Decomposing Food Price Inflation in the United States

Measuring the Contribution of Supply- and Demand-side Factors

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Disclaimer

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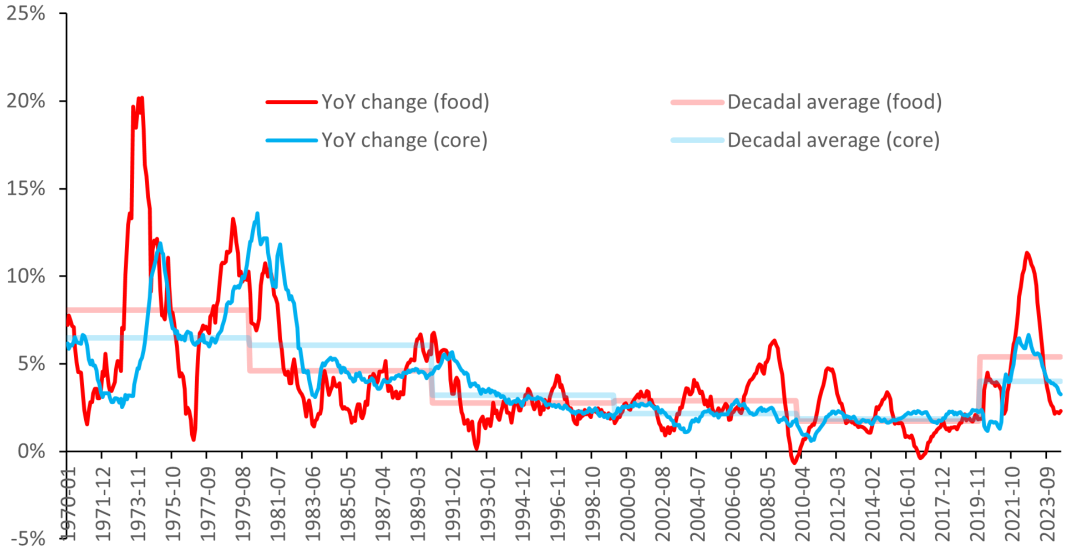
Takeaways

- We use a time series model to identify how supply and demand forces contribute to nationwide U.S. food price inflation
- We find that the demand side of the market is far more important to recent inflation than previous episodes
  - Supply shocks, on the other hand, are evident immediately following pandemic onset (likely due to backups/shortages), and Russia's invasion of Ukraine
- We also explore the role of various explanatory factors
  - Demand-driven inflation is reduced by monetary tightening, but increases are associated with excess savings, concern over shortages, supply chain pressure, and labor market tightness
  - Supply-driven inflation is associated with industrial production, supply chain pressure, supply chain markups, and labor market tightness
- In ongoing work, we apply the model used in the paper to a more granular set of food products in individual markets around the United States; the idea is to develop regional insights about the pressures of supply-side forces

Surge in U.S. Food Prices

- From 2022-2023, U.S. food prices surged at a historic rate, with a 10.6% increase over the 12 months ending in November 2022–the steepest in forty years
- This rise is reminiscent of the sharp food inflation of the 1970s and 1980s
- Food price inflation is significant as food consumption is unavoidable and makes up a larger share of lower-income households' budgets
- Since the onset of the pandemic in 2020, food prices escalated more rapidly than prices for other goods and services
- ”Stubbornly high” food prices are routinely cited in popular surveys as the strongest channel through which Americans are affected by inflation (Bhattarai and Stein, 2024)

Inflation in the United States (Year over Year)



