Decomposing Supply and Demand Driven Inflation

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- 1970's high inflation $\rightarrow$ Oil-related supply factors (Blinder and Rudd 2013) and monetary-policy related demand factors (Primiceri 2006))
- Post-covid inflation surge $\rightarrow$ both supply and demand factors appear responsible (Jorda et al. 2021) and (Ball et al. 2022)

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"What [the Fed] can control is demand, we can't really affect supply with our policies. . . so the question whether we can execute a soft landing or not, it may actually depend on factors that we don't control." -Jerome Powell

Motivation

Is there a way to measure, in real time, the extent to which supply or demand is driving inflation?

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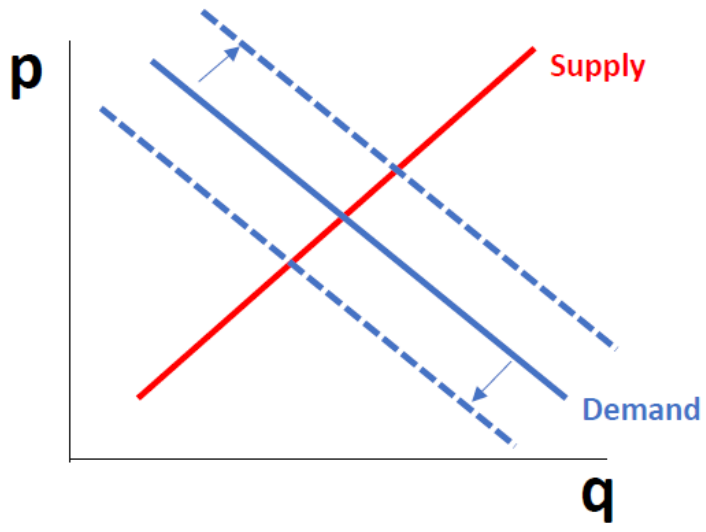
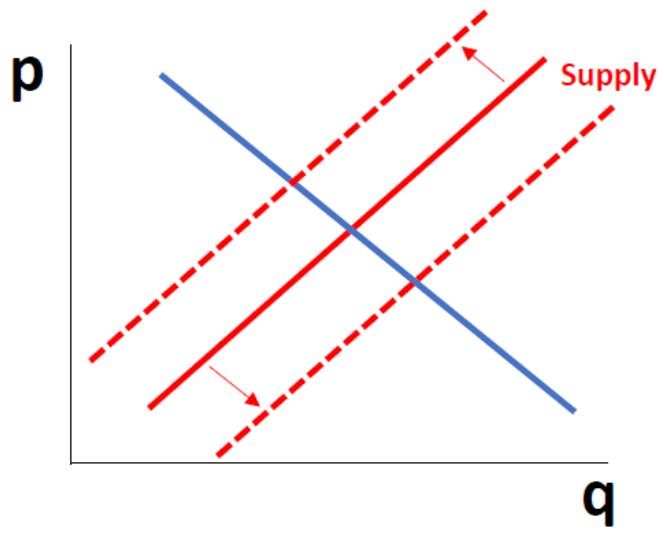
This study $\Rightarrow$ two new data series:

Supply-driven inflation: categories where prices $\uparrow\downarrow$ due to a supply surprise
Demand-driven inflation: categories where prices $\uparrow\downarrow$ due to a demand surprise

Identification based on Economics 101:

- Supply shock: price and quantity move in the opposite direction
- Demand shock: price and quantity move in the same direction





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Solution:

- Sectoral data $\rightarrow$ **continuous** measure of *magnitude* of shocks
  - Aggregating over binary information using category weights

Methodology

Upward sloping supply curve and a downward sloping demand curve applied to each sector i:

$$\begin{aligned} \text{Supply curve:} \quad & q_i = \sigma^i p_i + \alpha^i \\ \text{Demand curve:} \quad & p_i = -\delta^i q_i + \beta^i \end{aligned}$$

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$$\begin{aligned} \text{Supply shock:} \quad \varepsilon_i^s &= (q_{i,t} - \sigma^i p_{i,t}) - (q_{i,t-1} - \sigma^i p_{i,t-1}) \\ \text{Demand shock:} \quad \varepsilon_i^d &= (\delta^i q_{i,t} + p_{i,t}) - (\delta^i q_{i,t-1} + p_{i,t-1}) \end{aligned}$$

Methodology

$$A^i \nu_{i,t} = \varepsilon_{i,t}$$

Sign restrictions:

$$A^i = \begin{bmatrix} 1 & -\sigma^i \\ \delta^i & 1 \end{bmatrix} \rightarrow$$

$$\begin{aligned}
\nu^p_{i,t} > 0, \nu^q_{i,t} > 0 \rightarrow \varepsilon^d_{i,t} > 0 \quad & (+ \text{ Demand Shock}) \\
\nu^p_{i,t} < 0, \nu^q_{i,t} < 0 \rightarrow \varepsilon^d_{i,t} < 0 \quad & (\text{- Demand Shock}) \\
\nu^p_{i,t} < 0, \nu^q_{i,t} > 0 \rightarrow \varepsilon^s_{i,t} > 0 \quad & (+ \text{ Supply Shock}) \\
\nu^p_{i,t} > 0, \nu^q_{i,t} < 0 \rightarrow \varepsilon^s_{i,t} < 0 \quad & (\text{- Supply Shock})
\end{aligned}$$

Data

Publicly available price and quantity PCE data from the BEA.

