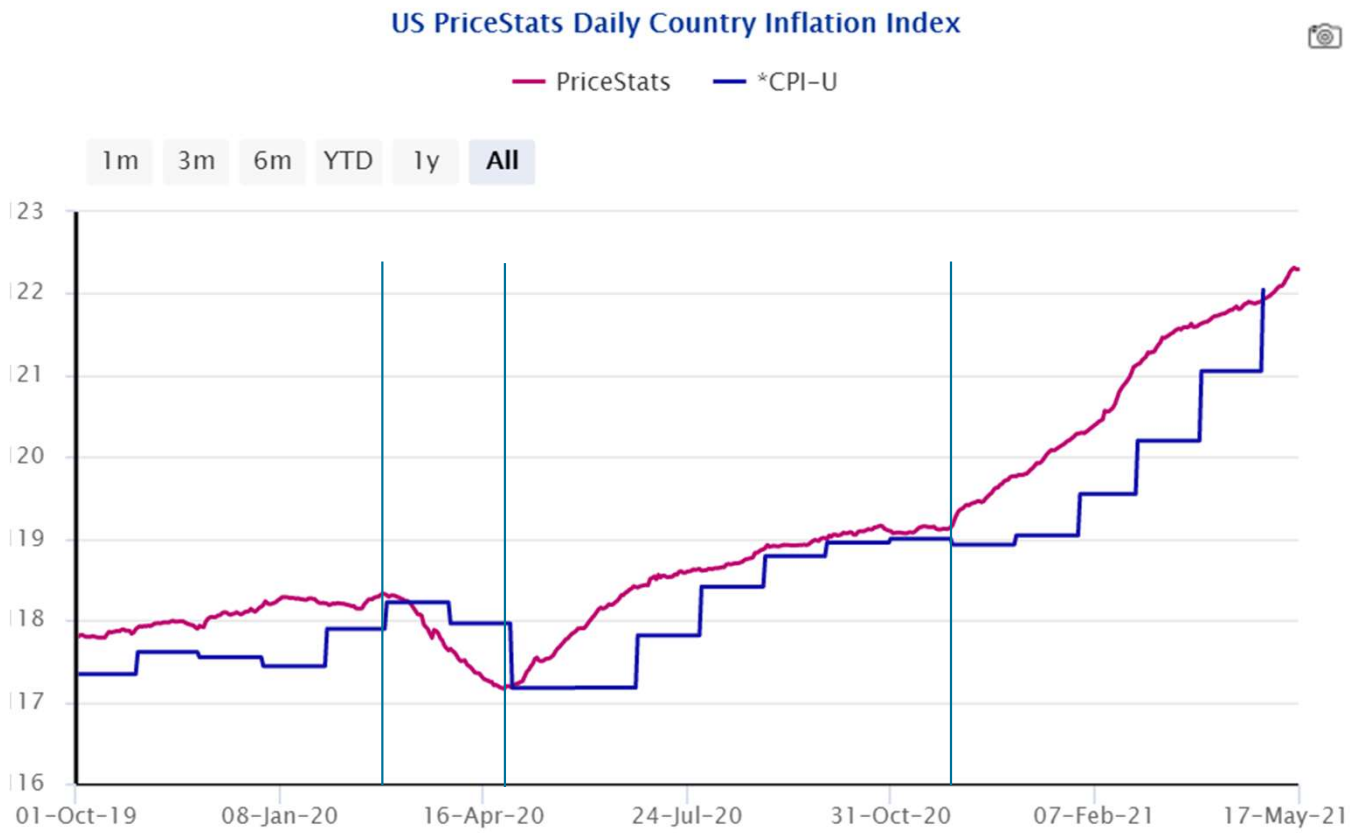
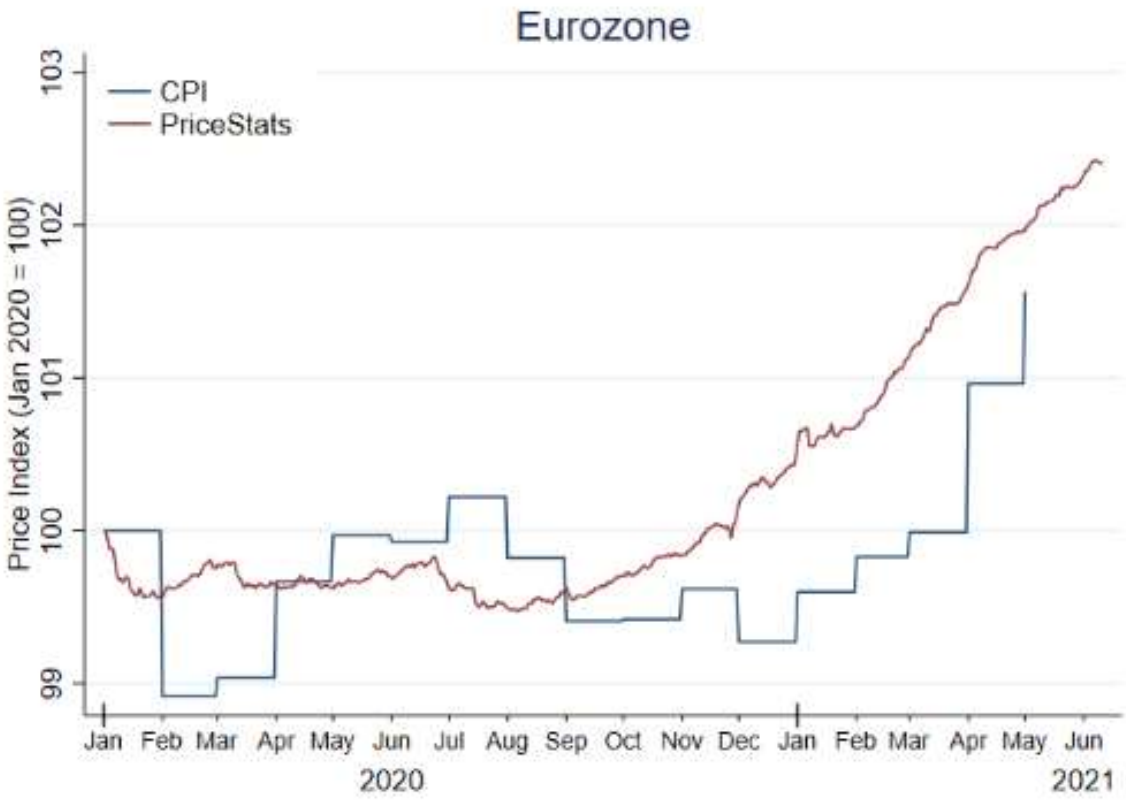
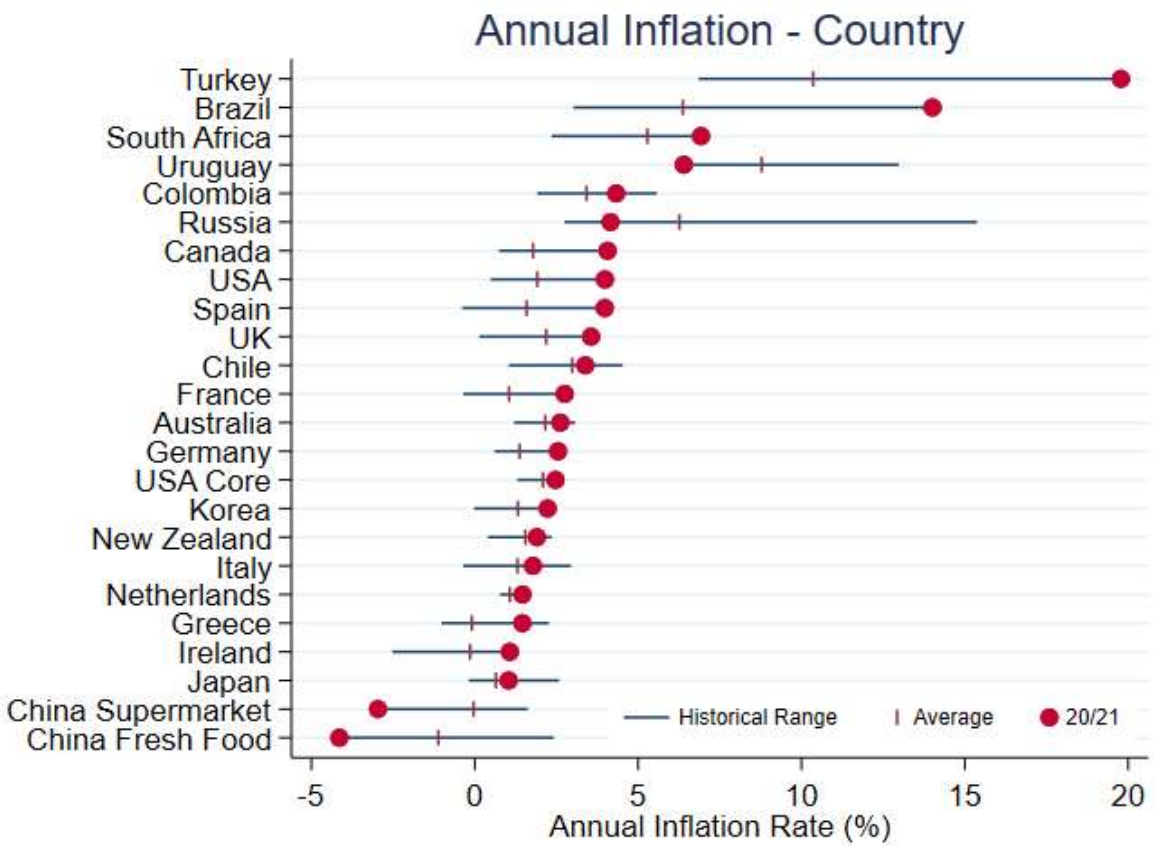


Source: PriceStats – State Street , BLS

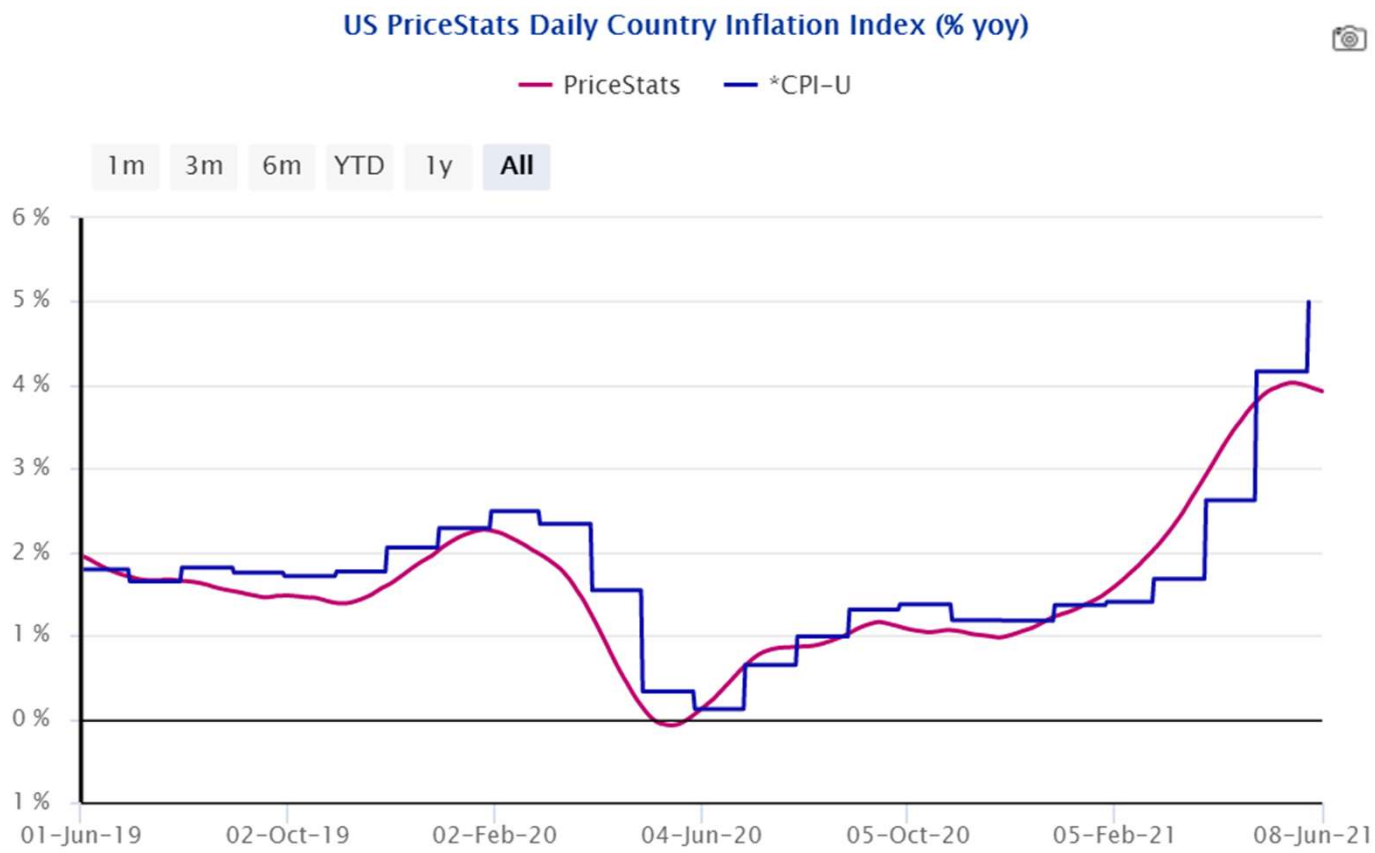
Covid “Turning Points”



Nearly all countries are now at the highest inflation level in 13 years



What explains the rise of US inflation?