Understanding Rising Food Prices

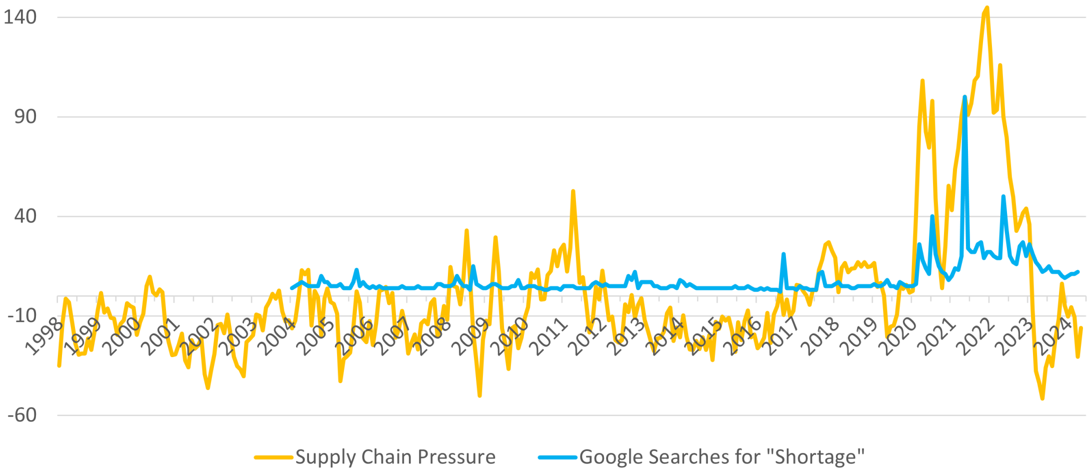
- Our research investigates why food prices escalated so rapidly; according to basic economic theory, price increases can occur due to positive shifts in demand or negative shifts in supply
  - Supply shocks due to, e.g., transport disruptions, may be to blame
  - On the demand side, excess savings increased very rapidly due to fiscal (stimulus/unemployment/child credits/PPP/eviction moratoria) and monetary policies meant to counter the effects of the pandemic (Abdelrahman and Oliveira, 2023); the drawdown in excess savings began just as food price inflation increased

- Previous studies used conventional time series methods to estimate how specific factors affect food prices (e.g., Adjemian et al., 2023)

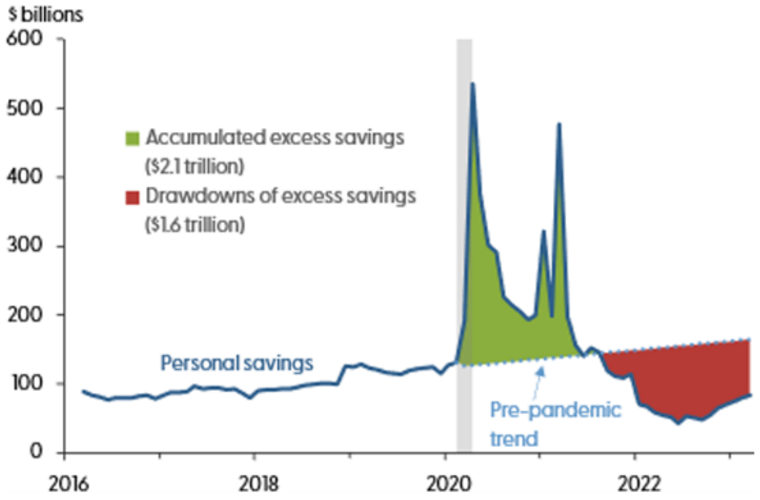
- In contrast, our work applies Shapiro's model (2024), producing easy-to-interpret results without strong assumptions

- Understanding the source of price shocks is key because it guides policymakers about how to address the issue

Supply Chain Pressure and Google Searches for "Shortage", Indices=100 in May, 2021



Excess savings accumulation and drawdown in the United States (Abdelrahma and Oliveira’s Figure 2, 2023)



Shapiro's Approach Model Details

- Shapiro (2024) uses category-level time series regressions to decompose changes in the personal consumption expenditure price (PCE) index into supply and demand shocks

- His model determines if a category experienced a same-direction change in price and quantity (demand shock) or an opposite-direction change (supply shock) from one month to the next
  - Quantity, price, and expenditures are drawn from BEA tables 2.4.3U, 2.4.4U, and 2.4.5U, respectively
  - Precision cutoffs (shocks greater than 0.25/0.05/0.025 SDs for more/mid/less precise) used to address labeling ambiguity