I use the fourth level of disaggregation, for example:

- (1) services $\rightarrow$ (2) transportation services $\rightarrow$ (3) public transportation $\rightarrow$ (4) air transportation.

136 categories in the PCE price index
124 categories in the core PCE index
Available back to 1988

Estimation

Price & quantity regressions for each of the 136 categories, i, in the PCE:

$$
\begin{aligned}
q_{i,t} &= \sum_{j=1}^{12} \gamma_j^{qp} p_{i,t-j} + \sum_{j=1}^{12} \gamma_j^{qq} q_{i,t-j} + \nu_{i,t}^{q} \\
p_{i,t} &= \sum_{j=1}^{12} \gamma_j^{pp} p_{i,t-j} + \sum_{j=1}^{12} \gamma_j^{pq} q_{i,t-j} + \nu_{i,t}^{p}
\end{aligned}
$$

$q_{i,t} \rightarrow$ log quantity index of category i
$p_{i,t} \rightarrow$ log price index of category i

Supply- and demand-driven contributions to inflation

Two indicator functions defining whether category i experienced a supply shock or demand shock :

$$\mathbb{1}_{i \in sup,t} = \begin{cases} 1 & \text{if } \nu^p_{i,t} > 0, \nu^q_{i,t} < 0 \text{ or } \nu^p_{i,t} < 0, \nu^q_{i,t} > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\mathbb{1}_{i \in dem,t} = \begin{cases} 1 & \text{if } \nu^p_{i,t} > 0, \nu^q_{i,t} > 0 \text{ or } \nu^p_{i,t} < 0, \nu^q_{i,t} < 0 \\ 0 & \text{otherwise} \end{cases}$$

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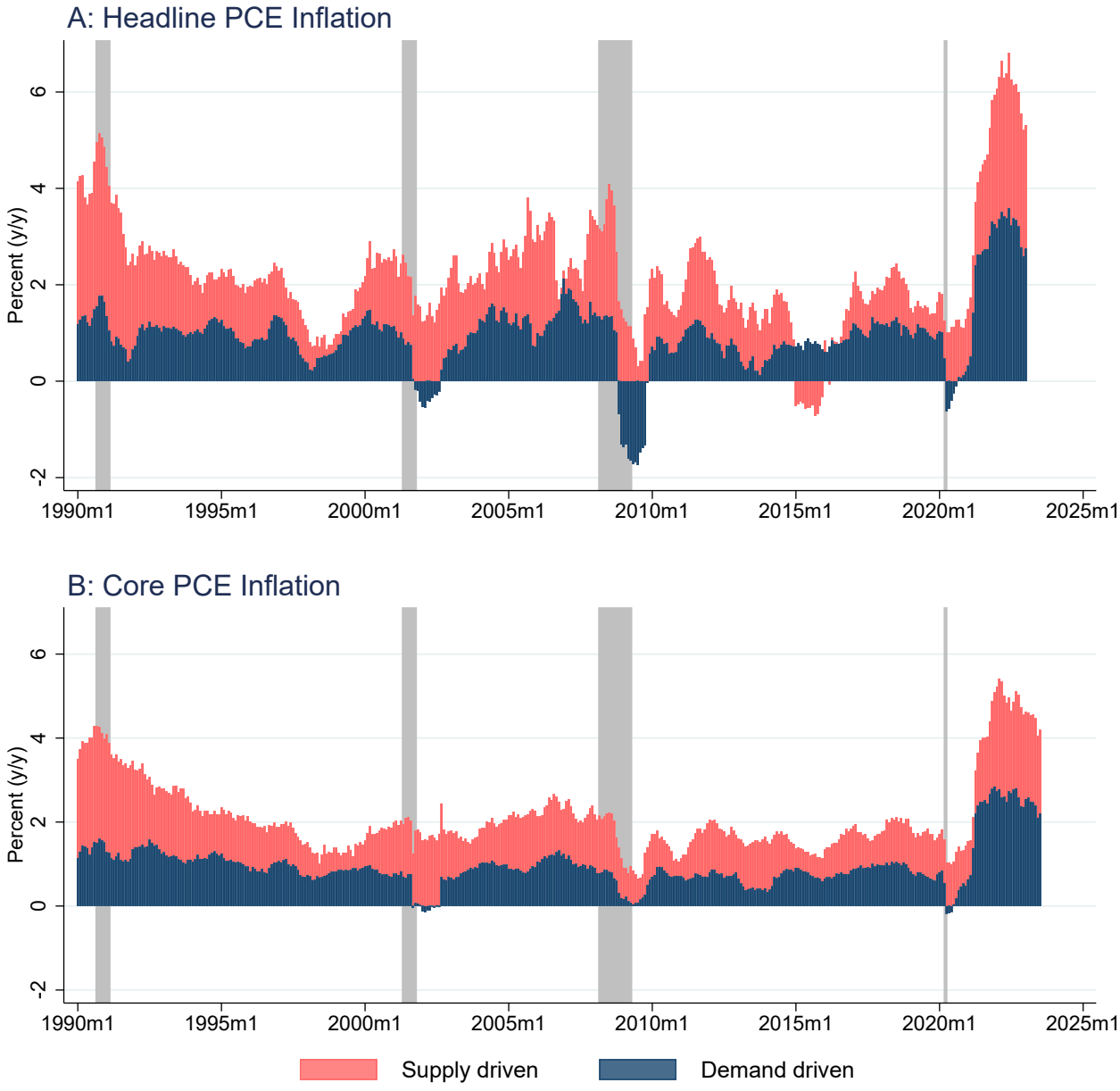
$$\mathbb{1}_{i \in dem,t} = \begin{cases} 1 & \text{if } \nu^p_{i,t} > 0, \nu^q_{i,t} > 0 \text{ or } \nu^p_{i,t} < 0, \nu^q_{i,t} < 0 \\ 0 & \text{otherwise} \end{cases}$$