What explains the rise of US inflation?

Three factor that are frequently mentioned:

1) Measurement Distortions

2) Supply Disruptions

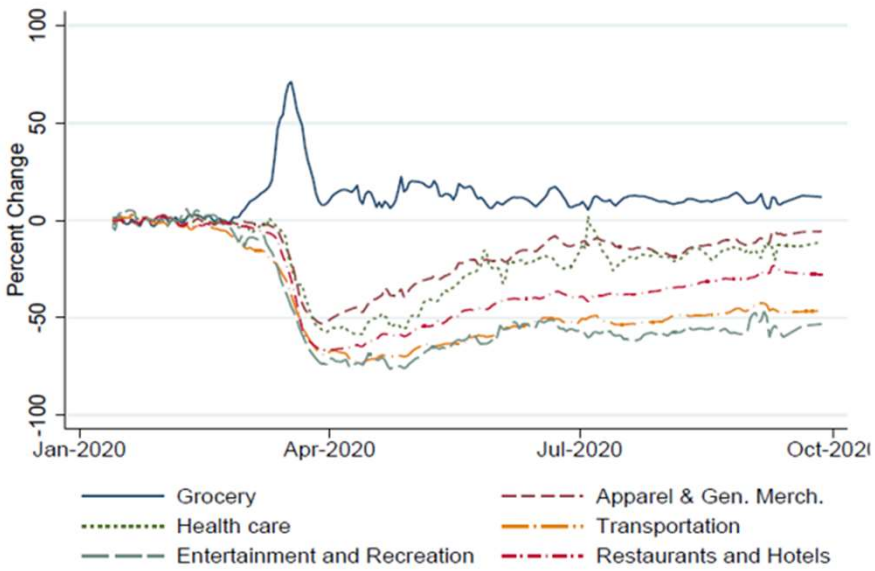
3) Pent-up Demand

Can we use real-time data to estimate their impact on current inflation numbers?

Measurement Distortions: CPI Weights

Cavallo (2020) "Inflation with Covid Consumption Baskets" NBER WP 27352

- The US CPI weights are adjusted every December with 2-year lagged expenditure data
- But the Pandemic dramatically changed consumption patterns → more food, less transportation



(a) Consumer Spending (Opportunity Insights)

Source: Cavallo (2020) "Inflation with COVID Consumption Baskets." NBER WP, No. 27352. More up-to-date results at https://projects.iq.harvard.edu/covid-cpi

Measurement Distortions: CPI Weights

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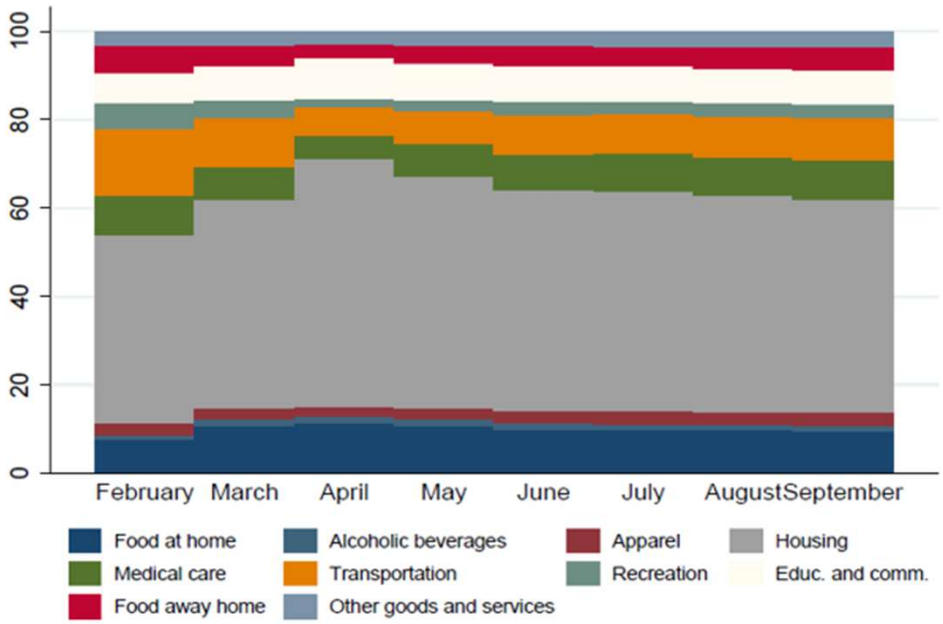
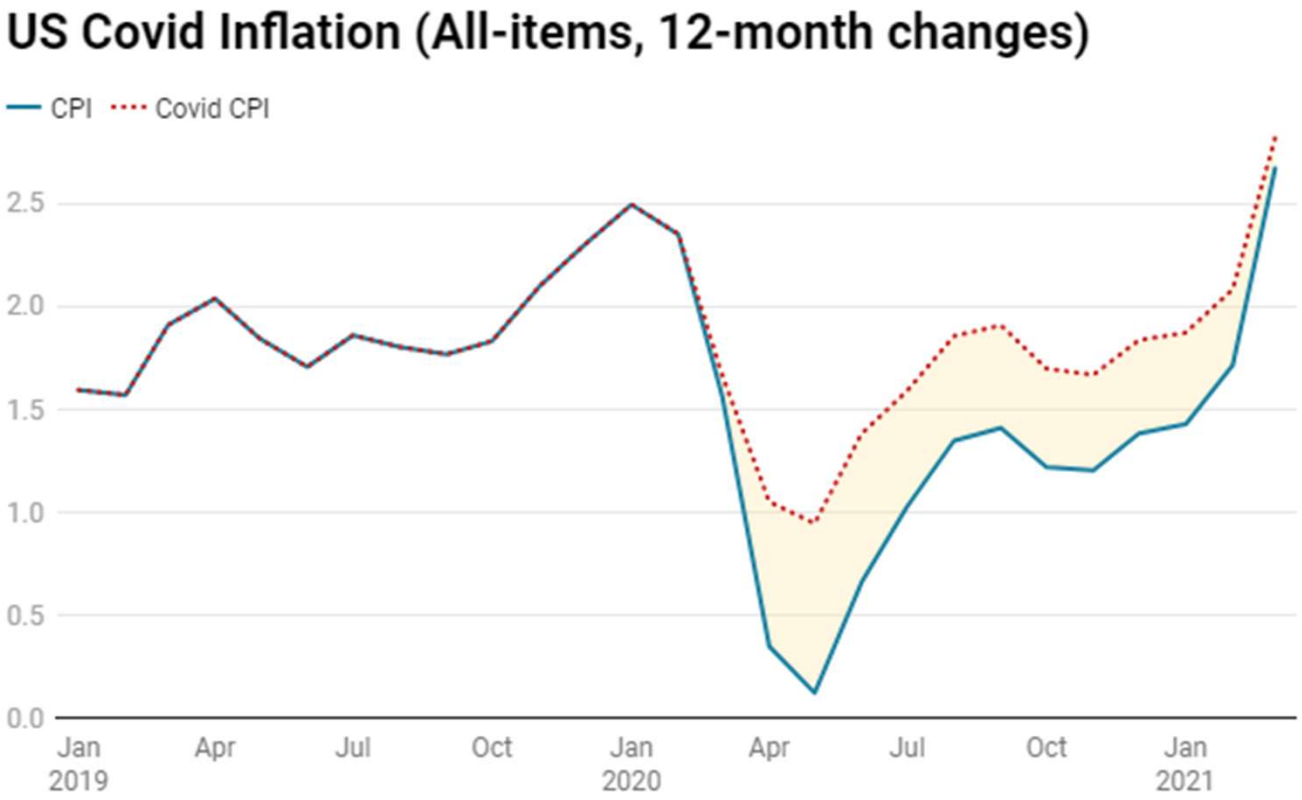


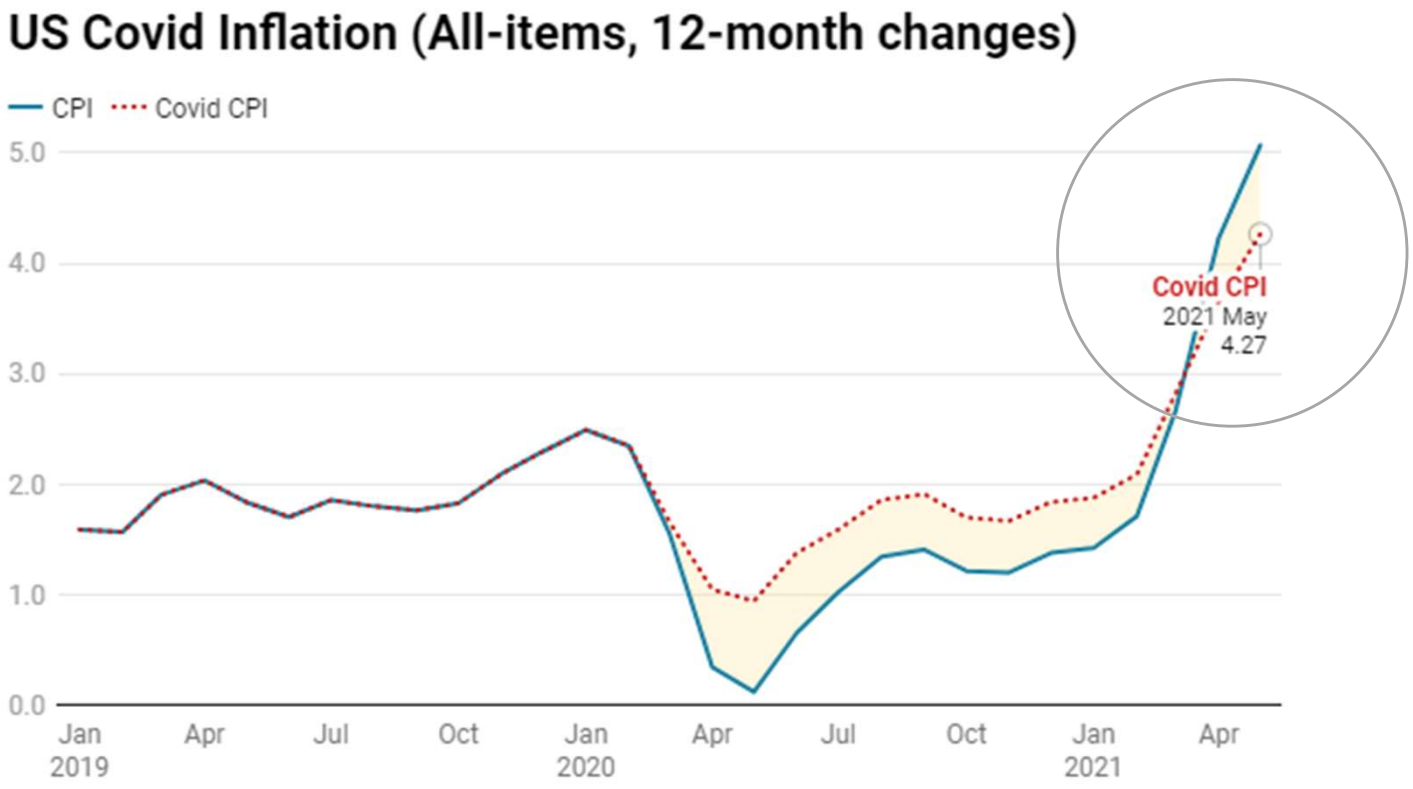
(b) Covid Basket Weights

Source: Cavallo (2020) "Inflation with COVID Consumption Baskets." NBER WP, No. 27352. More up-to-date results at https://projects.iq.harvard.edu/covid-cpi

