Covid Inflation: Evidence from Real-Time Data

Alberto Cavallo
Harvard Business School

17. June 2021  Markus Brunnermeier
Inflation whipsaw

- Bond traders' expectations
- Households

Sources: Federal Reserve Bank of St. Louis; University of Michigan
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”

Chart 1: COVID-Sensitive and COVID-Insensitive Contributions to Core PCE Inflation

+ 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
Fraction of Firms Planning to Raise Price

Source: Torsten Slok
Inventory to Sales Ratio in US

Source: Census Bureau, Torsten Slok
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>
<description>Leche Condensada</description>
<brnad>Nestlé</brnad>
<td price>$1.199 Uni</td>
Inflation Measurement with Online Data

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

Source: PriceStats, INDEC, The Billion Prices Project
Inflation Measurement with Online Data

• History:
  – 2007: Argentina Lies – “Inflacion Verdadera”
  – 2008: The Billion Prices Project
Inflation Measurement with Online Data

• History:
  – 2007: Argentina Lies – “Inflacion Verdadera”
  – 2008: The Billion Prices Project
    – 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
What are online price indices useful for?

- Cannot match the CPI inflation rates every month
What are online price indices useful for?

• Cannot match the CPI inflation rates every month
What are online price indices useful for?

• Anticipating changes in inflation trends

What are online price indices useful for?

• Anticipating changes in inflation trends

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 factors 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

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

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](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)

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

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

- 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?

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

<table>
<thead>
<tr>
<th>Products</th>
<th>Retailers</th>
<th>OOS, %</th>
<th>Duration (Days)</th>
<th>Abs size of p-chg, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>706114</td>
<td>14</td>
<td>39</td>
<td>19</td>
</tr>
<tr>
<td>Food and Beverages</td>
<td>73111</td>
<td>28</td>
<td>42</td>
<td>19</td>
</tr>
<tr>
<td>Furnishings &amp; Household</td>
<td>342148</td>
<td>8</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>Health</td>
<td>33930</td>
<td>15</td>
<td>93</td>
<td>24</td>
</tr>
<tr>
<td>Electronics</td>
<td>165433</td>
<td>8</td>
<td>31</td>
<td>14</td>
</tr>
<tr>
<td>Other Goods</td>
<td>98574</td>
<td>11</td>
<td>49</td>
<td>23</td>
</tr>
</tbody>
</table>
Measuring Retail Stockouts

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

USA
Temporary OOS

Percent, 7-day moving average

2020

Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May

5 10 15 20 25
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)

USA
Total Products (Normalized)

Normalized to 100 on 3/20

20% below Pre-Covid levels
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
Permanent and Temporary OOS

Furnishing & Household Goods
Permanent and Temporary OOS
But they are persistent in Food and Electronics

Food and Beverages
Permanent and Temporary OOS

Recreation and Electronics
Permanent and Temporary OOS
## Stockouts in L2 Categories

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

- 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


• 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
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.

- 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

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

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

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

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

Exchange-Rate Passthrough → inflationary in Brazil

“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)