- By weighting each category according to its share of total U.S. expenditures, the contributions of demand and supply shocks to the overall level of price inflation can be estimated

Applying Shapiro's Model to Food Prices

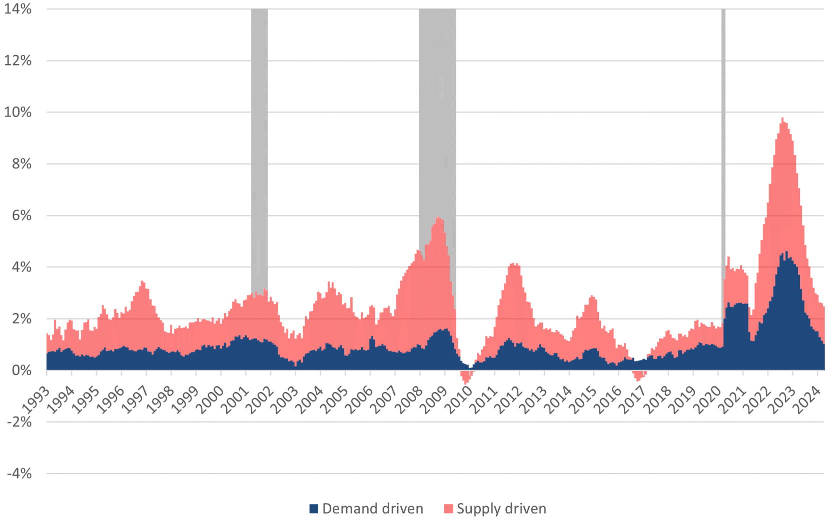
Model Details

- We apply Shapiro's method to food price increases for food consumed at home, food away from home (off-premises in the BEA nomenclature), and a total food category (that we construct with both types of categories)

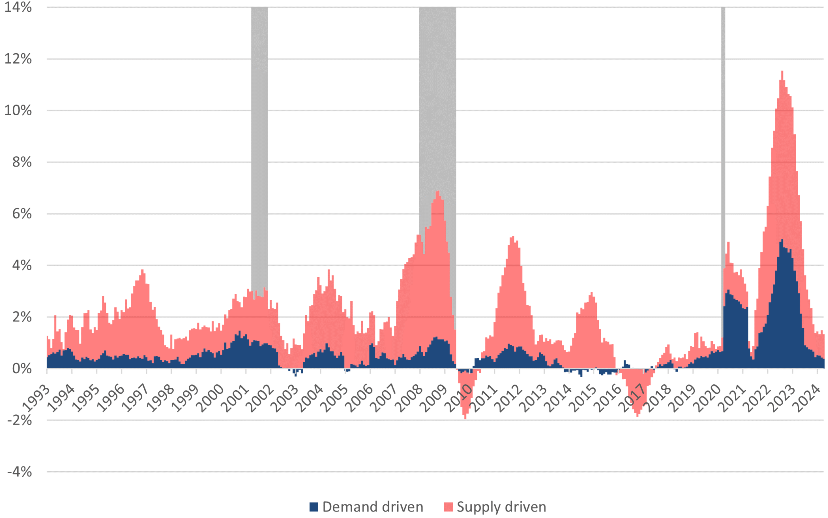
- Model outputs include new data series representing the overall contributions of the demand and supply sides of the market to food price inflation

- This decomposition permits us to examine how each contributes to changes in food prices at the category level