In 2020, the CPI was under-estimating the annual inflation rate



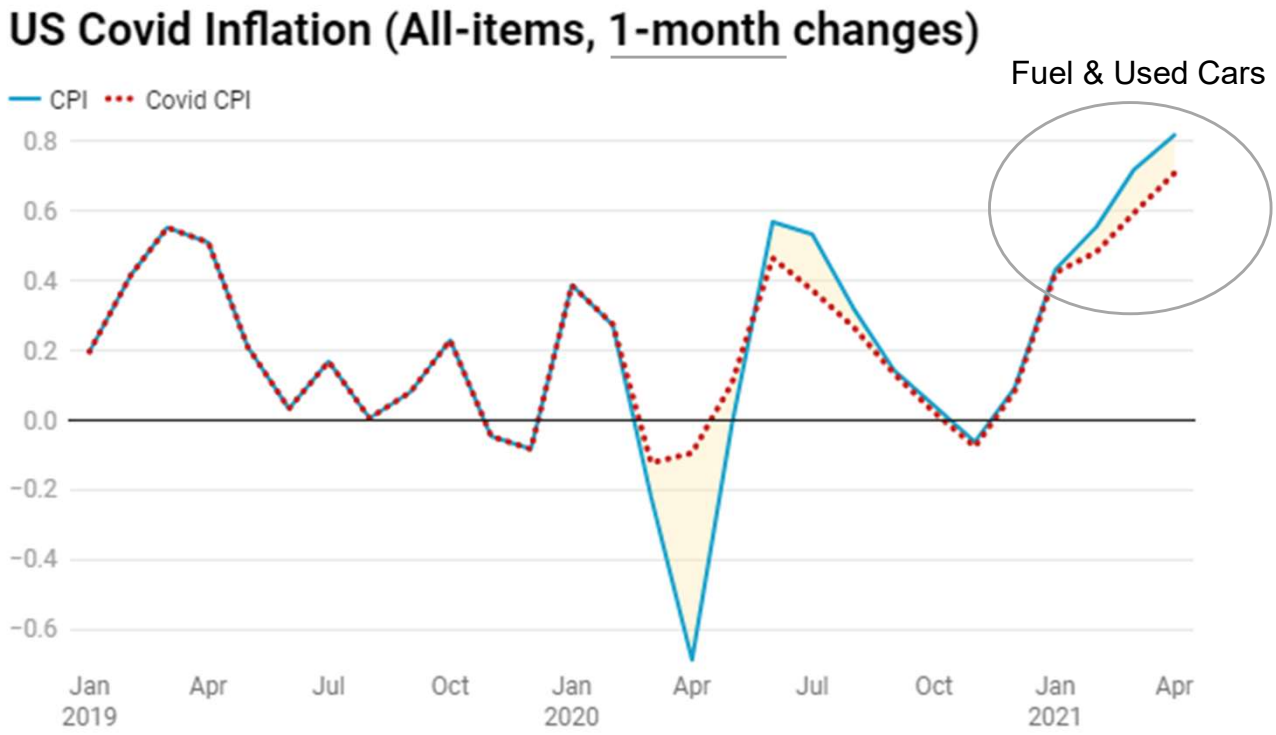
In 2021, the CPI is **over-estimating** the annual inflation rate



Source: Cavallo (2020) "Inflation with COVID Consumption Baskets." NBER WP, No. 27352. More up-to-date results at https://projects.iq.harvard.edu/covid-cpi

In 2021, the CPI is **over-estimating** the annual inflation rate

- Too much weight to transportation, even though spending is still ~25% below pre-Covid levels (Opportunity Insights)



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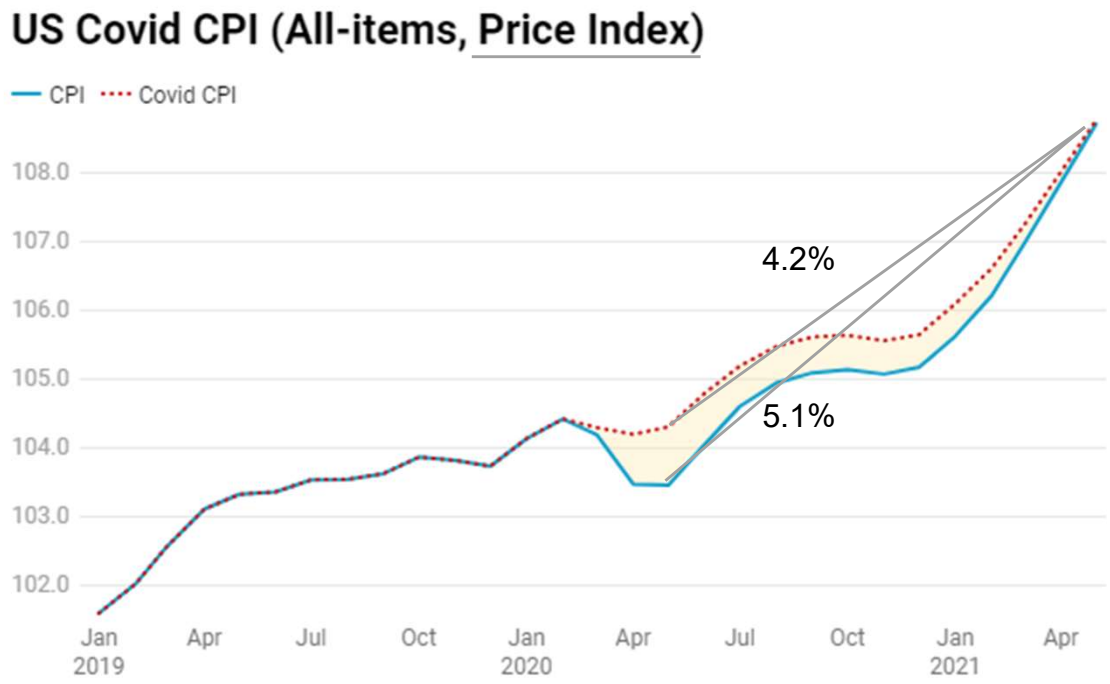
In 2021, the CPI is **over-estimating** the annual inflation rate

- Too much weight to transportation, even though spending is still ~25% below pre-Covid levels
- The fixed-basket exacerbated the temporary “base effects” in the annual inflation rate, because the CPI “fell too much” in 2020



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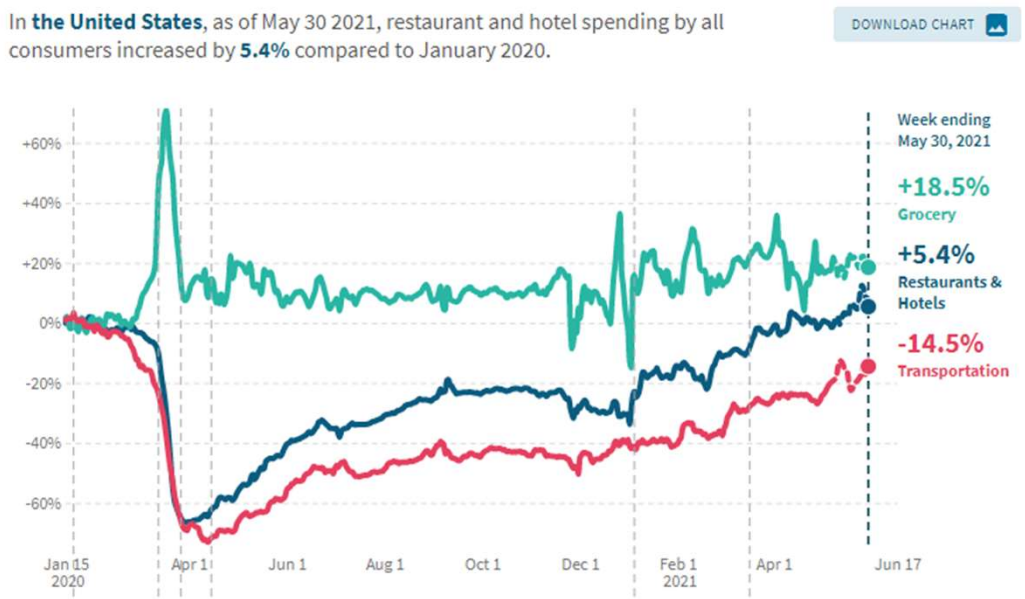
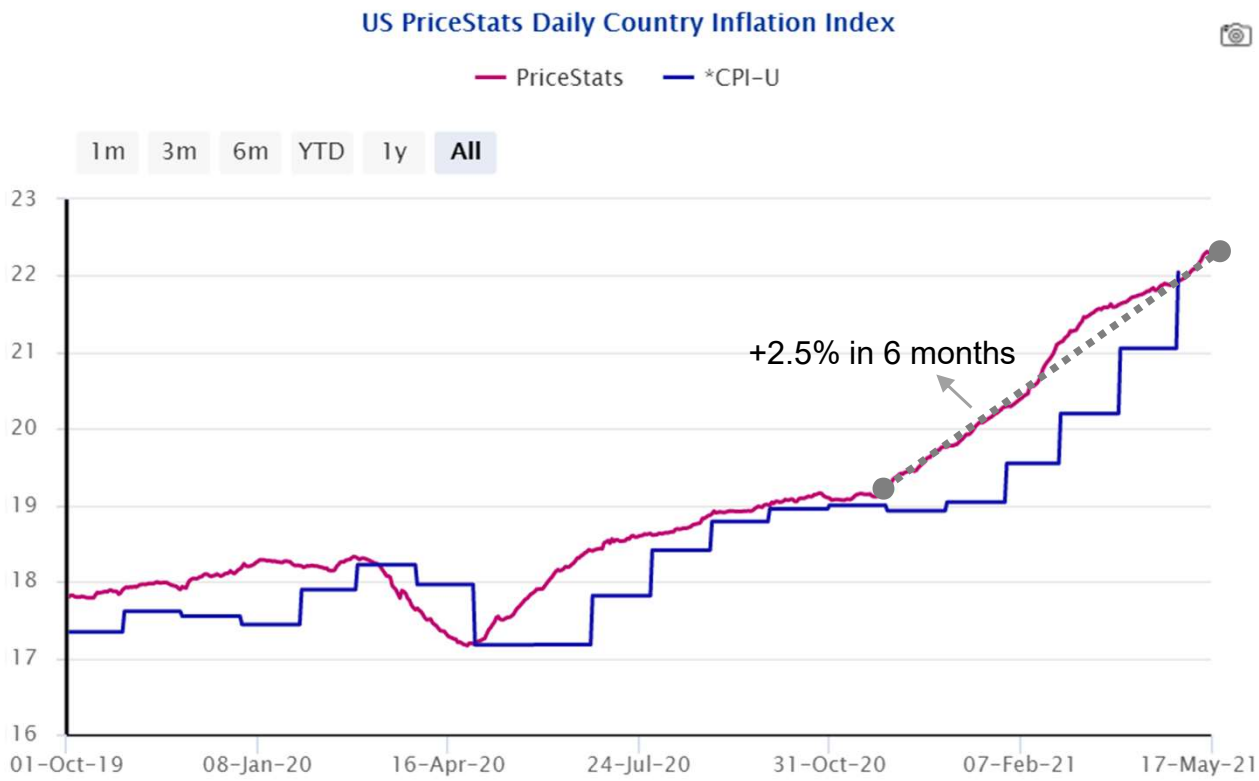
Measurement Distortions: CPI Weights

- Also affecting core (non-energy transportation)
- Some inflation inequality (low-income HHs consume more food, less transport)
- Similar bias in countries with divergence in sectoral inflation rates
- Temporary because spending patterns are normalizing (before the CPI weights)



But this not just about temporary measurement problems…

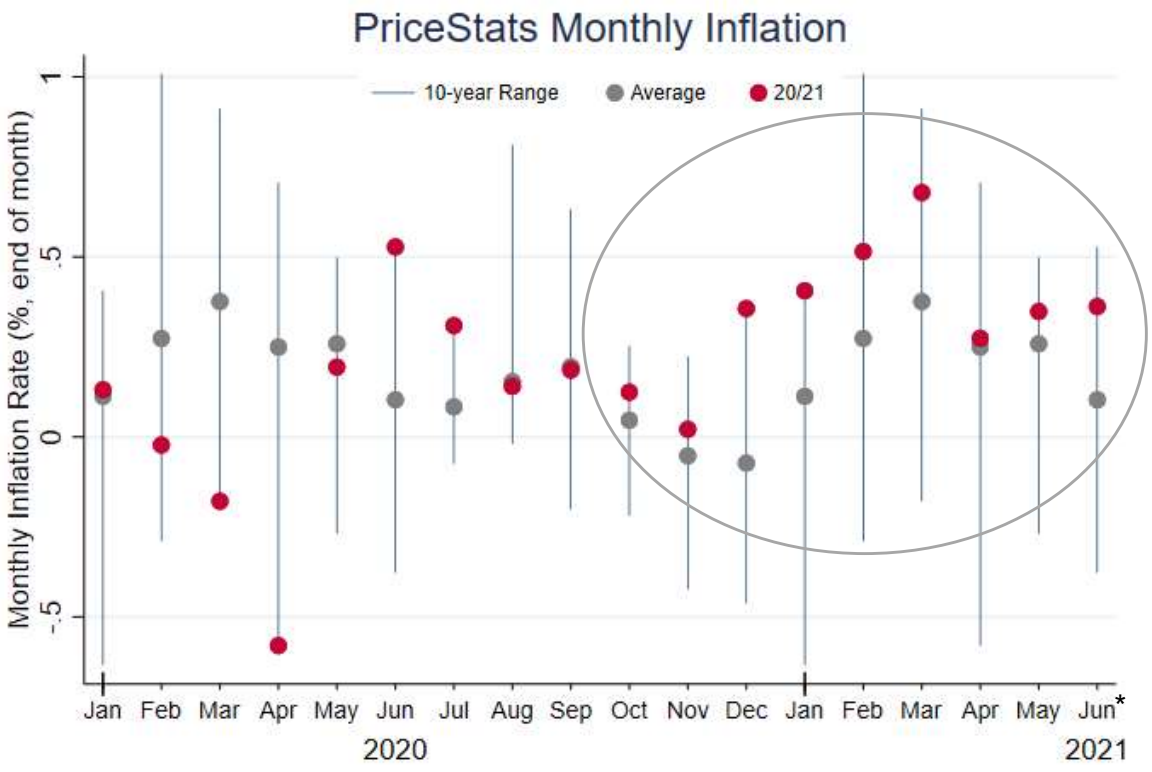
- The US online index appears to be on a new trajectory since late November (~5% annualized rate)



Source: State Street Global Markets, PriceStats, BLS

But this not just about temporary measurement problems…

- Above-average inflation in 8 of the last 9 months (even without “used cars and trucks”)



Note: * June 2021 numbers based on 10 days of data.
Source: PriceStats.