Monthly PCE inflation can be divided into two distinct components, the supply- and demand-driven contributions:

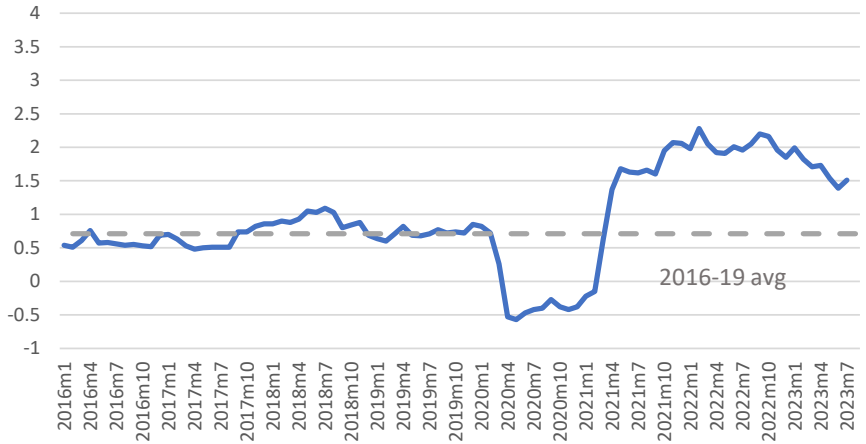
$$\pi_{t,t-1} = \underbrace{\sum_i \mathbb{1}_{i \in sup,t} \omega_{i,t} \pi_{i,t,t-1}}_{\text{supply-driven } (\pi^{sup}_{t,t-1})} + \underbrace{\sum_i \mathbb{1}_{i \in dem,t} \omega_{i,t} \pi_{i,t,t-1}}_{\text{demand-driven } (\pi^{dem}_{t,t-1})}$$

Supply- and demand-driven PCE Inflation

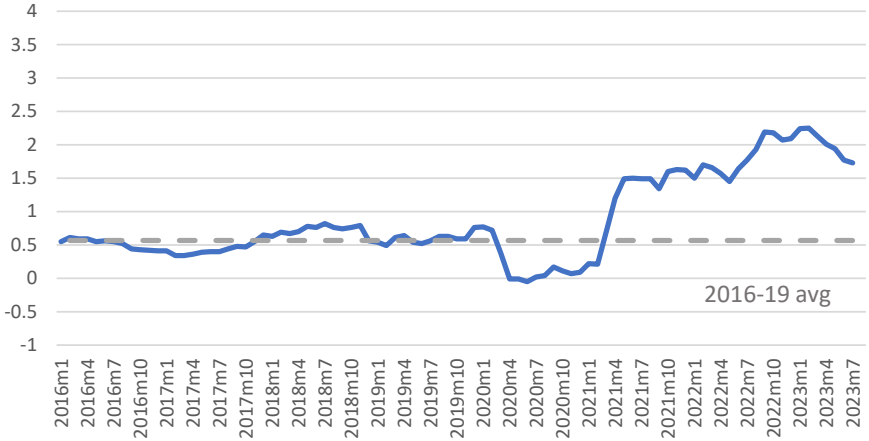


Recent supply- and demand-driven inflation

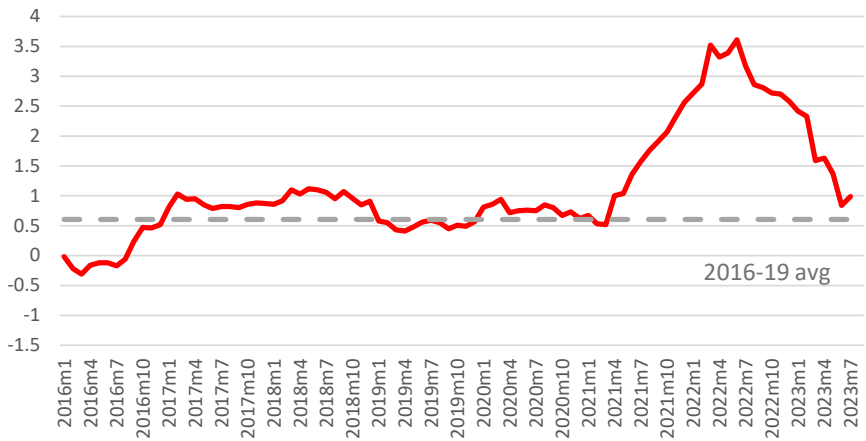
Demand-driven contribution to **Headline** inflation