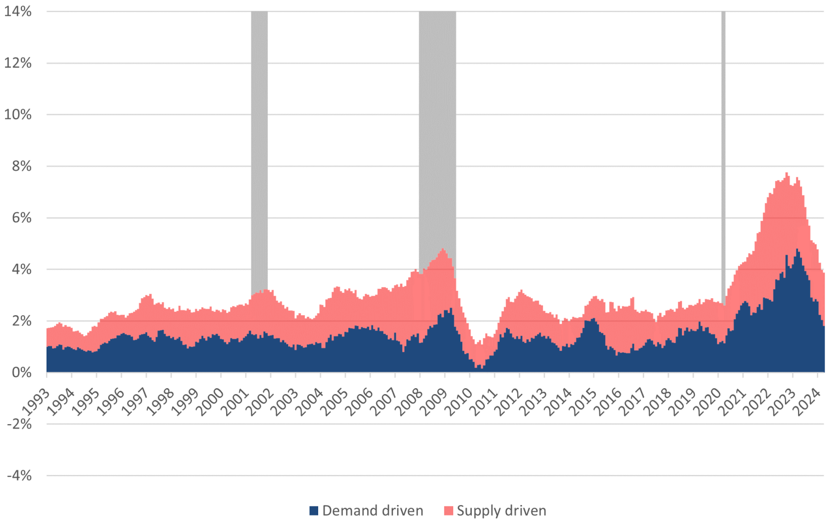
PCE inflation in the United States, all food



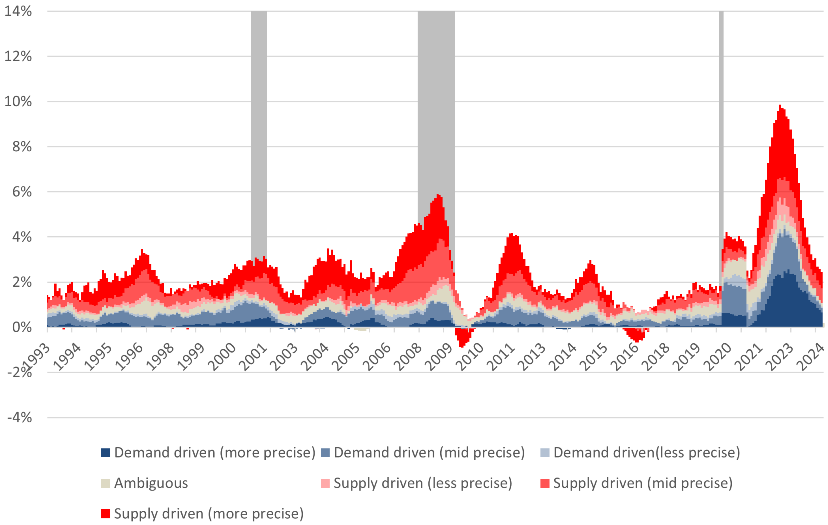
PCE inflation in the United States, food at home



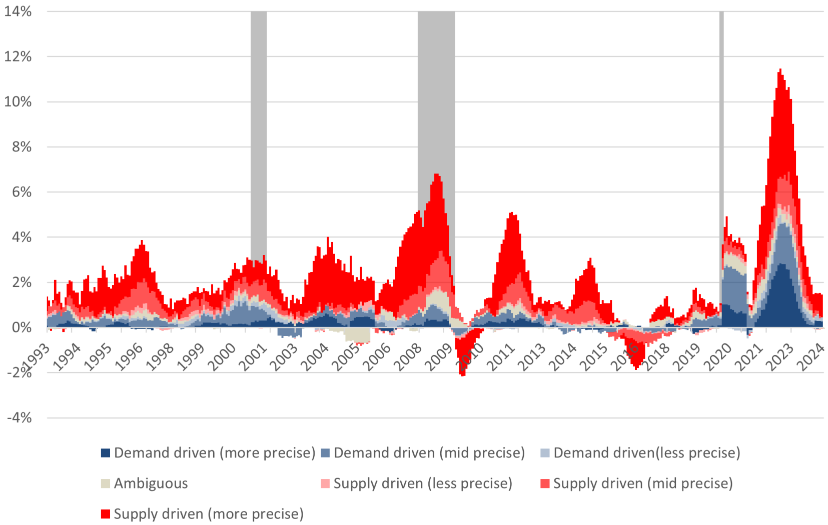
PCE inflation in the United States, food service