Are supply disruptions pushing prices up?

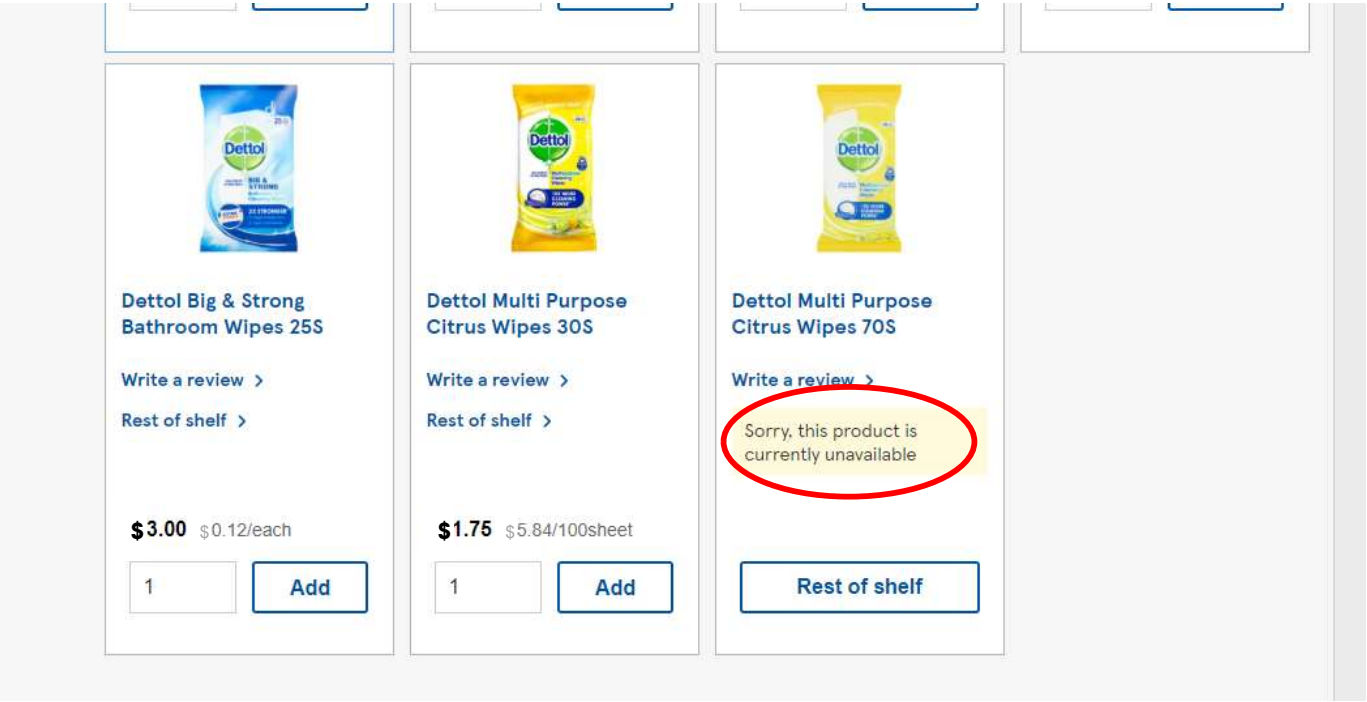
Cavallo & Kryvtsov (2021) "Stockouts, Supply Disruptions and Inflation: Evidence from Online Micro Data"
Disclaimer: The views expressed here are ours, and they do not necessarily reflect the views of the Bank of Canada.

- Covid Disruptions:
  - Operational shut-downs, hoarding, sudden change in distribution channels, costs of operating with social distancing, global supply-chain bottlenecks
  - Can we detect them at the retail level? Can we estimate the impact on prices?

- We measure stockouts in 17 large US retailers selling 700K products in 5 major good categories

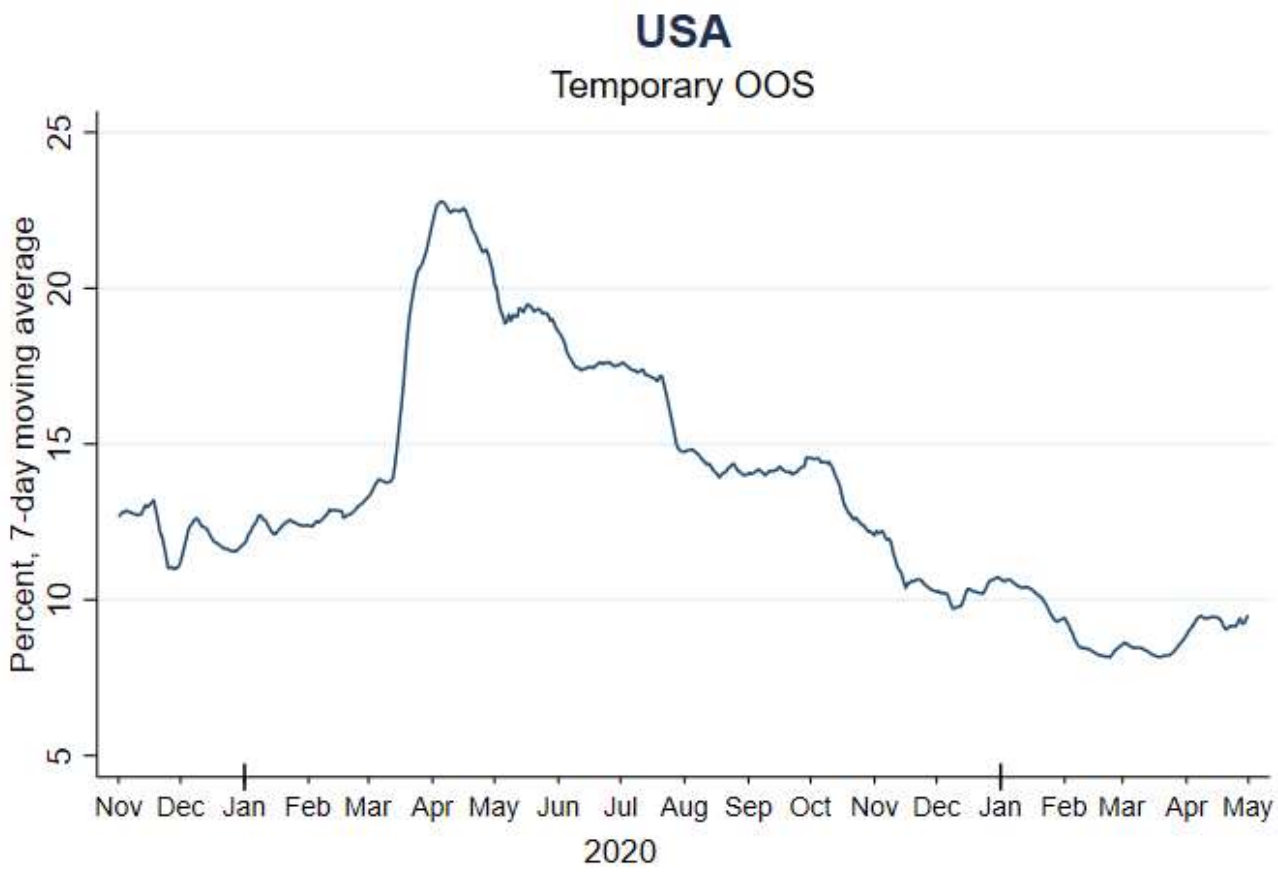
	Products	Retailers	OOS, %	Duration (Days)	Abs size of p-chg, %
All	706114	17	14	39	19
Food and Beverages	73111	13	28	42	19
Furnishings & Household	342148	15	8	25	13
Health	33930	17	15	93	24
Electronics	165433	17	8	31	14
Other Goods	98574	13	11	49	23

Measuring Retail Stockouts

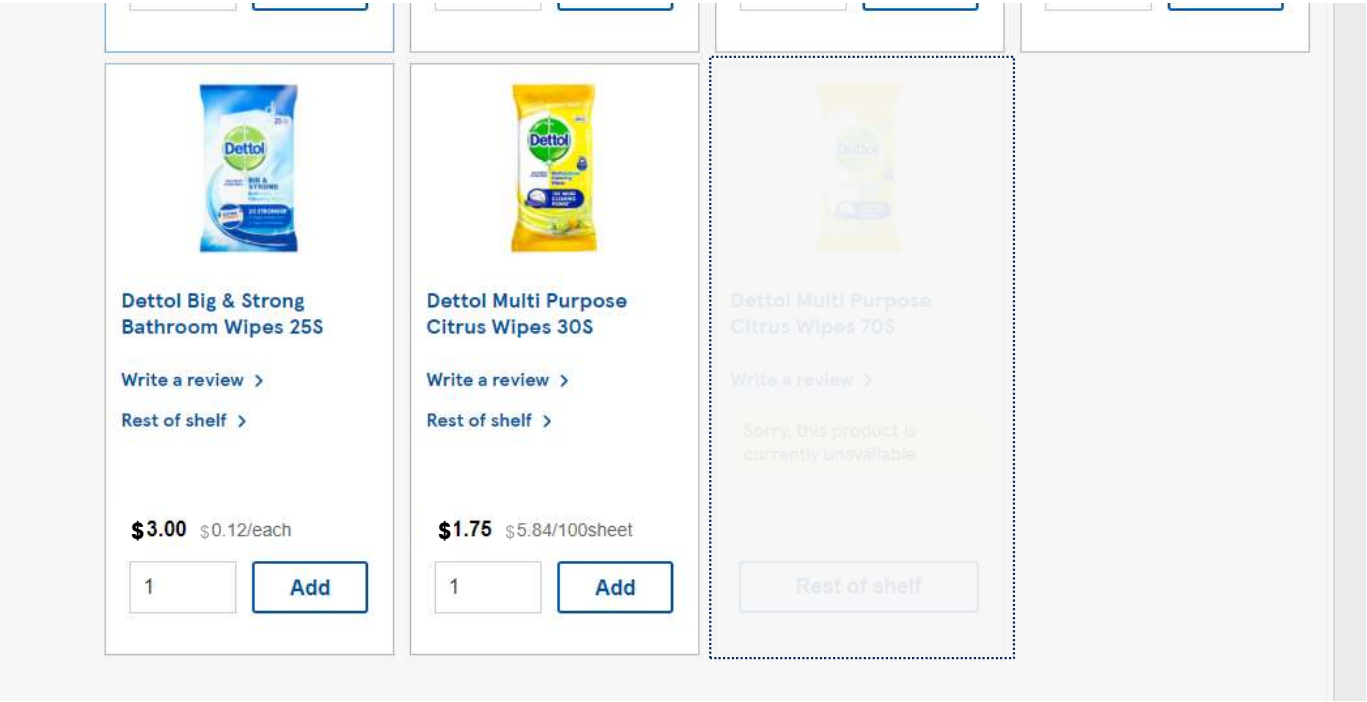


Note: This image illustrates the out of stock information, but this specific retailer may not be in the dataset