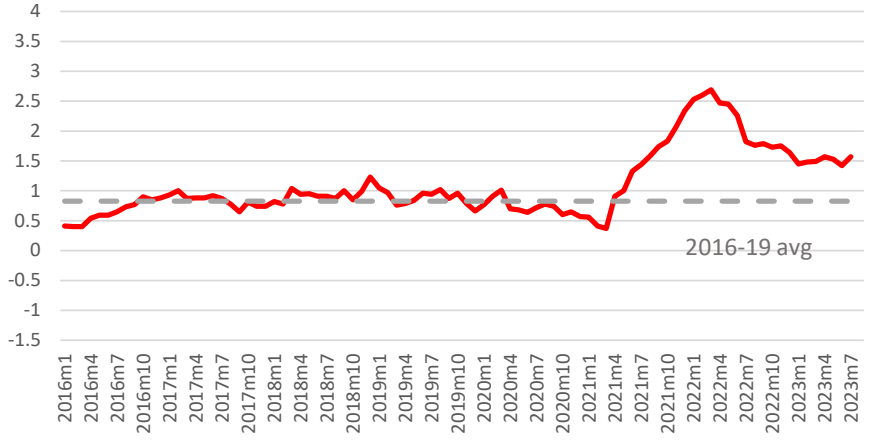
Demand-driven contribution to **Core** inflation



Supply-driven contribution to **Headline** inflation

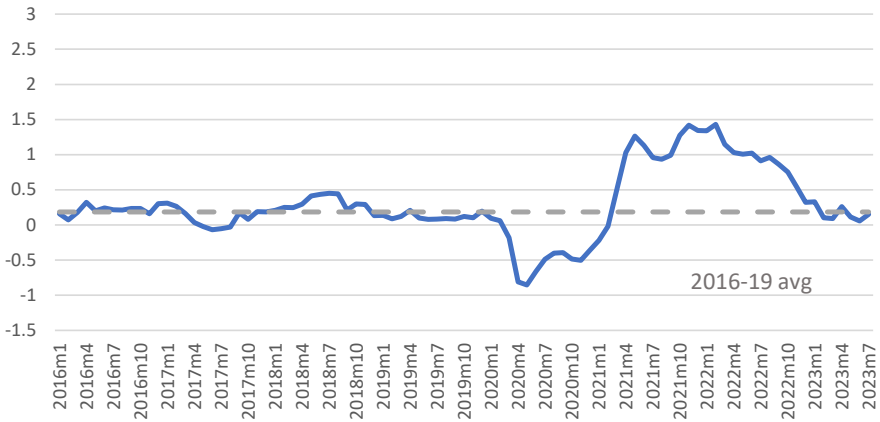


Supply-driven contribution to **Core** inflation

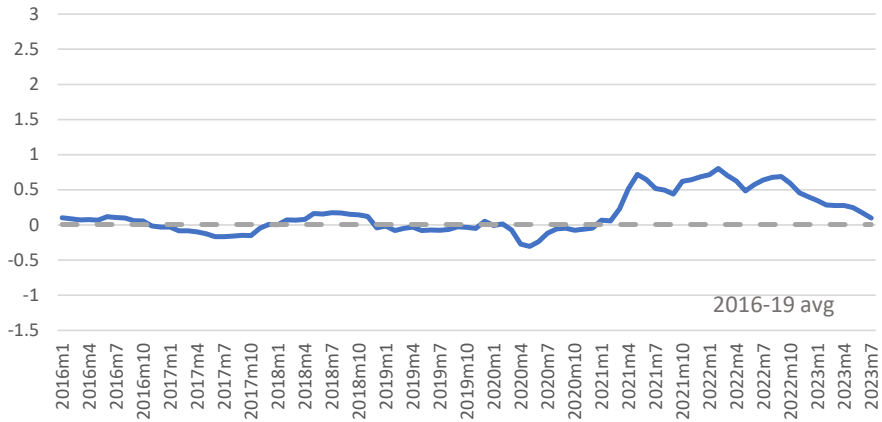


Supply factors heavily influenced goods inflation

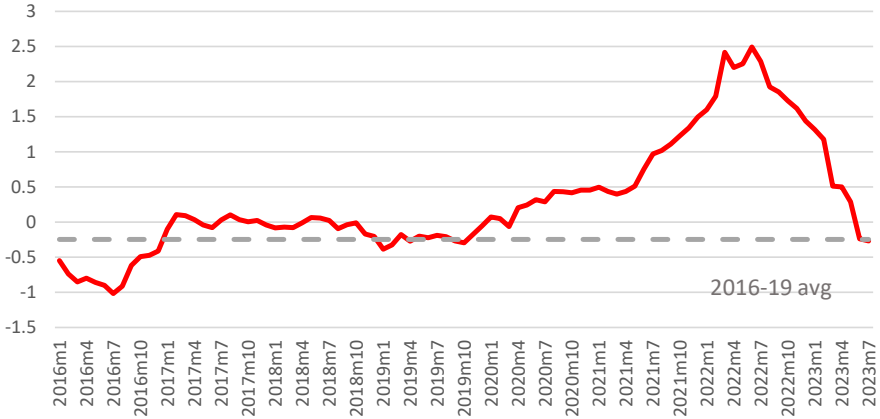
Demand-driven contribution: **Headline Goods**