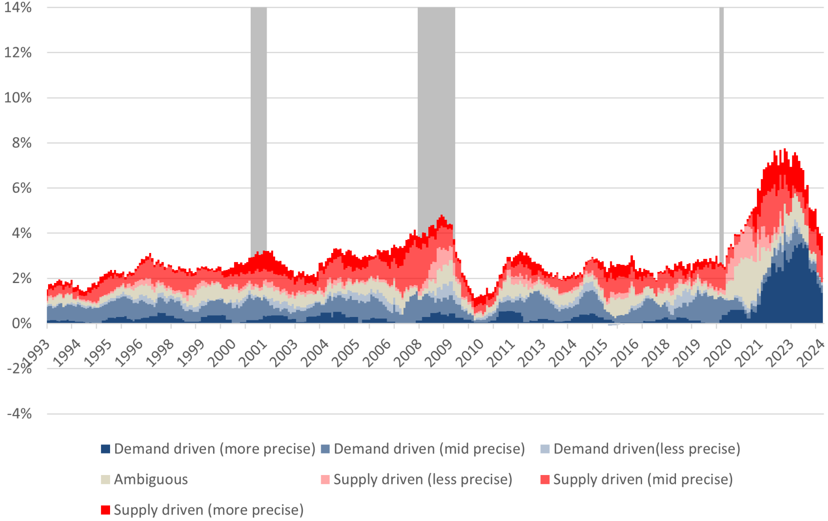
PCE inflation with precision cutoffs, all food



PCE inflation with precision cutoffs, food & bev at home



PCE inflation with precision cutoffs, food service



Demand-driven share of inflation increased for all food types

Back

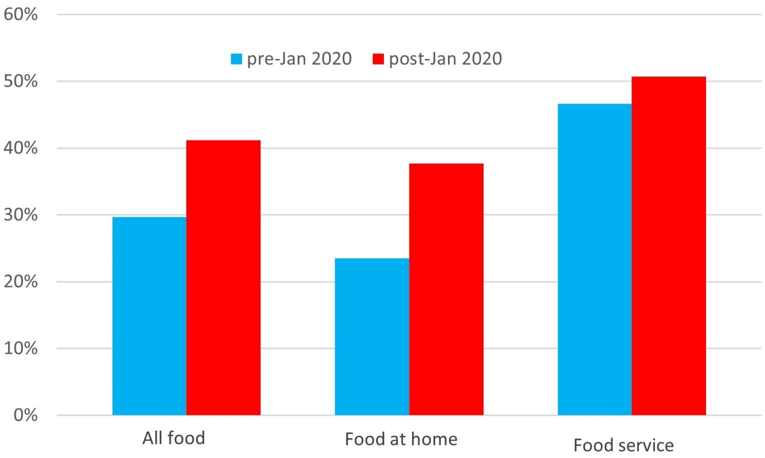
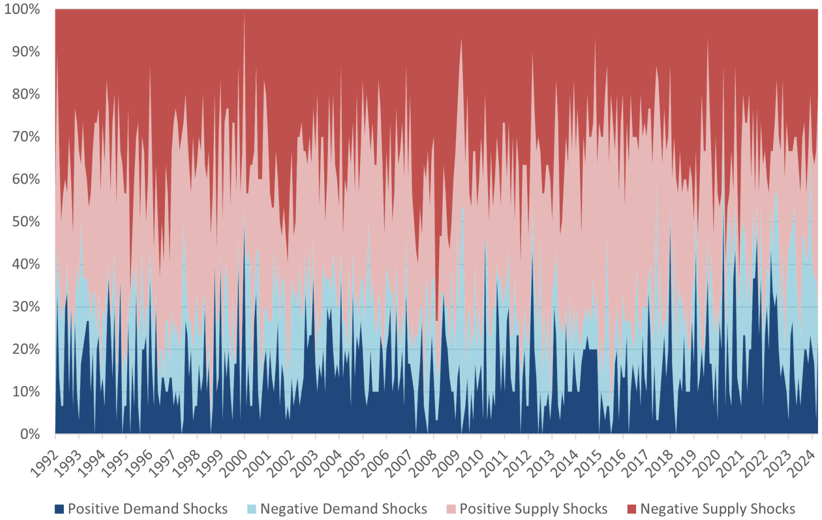