Temporary Stockouts

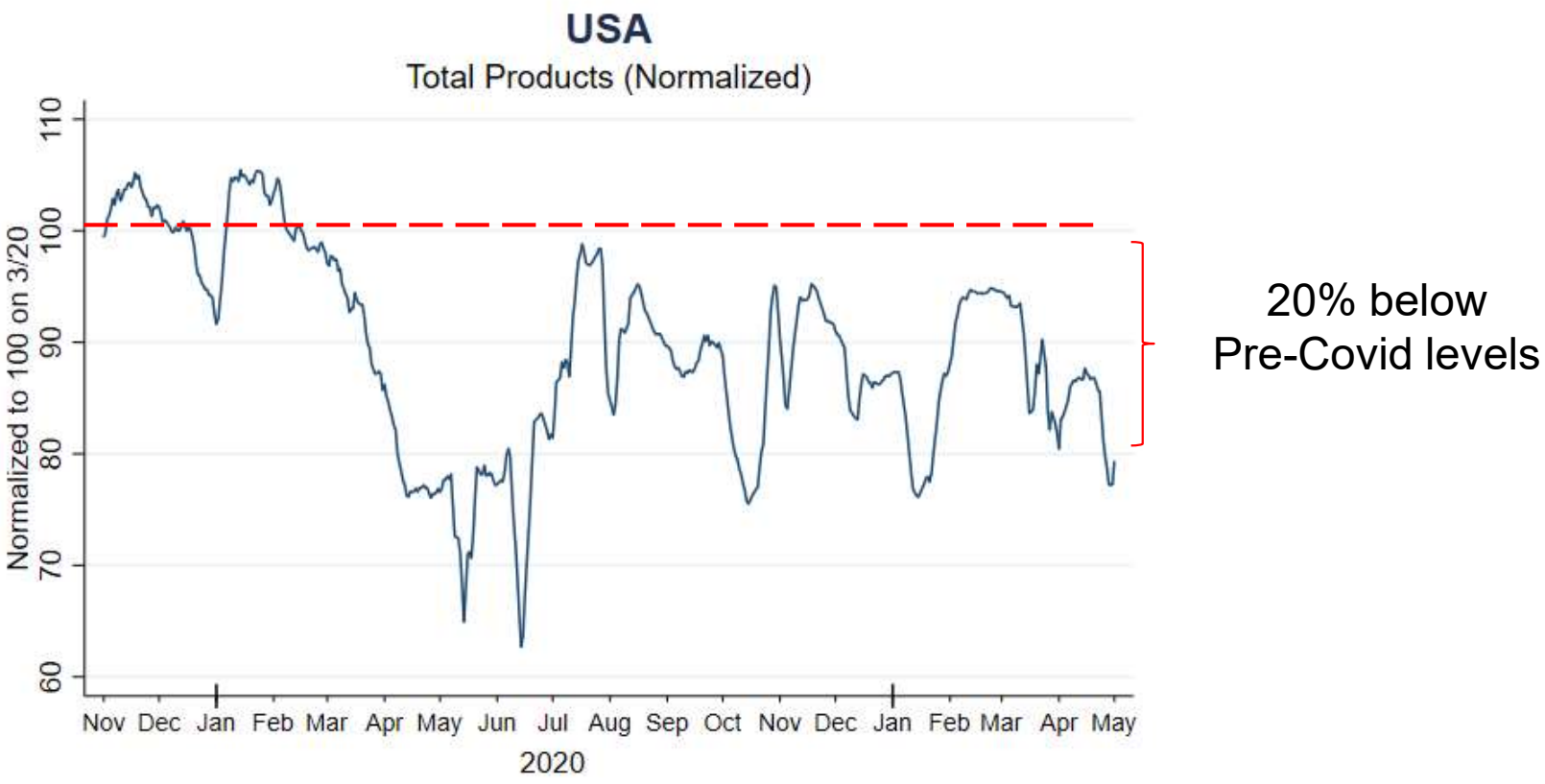


Measuring Retail Stockouts

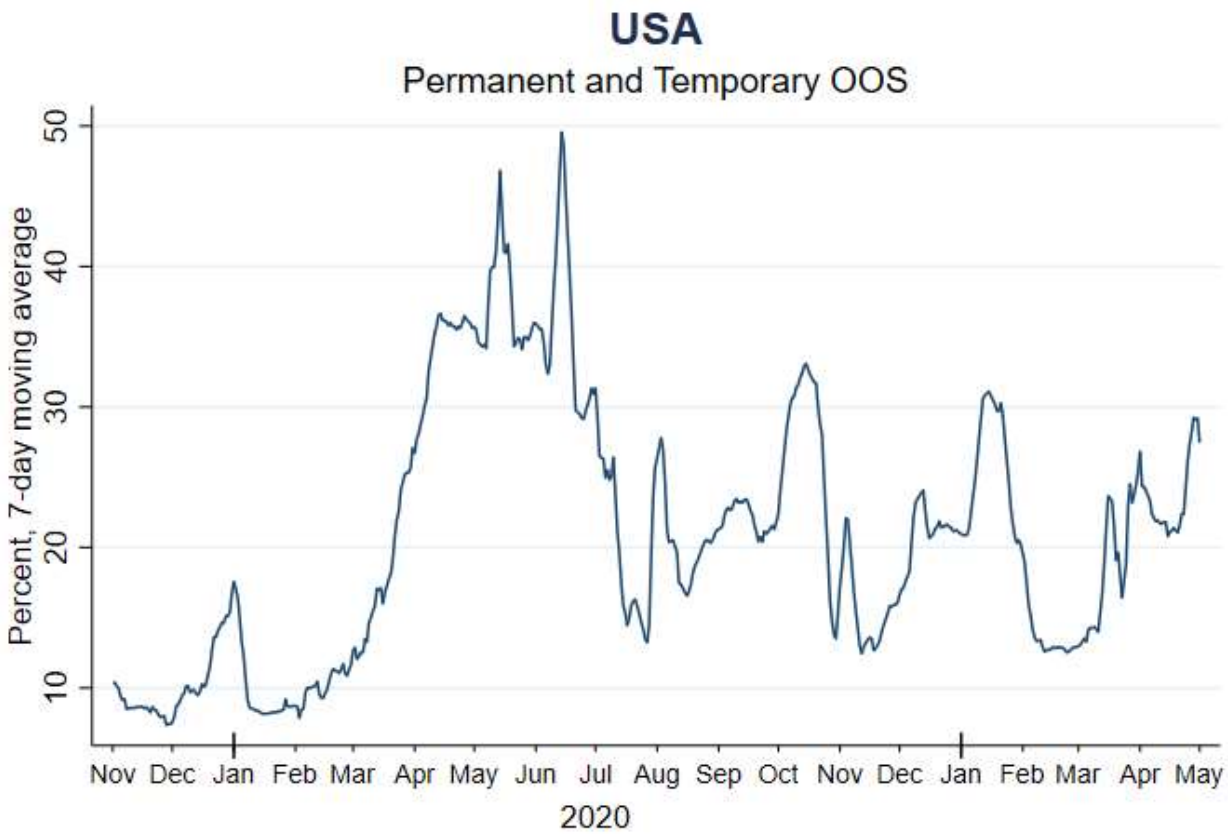


Note: This image illustrates the out of stock information, but this specific retailer may not be in the dataset

From Temporary to “Permanent Stockouts” (discontinued goods)



Total stockouts are still about 20% higher than pre-Covid levels



Source: Cavallo & Kryvtsov (2021) "Stockouts, Supply Disruptions and Inflation: Evidence from Online Micro Data" (Preliminary Results)
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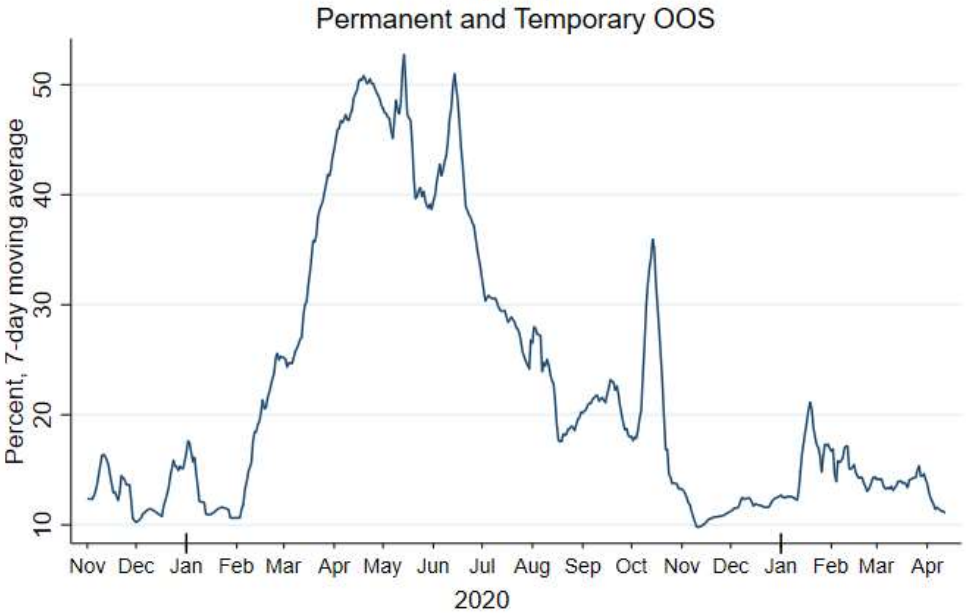
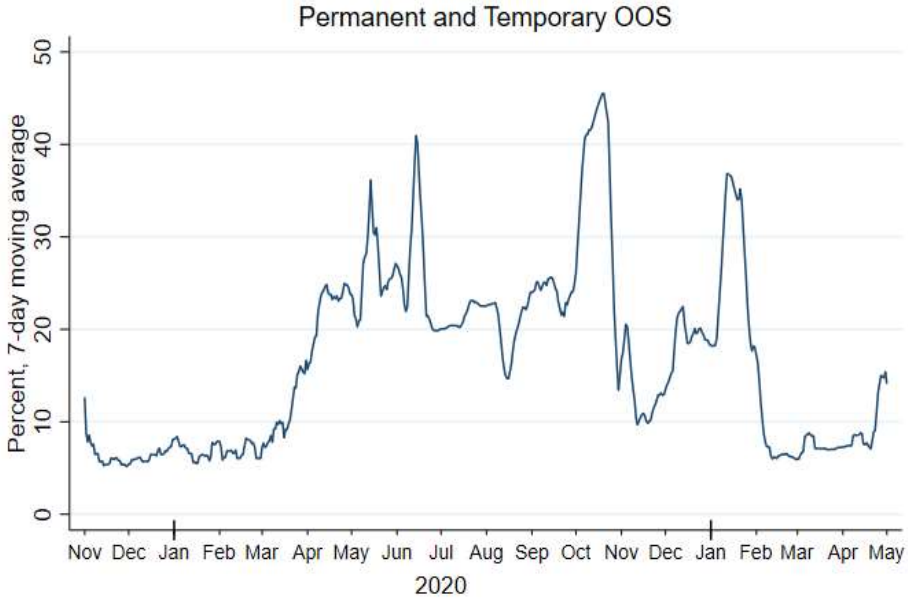
Stockouts have already fallen in some sectors