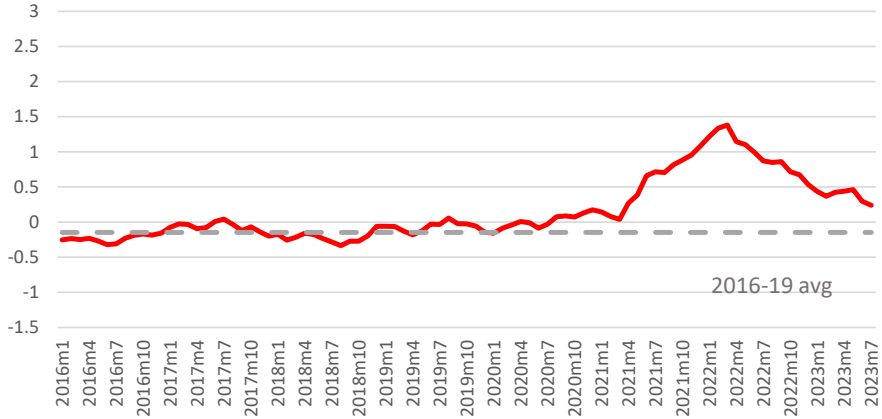
Demand-driven contribution: **Core Goods**



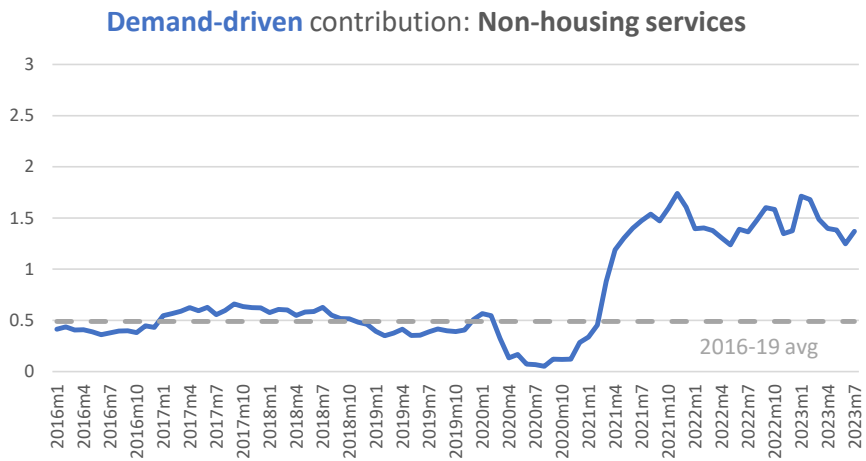
Supply-driven contribution: **Headline Goods**

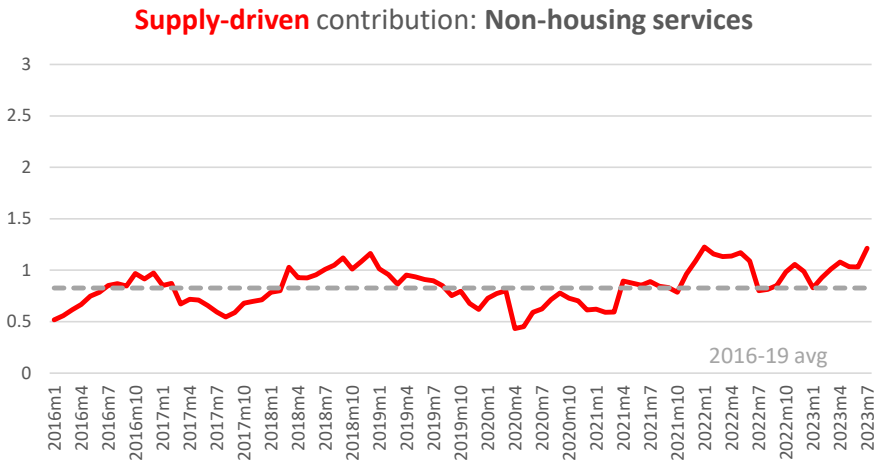


Supply-driven contribution: **Core Goods**



Demand factors continue to influence services inflation





Shocks over the recent inflation surge

	Positive Demand Shocks (Share of Months)	
	2021m4-2023m7	Full Sample
Restaurants	0.68	0.53
Lotteries	0.64	0.40
Child Care	0.59	0.42
Higher Education	0.59	0.47
Rent (owner occupied)	0.59	0.49
Amusement Parks	0.59	0.38
Funeral & Burial Services	0.59	0.47
Water Supply & Sewage Maintenance	0.55	0.45
Electricity	0.55	0.29
Life Insurance	0.55	0.44

	Negative Supply Shocks (Share of Months)	
	2021m4-2023m7	Full Sample
New Light Trucks	0.73	0.33
Rent (tenant occupied)	0.68	0.51
Domestic Services	0.64	0.60
Tobacco	0.64	0.45
Food	0.64	0.43
Household Cleaning Products	0.64	0.35
Tires	0.64	0.33
Stationery & Misc Printed Mtls	0.64	0.35
Carpets & Other Floor Coverings	0.59	0.36
Dishes and Flatware	0.59	0.34

External Validation

How do known aggregate shocks impact the inflation decompositions?