Figure: All food and FAH differences significant at the 1% level; FAFH significant at the 8% level

Share of monthly all-food inflation explained by different contributions

Back



Empirical Observations

Figure 5 Figure 6

- In the pre-pandemic period (January 1992 - December 2019) supply shocks dominated observed food price changes, accounting for over 70 percent of all food category shocks (so the demand side accounted for 30 percent)
  - This is especially true for the most-precisely identified demand shocks
- However, from January 2020 to April 2024, over 40 percent of observed food price shocks are attributed to movements in the demand curve
  - This marks a significant shift in the drivers of food price inflation compared to the previous thirty years
- Storytelling: While FAH demand shocks grow in importance beginning with the onset of Covid-19 (stockpiling / precautionary demand) and then rise again for FAH and FAFH as excess savings draw down, supply shocks play an important role (1) early in the pandemic (transport backups & workplace/distance restrictions) and (2) then again just following Russia's invasion of Ukraine

Local Projections Impulse Responses

Demand-FAFH Demand-FAH Supply-FAFH Supply-FAH

- To better understand the factors affecting food price inflation, we estimate cumulative impulse responses of supply- and demand-driven food price inflation to different kinds of shocks; externally-identified shocks (monetary tightening and agricultural news) are exogenous and can be interpreted causally, while the remaining are associative
- Tighter monetary policy reduces the demand-side contribution to FAH and FAFH inflation. Poor agricultural supply news affects the supply-side contribution differently, but the effect is very small.
- Concern over shortages, supply chain pressure, and tighter labor markets are associated with increased demand-side inflation; higher excess savings raises FAFH prices after a lag
- Supply-side inflation is positively associated with industrial production (weakly), supply-chain pressure, and markups at various stages of production; labor market tightness pressures FAFH prices higher

Ongoing Work

- Extend macro-level findings of this article using similar techniques to study micro-level shocks in individual markets (e.g., counties)

- Use high-frequency scanner data that provides far more granular information on retail and household-level expenditures, prices, and quantities to investigate how demand and supply shocks affect food prices across the United States

- Generate a detailed data set that provides insight into the nature of inflation in near real-time

- We anticipate that, for instance, measuring the impact of category-specific supply shocks across temporal and spatial dimensions will highlight areas where policymakers might target infrastructure investments to minimize the risk of future stockouts or supply-chain stress

Thank you

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- read the working paper @ my UGA faculty webpage:

  Adjemian, M.K., Q. Li, and J. Jo. “Decomposing Food Price Inflation into Supply and Demand Shocks”

Conceptual Model Back

Identifying supply and demand shocks

Following Shapiro (2024), with quantity and price data for food category i, and facing supply curve slope σ^i and demand curve slope δ^i, running the vector autoregression (VAR) model:

$$z_{i,t} = [A^i]^{-1} \sum_{j=1}^{N} A^i_j z_{i,t-j} + \nu_{i,t} \tag{1}$$

where $A^i = \begin{bmatrix} 1 & -\sigma^i \\ \delta^i & 1 \end{bmatrix}$, $z_i = \begin{bmatrix} q_i \\ p_i \end{bmatrix}$, and j lags produce reduced-form residuals $\nu_i = \begin{bmatrix} \nu_i^q \\ \nu_i^p \end{bmatrix}$.

Conceptual Model Back

Structural supply and demand shocks

These residuals can be transformed to recover the structural supply and demand shocks $\epsilon_i = \begin{bmatrix} \epsilon_i^s \\ \epsilon_i^d \end{bmatrix}$, where:

$$\epsilon_i^s = q_i - \sigma^i p_i \tag{2}$$
$$\epsilon_i^d = \delta^i q_i + p_i, \tag{3}$$

according to:

$$\epsilon_{i,t} = A^i \nu_{i,t}. \tag{4}$$

Signs of the Residuals and Structural Shocks

Back

Restrictions on the sign of the supply and demand slopes specified in A^i (consistent with basic economic theory) imply restrictions on both the signs of the reduced-form residuals and structural shocks (Calvert Jump and Kohler, 2022).