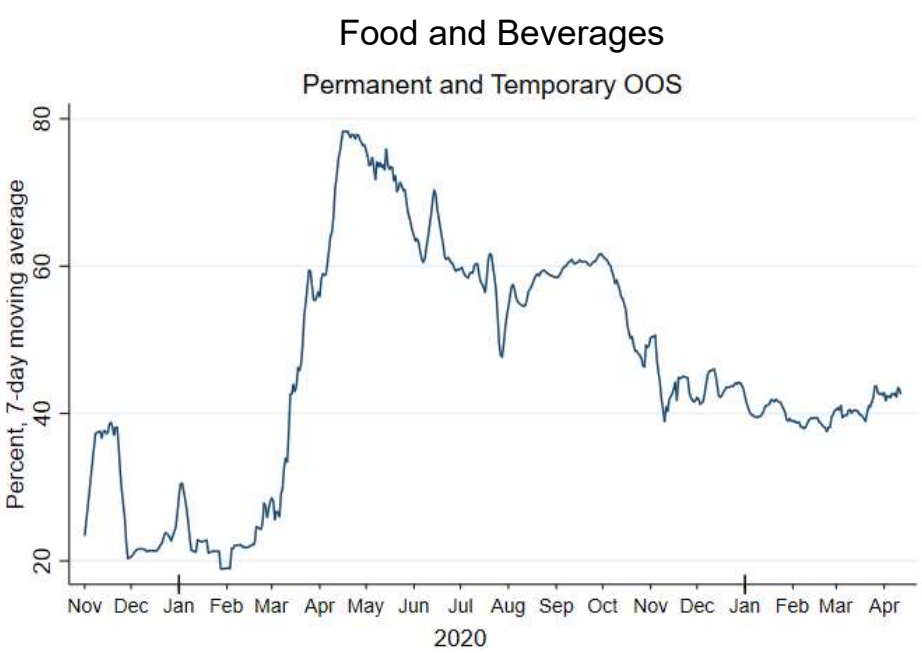
Healthcare Goods

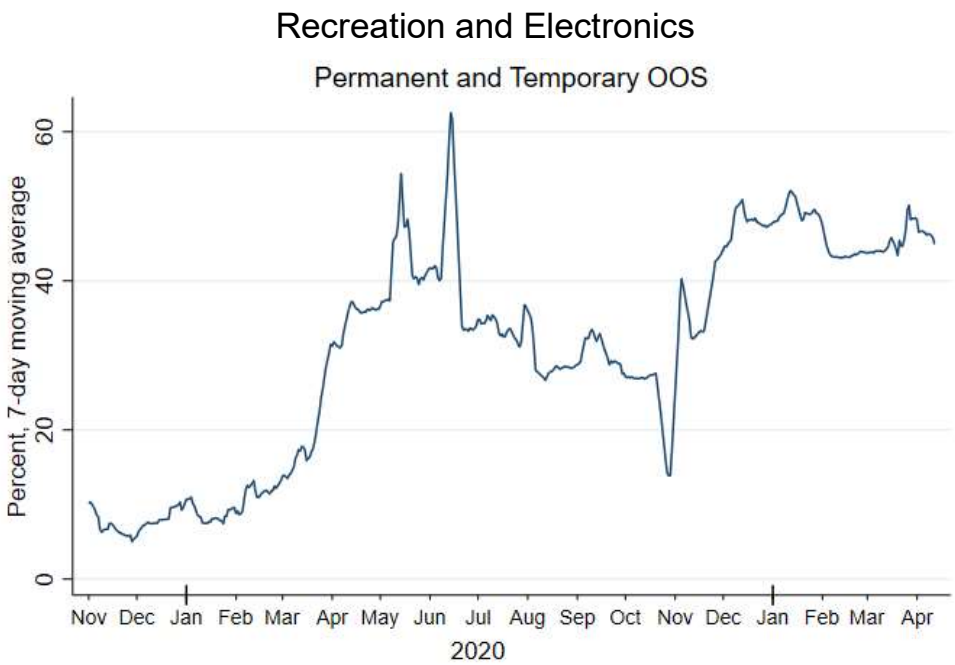


Furnishing & Household Goods



But they are persistent in Food and Electronics

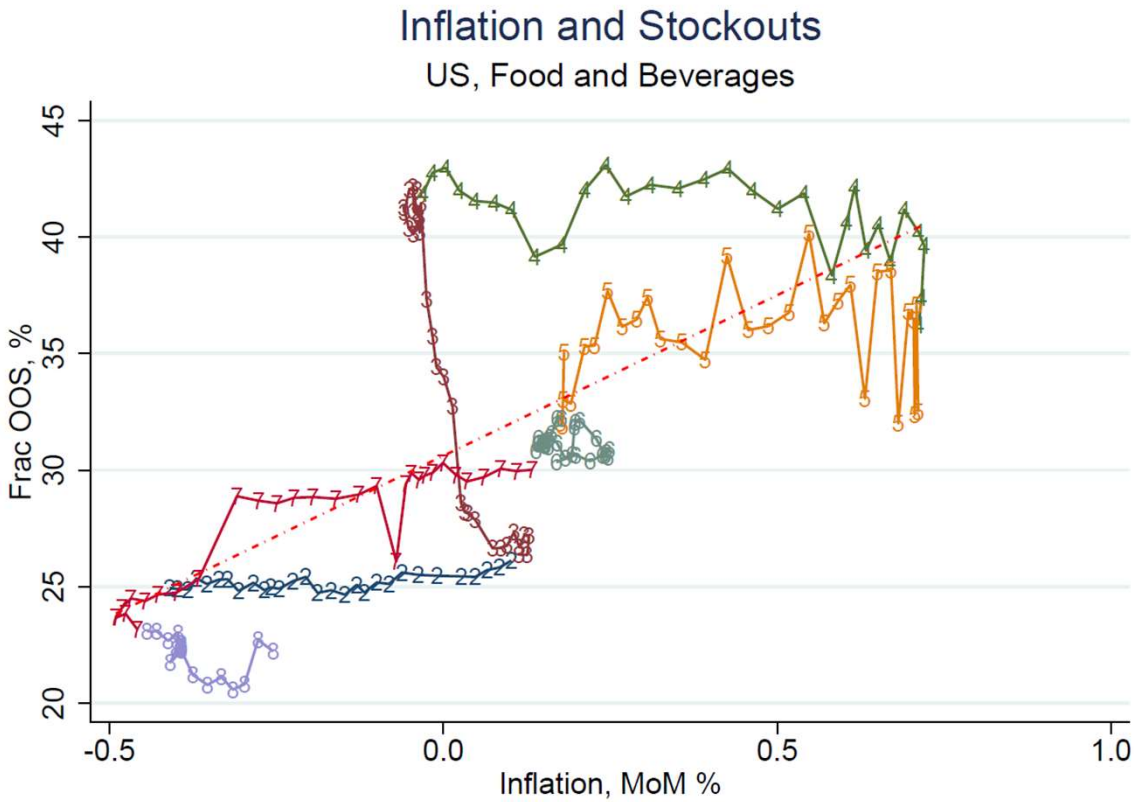




Stockouts in L2 Categories

Category	Max Temp OOS	Max All OOS	Latest All OOS
Food	15	53	11
Goods and services for routine household maintenance	11	42	10
Non-alcoholic beverages	10	40	27
Other major durables for recreation and culture	10	79	78
Personal care	8	35	1
Audio-visual, photographic and information processing equipment	6	36	27
Other recreational items and equipment, gardens and pets	6	45	34
Medical products, appliances and equipment	6	25	-13
Glassware, tableware and household utensils	6	36	-5
Furniture and furnishings, carpets and other floor coverings	6	31	5
Household appliances	5	32	22
Tools and equipment for house and garden	5	59	58
Household textiles	3	21	-5
Personal effects n.e.c.	0	29	-16

Stockouts are correlated with sectoral inflation rates



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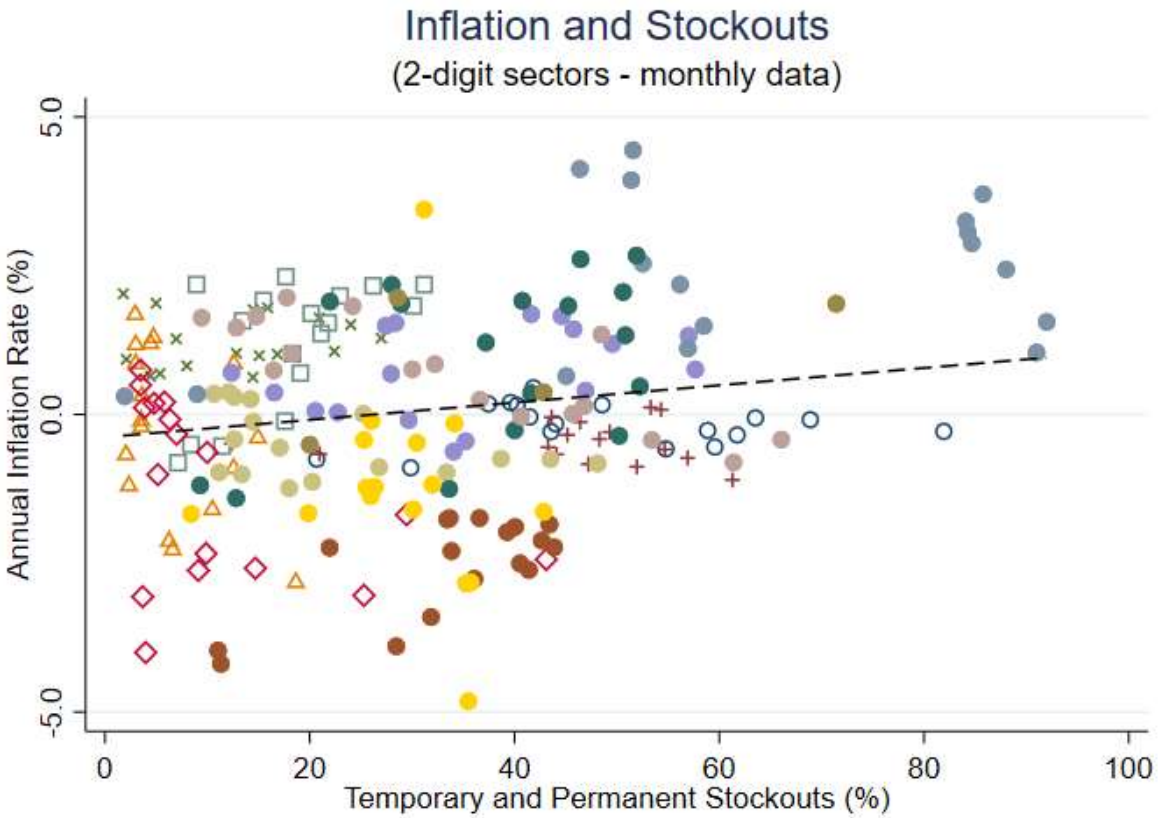
Stockouts are correlated with sectoral inflation rates



Source: Cavallo & Kryvtsov (2021) "Stockouts, Supply Disruptions and Inflation: Evidence from Online Micro Data" (Preliminary Results)
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Stockouts are correlated with sectoral inflation rates

	All Goods	Food & Beverages	Household Goods	Electronics
OOS (%)	0.023***	0.005***	0.002*	0.017***
	(0.001)	(0.001)	(0.001)	(0.001)
Adj. R^2	0.265	0.766	0.557	0.808
Obs.	16,856	5,346	3,888	5,192
Fixed Effects	Sector, Month	Sector, Month	Sector, Month	Sector, Month

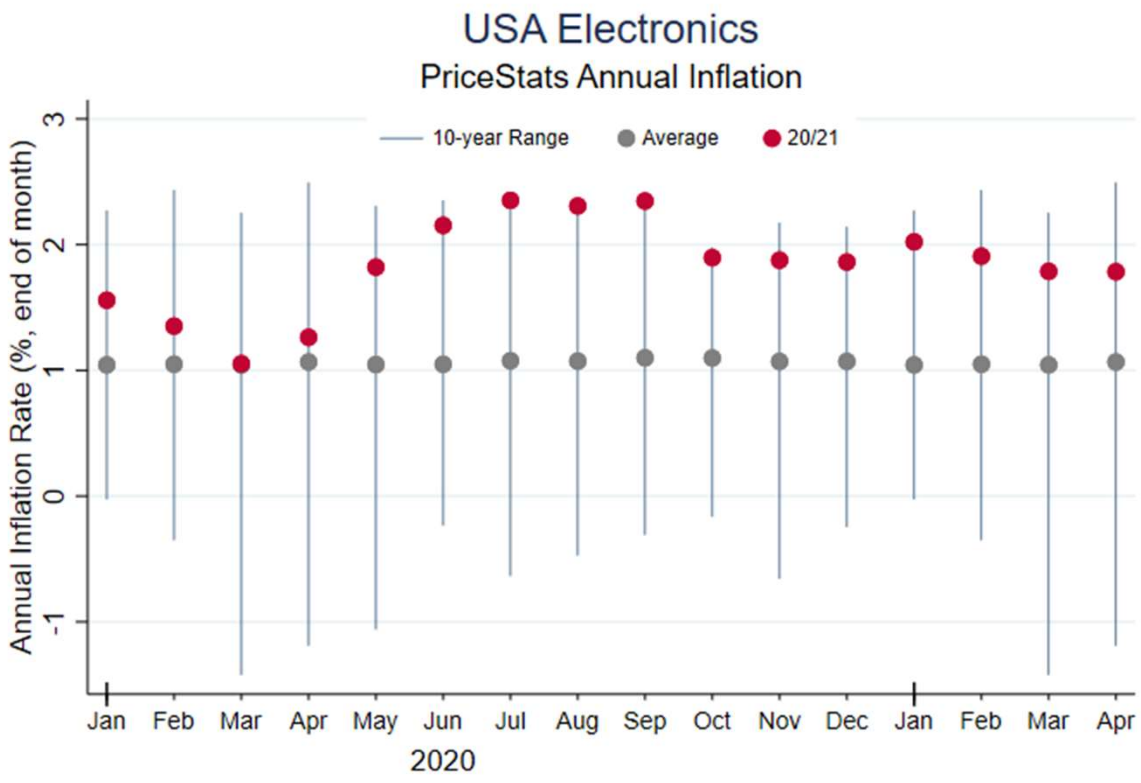
Table 1: Impact of OOS on Annual Inflation Rates

Notes: Monthly observations. Robust standard errors shown in parentheses.