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- MP tightening $\rightarrow$
  - $\downarrow$ demand-driven inflation (e.g. Smets and Wouters (2003))
  - $\uparrow$ supply-driven inflation (e.g. Barth and Ramey (2001))

- Oil supply decline $\rightarrow$
  - $\uparrow$ supply-driven inflation (e.g. Hamilton (1983))
  - $\downarrow$ demand-driven inflation (e.g. Hamilton (2008))

External Validation

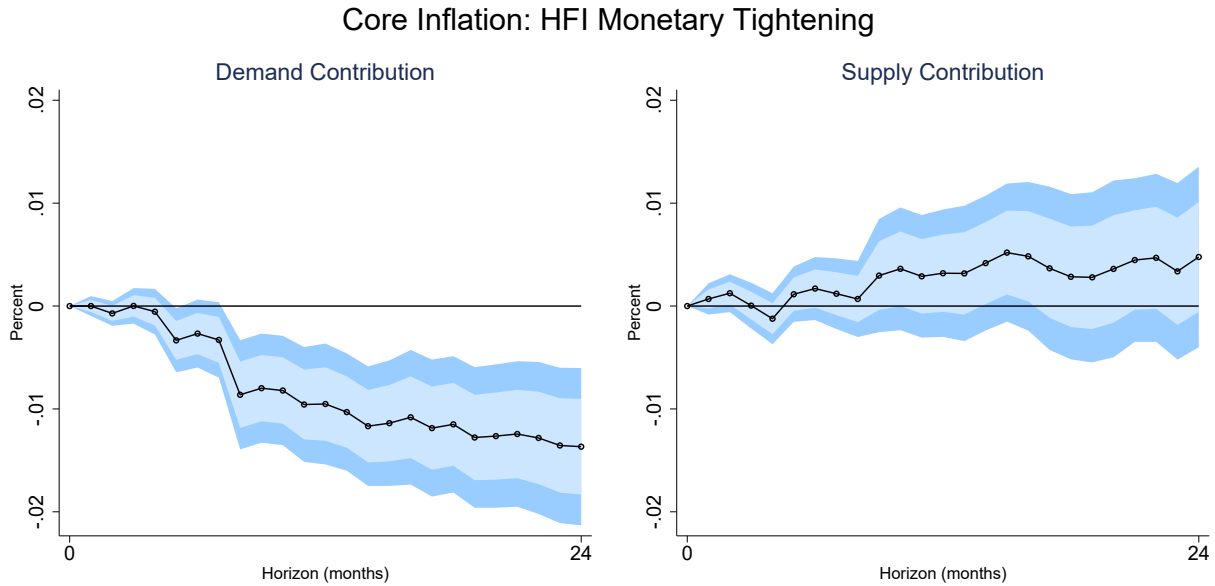
How do known aggregate shocks impact the inflation decompositions?

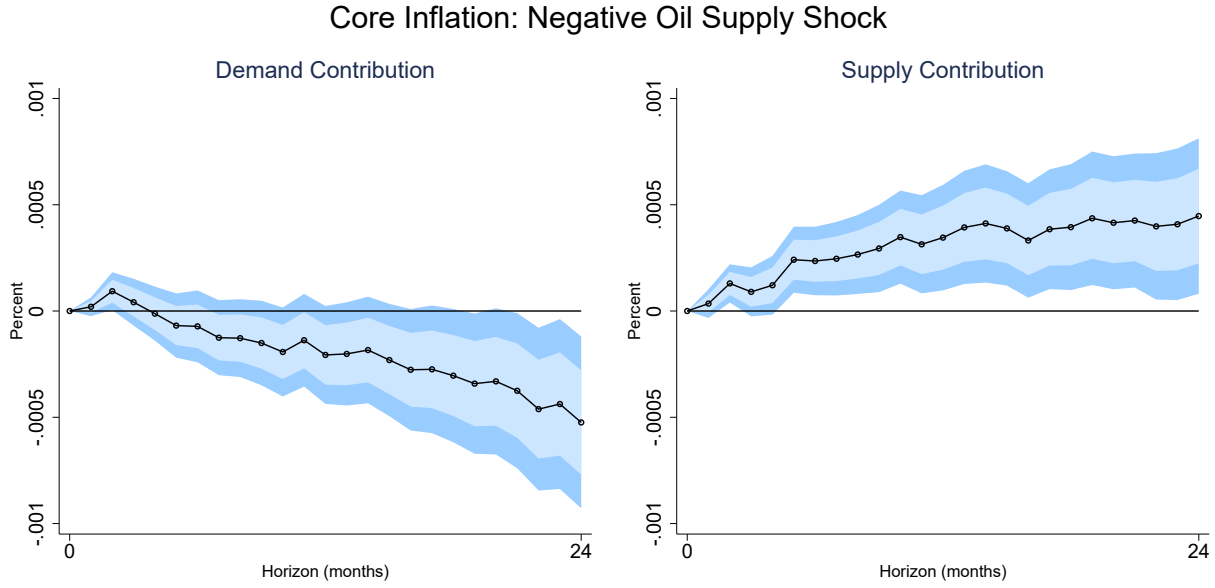
- high-frequency identified (HFI) monetary policy shocks
  - Gurkaynak et al. 2005
- externally-identified oil supply (OS) shocks
  - Baumeister and Hamilton 2019