The unexpected time t shifts in price and quantity for different food categories reveal supply and demand shocks:

$$\text{Pos. Supply Shock:} \quad \nu^p_{i,t} < 0 \quad \text{and} \quad \nu^q_{i,t} > 0 \quad \rightarrow \quad \epsilon^s_{i,t} > 0 \tag{5}$$

$$\text{Neg. Supply Shock:} \quad \nu^p_{i,t} > 0 \quad \text{and} \quad \nu^q_{i,t} < 0 \quad \rightarrow \quad \epsilon^s_{i,t} < 0 \tag{6}$$

$$\text{Pos. Demand Shock:} \quad \nu^p_{i,t} > 0 \quad \text{and} \quad \nu^q_{i,t} > 0 \quad \rightarrow \quad \epsilon^d_{i,t} > 0 \tag{7}$$

$$\text{Neg. Demand Shock:} \quad \nu^p_{i,t} < 0 \quad \text{and} \quad \nu^q_{i,t} < 0 \quad \rightarrow \quad \epsilon^d_{i,t} < 0 \tag{8}$$

Decomposition of Food Price Inflation Back

Once time t shocks for each food category are segregated into supply and demand shocks according to equations (5)-(8), they can be used to decompose observed food price inflation into the portion driven by each broad side of the market.

We specify indicator functions that classify whether a food category experienced a supply or demand shock in period t:

$$I_{i \in \text{sup},t} = \begin{cases} 1 & \text{if } \epsilon^{s}_{i,t} > 0 \text{ or } \epsilon^{s}_{i,t} < 0 \\ 0 & \text{otherwise} \end{cases} \tag{9}$$

$$I_{i \in \text{dem},t} = \begin{cases} 1 & \text{if } \epsilon^{d}_{i,t} > 0 \text{ or } \epsilon^{d}_{i,t} < 0 \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

Decomposition of Food Price Inflation

Back

Then the observed price inflation between $t-1$ and t can be decomposed into supply- ($\pi^{\text{sup}}_{t,t-1}$) and demand-driven ($\pi^{\text{dem}}_{t,t-1}$) components.

$$\pi_{t,t-1} = \pi^{\text{sup}}_{t,t-1} + \pi^{\text{dem}}_{t,t-1} \tag{11}$$

$$\pi_{t,t-1} = \sum_i I_{i\in\text{sup},t}\,\omega_{i,t}\,\pi_{i,t,t-1} + \sum_i I_{i\in\text{dem},t}\,\omega_{i,t}\,\pi_{i,t,t-1} \tag{12}$$

where $\omega_{i,t}$ represents the share of time $t-1$ expenditures on category i, while $\pi_{i,t,t-1}$ is the percent change in price for category i between periods $t-1$ and t.

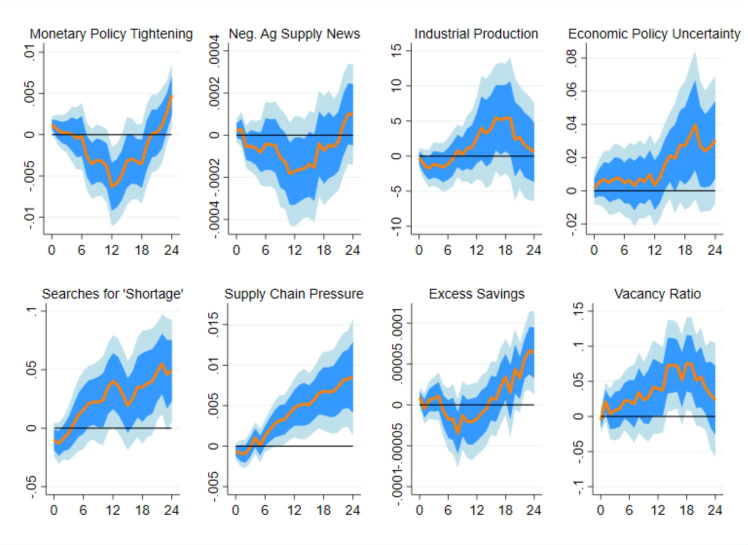
Year-over-Year Inflation Back

If the frequency of the data is monthly, then the contributions of the supply and demand shocks to year-over-year inflation is the combination of their twelve-month running sums.