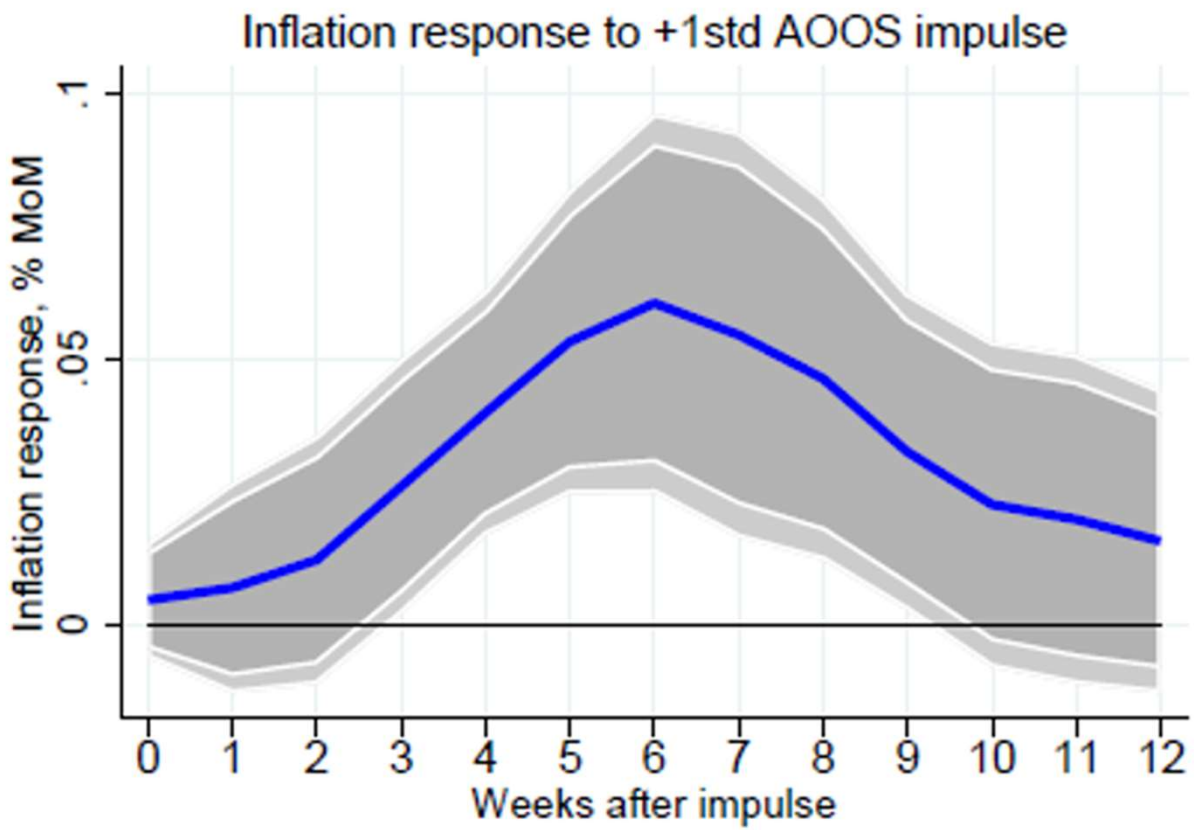
- More impact on electronics and food, where the stockouts are more persistent
- A 20 percentage point increase in OOS → 0.46% increase in annual inflation for these goods

The impact on inflation is significant

- Roughly 1/2 of the additional annual inflation in some of these sectors



The impact on inflation is gradual and peaks at 6 weeks



Note: Impulse response using Jorda (2005) linear projection method. OOS shock computed as the residual of AR(1) process with weekly data. Dependent variable is the change in MoM regressed on lags of OOS shock and MoM, with sector fixed effects.

Looking ahead: should we worry about these supply disruptions?

- No…
  - Stockouts are starting to fall in many sectors, consistent with the idea that these are temporary shocks
  - Price impact is limited to sectors where the disruption was more persistent (Cavallo, Gopinath, Neiman & Tang (2020) “Tariffs Passthrough at the Border and at the Store: Evidence from US Trade Policy” AER Insights)
- Yes…
  - Price effects will remain for a while, potentially contributing to higher inflation expectations (Cavallo, Cruces, Perez-Truglia (2017) "Inflation Expectations, Learning, and Supermarket Prices: Evidence from Survey Experiments." AEJ: Macro)
  - Covid moved transactions online, where prices react faster to shocks (Cavallo (2018) “More Amazon Effects: Online Competition and Pricing Behaviors”, Jackson Hole Symposium)

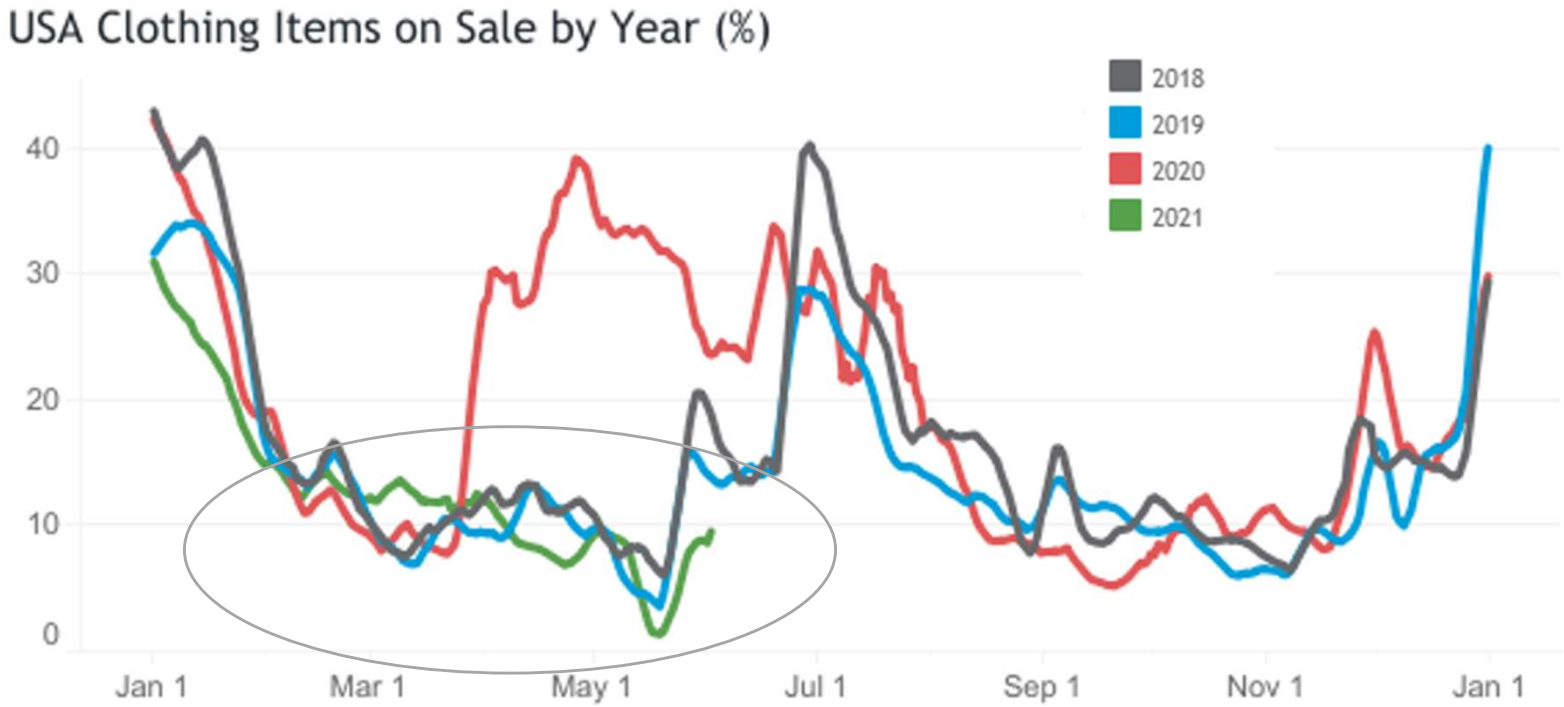
Pent-Up Demand: US Sales Behavior

- Preliminary Results (truly “real time”)
- Some recent papers have shown that sales tend to be counter-cyclical

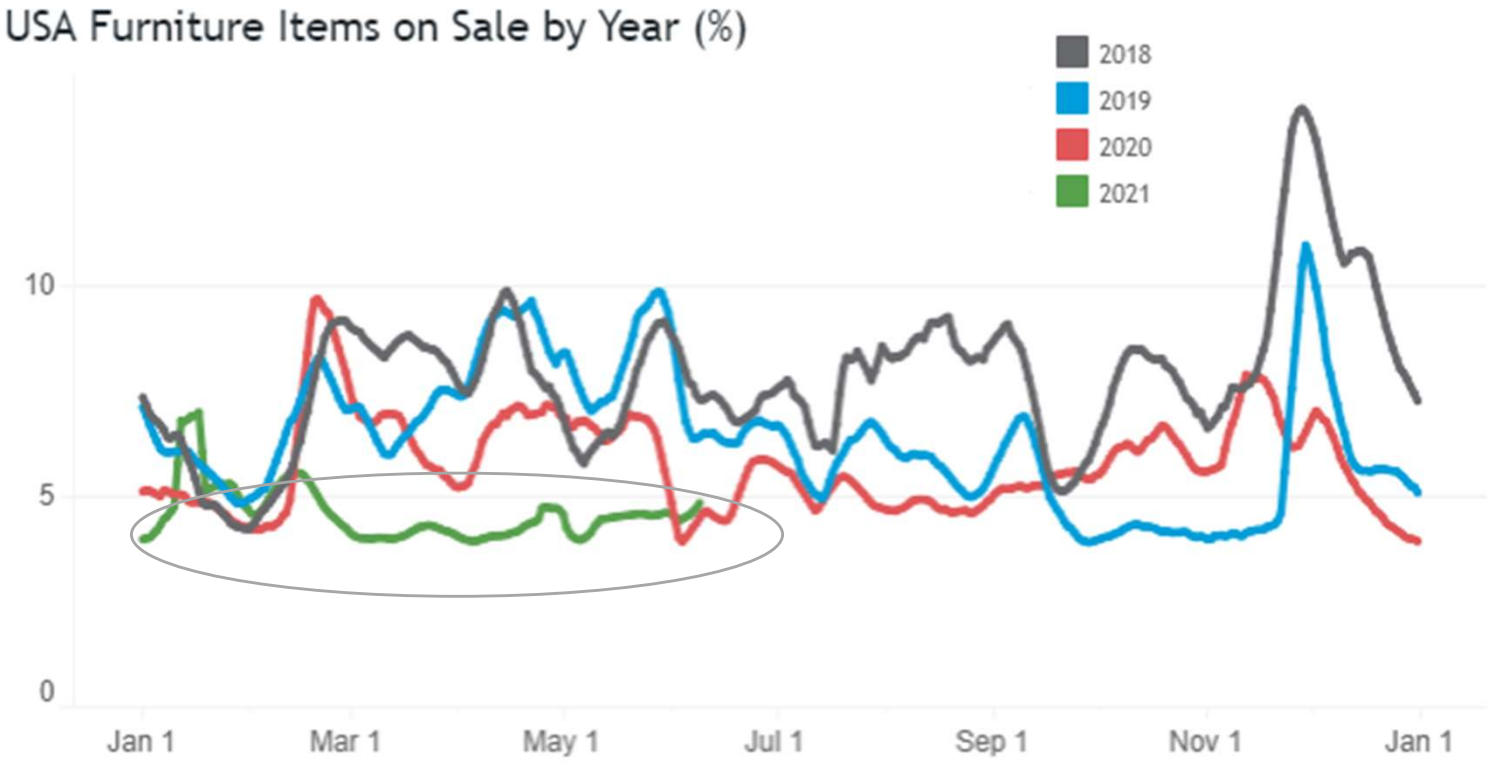
  → Kryvtsov & Vincent (2021) “The Cyclicality of Sales and Aggregate Price Flexibility”, Review of Economic Studies

- Can we look at “sales” behaviors across sectors to say something about current demand dynamics?
- Using online micro data, we can measure the share of sales (discounts) every day using a “sales flag” and/or a price-drop algorithm