Local projections:

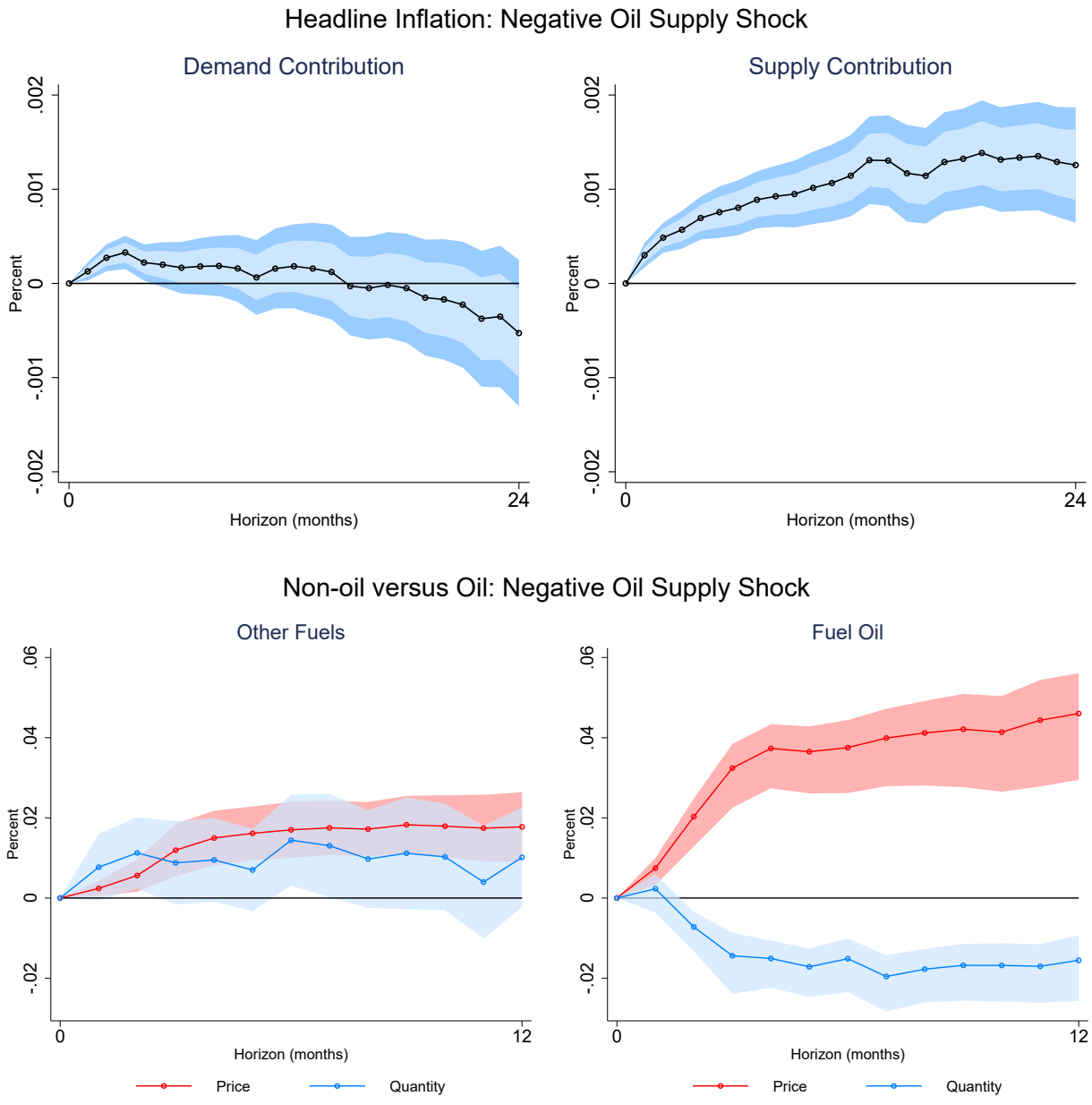
$$\pi^{j}_{t+h,t} = \alpha^{h}_{j} HFI_t + \beta^{h}_{j} OS_t + \mathsf{A}^{h}_{j} \sum_{\tau=1}^{6} \mathsf{Y}_{t-\tau} + \zeta_{j,t+h}.$$