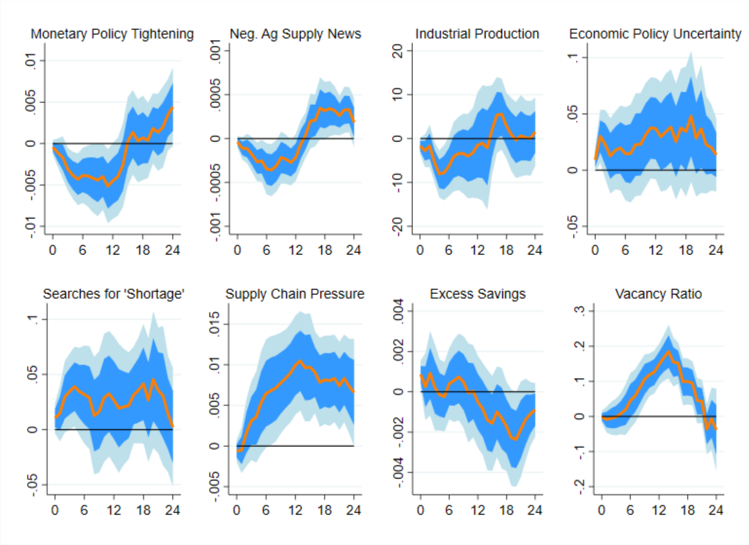
$$\pi_{t,t-12} = \pi^{\text{sup}}_{t,t-12} + \pi^{\text{dem}}_{t,t-12} \tag{13}$$

$$\pi^{m}_{t,t-12} = \sum_{k=0}^{11} \pi^{m}_{t-k,t-k-1}, \quad \text{for } m \in \{\text{sup}, \text{dem}\} \tag{14}$$

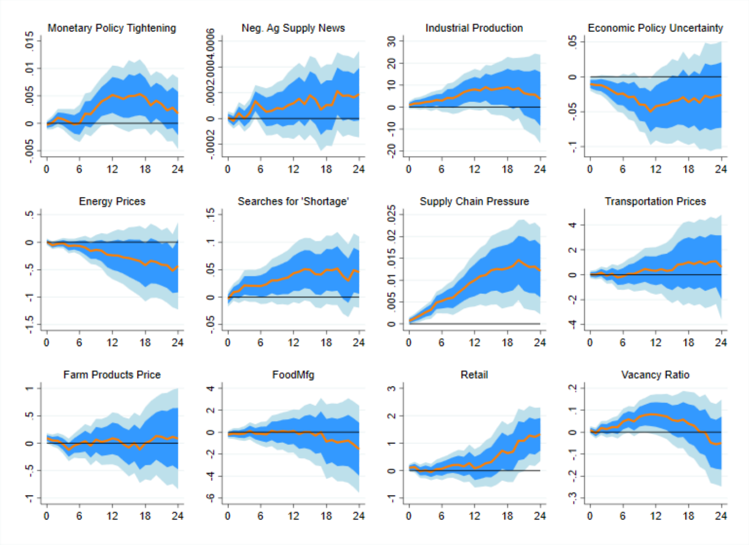
Impulse responses of the **demand-driven** contribution to FAFH inflation to a 10% increase (from the mean) in... Back



Impulse responses of the **demand-driven** contribution to FAH inflation to a 10% increase (from the mean) in... Back



Impulse responses of the **supply-driven** contribution to FAFH inflation to a 10% increase (from the mean) in... Back



Impulse responses of the **supply-driven** contribution to FAH inflation to a 10% increase (from the mean) in... Back