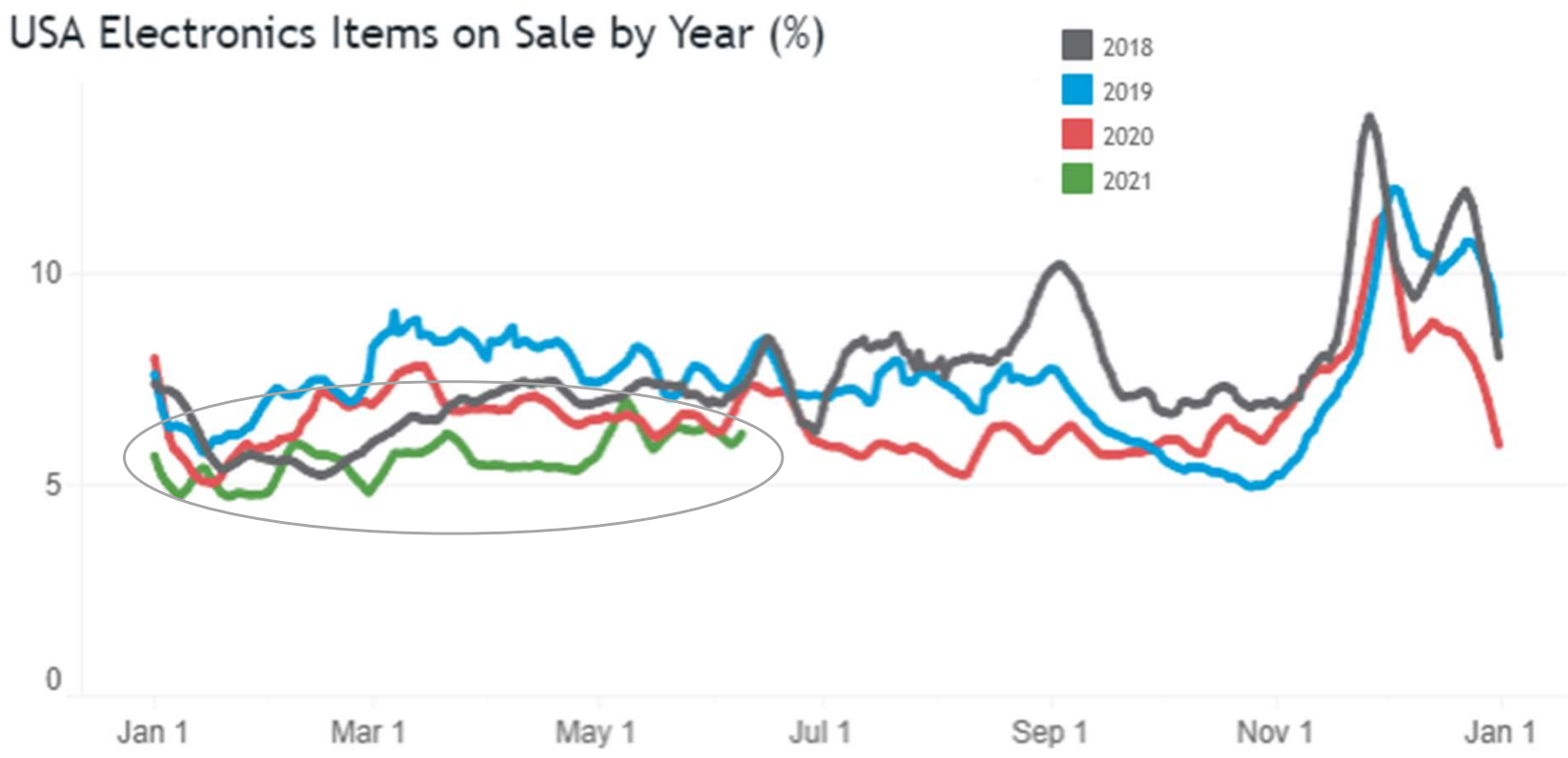
Clothing: Back to Normal



Furniture: Sales are still abnormally low → high demand



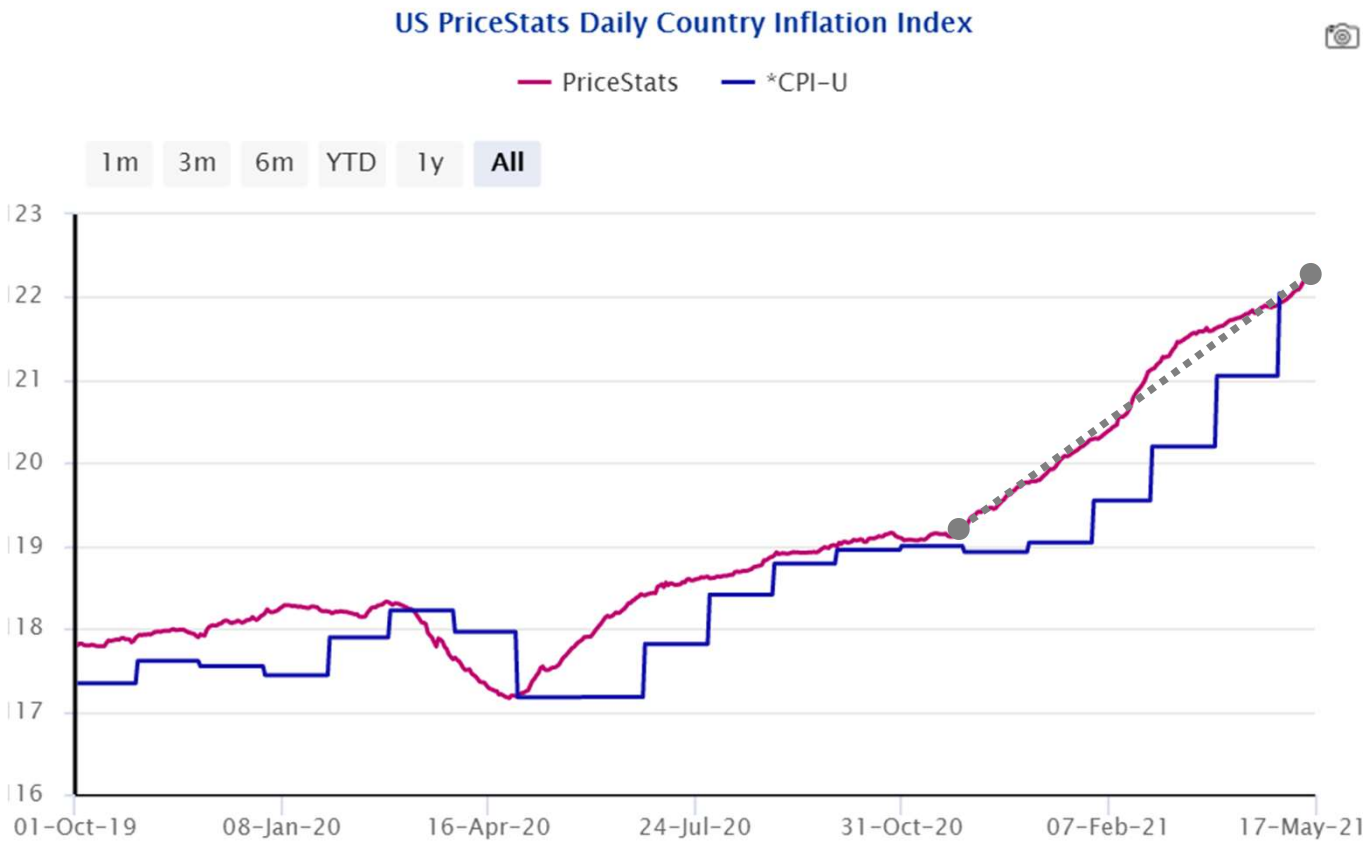
Electronics: Low sales, but normalizing



Summary of Results

- Measurement distortions are adding ~0.9% to the US annual inflation rate (CPI, May)
  - Consumption basket → over-estimating impact of fuel and used cars, exacerbating "base effects"
- Supply disruptions putting significant pressure on inflation (Consumer Goods, April)
  - Stockouts remain high → at 20% above pre-Covid levels for a weighted-basket of CPI goods
  - The price impact is concentrated in electronics and food, where the disruption has been more persistent
  - Many sectors are already "back to normal" (health products, household goods, personal care and others)
- Pent-up Demand
  - US sales behavior consistent with unusually high demand in furniture, but normalizing for apparel and electronics

US Inflation



Alberto Cavallo
HBS, NBER
www.albertocavallo.com

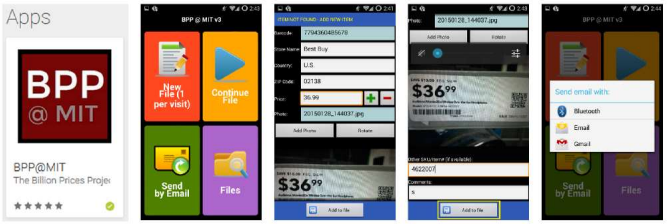
Additional Slides

Are Online and Offline Prices Similar?

- Cavallo (2017) “Are Online and Offline Prices Similar: Evidence from Large Multi-Channel retailers”, AER

- Large-scale comparison of online and offline prices collected simultaneously in ~50 retailers in 10 countries.

- Crowdsourced workers scan random barcodes, enter prices, send emails with data files.



App available for download at the Google Play Store: https://play.google.com/store/apps/details?id=com.mit.bpp

Figure 1: Screenshots from BPP App for Android Phones

- We then scraped the online price for the same good-retailer (within 7 days).

Prices are identical ~70% of the time

Table 3: Country - Level Differences

Country	(1) Ret.	(2) Obs	(3) Identical (%)	(4) High On (%)	(5) Low On (%)	(6) Markup (%)	(7) Difference (%)
Argentina	5	3699	60	27	13	3	1
Australia	4	3797	74	20	5	5	1
Brazil	5	1915	42	18	40	-7	-4
Canada	5	4031	91	3	5	-5	0
China	2	513	87	7	6	3	0
Germany	5	1604	74	4	23	-8	-2
Japan	4	2186	48	7	45	-13	-7
South Africa	5	3212	85	6	9	-3	-1
UK	4	2094	91	2	7	-8	-1
USA	17	15332	69	8	22	-5	-1
ALL	56	38383	72	11	18	-4	-1

Note: Results updated 5 Apr 2016. Column 3 shows the percentage of observations that have identical online and offline prices. Column 4 has the percent of observation where prices are higher online and column 5 the percentage of price that are lower online. Column 6, is the online markup, defined as the average price difference excluding cases that are identical. Column 7 is the average price difference including identical prices.

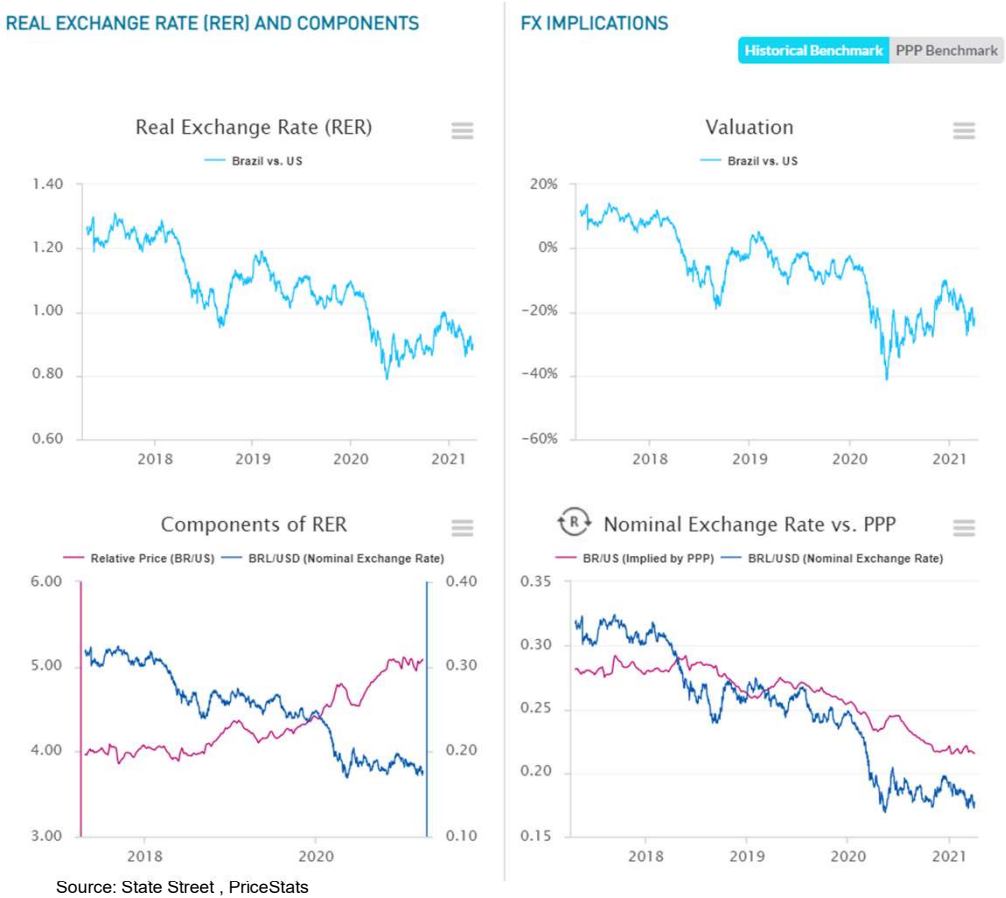
Table 4: Sector - Price Level Differences

Sector	(1) Ret.	(2) Obs	(3) Identical (%)	(4) High On (%)	(5) Low On (%)	(6) Markup (%)	(7) Difference (%)
Food	10	5953	52	32	15	3	1
Clothing	7	2534	92	5	3	3	0
Household	9	7875	79	5	16	-8	-2
Drugstore	4	3053	38	11	52	-5	-3
Electronics	5	3712	83	4	13	-9	-1
Office	2	1089	25	37	38	1	1
Multiple/Mix	18	14149	80	5	15	-9	-2

Note: Results updated 5 Apr 2016. Markup excludes identical prices. Difference includes identical prices.

Source: Cavallo (2017) “Are Online and Offline Prices Similar? Evidence from Large Multi-Channel Retailers”, American Economic Review Vol 107(1)

Exchange-Rate Passthrough → inflationary in Brazil



Source: State Street , PriceStats

"PPP" indices created as a weighted basket of thousands of product-level RERs for identical products matched across countries (in 3 categories: food, fuel, electronics)

Brazil

→ Depreciation *lowered* the relative cost of tradable goods

→ Some passthrough into relative prices, but still the basket cost is too low relative to historical standards (~20% "undervalued")

→ Pressure for relative prices to increase (exchange rate passthrough) or the currency to appreciate (less likely in Brazil)