Monetary and Oil Shocks





Interesting substitution effects

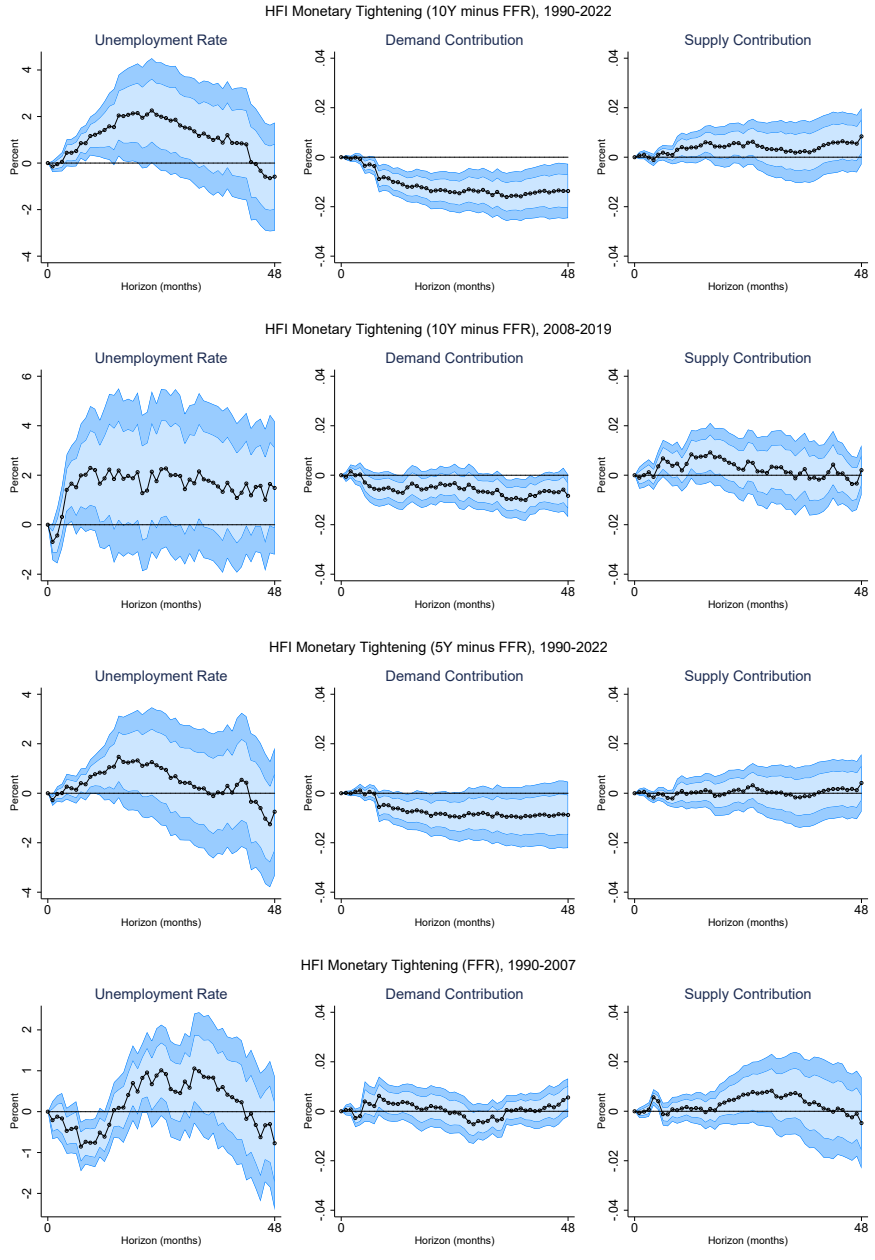


Data available on FRBSF data page

and on my webpage: sites.google.com/site/adamshap/research

Additional slides

Robustness


HFI Monetary Tightening (10Y minus FFR), 1990-2022
Unemployment Rate
Demand Contribution
Supply Contribution
HFI Monetary Tightening (10Y minus FFR), 2008-2019
Unemployment Rate
Demand Contribution
Supply Contribution
HFI Monetary Tightening (5Y minus FFR), 1990-2022
Unemployment Rate
Demand Contribution
Supply Contribution
HFI Monetary Tightening (FFR), 1990-2007
Unemployment Rate
Demand Contribution
Supply Contribution
Percent
Horizon (months)
0
48

Robustness

Table: Cross-correlations, alternative measures of supply- and demand-driven contributions to PCE inflation

Variables	Baseline	Smooth-1	Smooth-2	Smooth-3	AR-3	AR-24	Wt. (Param.)	Wt. (Bayes.)	Rolling	Precision
					Supply-driven contribution					
Baseline	1.000									
Smooth-1	0.929	1.000								
Smooth-2	0.925	0.936	1.000							
Smooth-3	0.917	0.961	0.967	1.000						
AR-3	0.933	0.867	0.814	0.832	1.000					
AR-24	0.946	0.902	0.925	0.898	0.816	1.000				
Wt. (Param.)	0.958	0.923	0.939	0.938	0.897	0.925	1.000			
Wt. (Bayes.)	0.965	0.921	0.877	0.889	0.984	0.878	0.936	1.000		
Rolling	0.958	0.884	0.876	0.875	0.889	0.895	0.960	0.934	1.000	
Precision	0.963	0.889	0.845	0.854	0.954	0.868	0.895	0.966	0.909	1.000
					Demand-driven contribution					
Baseline	1.000									
Smooth-1	0.887	1.000								
Smooth-2	0.869	0.887	1.000							
Smooth-3	0.873	0.935	0.938	1.000						
AR-3	0.923	0.820	0.731	0.782	1.000					
AR-24	0.936	0.874	0.882	0.867	0.808	1.000				
Wt. (Param.)	0.937	0.858	0.861	0.887	0.891	0.908	1.000			
Wt. (Bayes.)	0.954	0.877	0.797	0.838	0.984	0.859	0.918	1.000		
Rolling	0.945	0.850	0.821	0.832	0.891	0.865	0.918	0.919	1.000	
Precision	0.989	0.890	0.873	0.879	0.907	0.925	0.922	0.942	0.946	1.000