

Supply and Demand breakdown of driven Inflation through Sign Restrictions

Pablo Barrio, Benjamin Pipaud, Pierre Rouillard

ENSAE

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Prime objectives

- ▶ Decompose YoY% inflation in **France** into two components : **Supply** or **Demand** driven (Shapiro (2022))
- ▶ Decompose both into **Persistent** and **Transitory** components (Sheremirov (2022))

Data

Original papers: price and quantity indexes for Personal Consumption Expenditures by type of product

We lack similar data and have to use a proxy for the quantity series :

- ▶ price indexes : HICP series (COICOP classification)
- ▶ quantity indexes : deflated turnover series (NACE Rev.2 classification)
 - ▶ Match as many COICOP sectors to a corresponding turnover series
 - ▶ Matched on average around 80% of overall inflation

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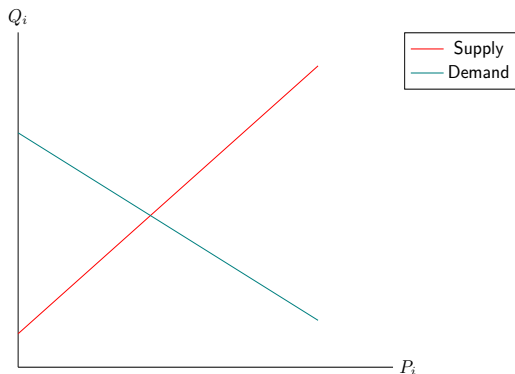
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Supply and Demand Curves



- Aggregate demand and supply curves for each sector i , with $\sigma_i > 0$ and $\delta_i > 0$:

$$\text{Supply : } Q_i = \sigma_i \cdot P_i + \alpha_i$$

$$\text{Demand : } P_i = -\delta_i \cdot Q_i + \beta_i$$

Theoretical results

- Theoretical framework derived from Jump and Kohler (2022)
- Shocks defined as:

$$\text{Supply shock : } \varepsilon_t^s = \Delta\alpha_i = \Delta Q_{i,t} - \sigma_i \Delta P_{i,t}$$

$$\text{Demand shock : } \varepsilon_t^d = \Delta\beta_i = \Delta P_{i,t} + \delta_i \Delta Q_{i,t}$$

$$\Rightarrow \Delta Q_{i,t} = \frac{1}{1 + \delta_i} (\varepsilon_t^s + \sigma_i \varepsilon_t^d)$$

$$\Rightarrow \Delta P_{i,t} = \frac{1}{\sigma_i(1 + \delta_i)} (\sigma_i \varepsilon_t^d - \delta_i \varepsilon_t^s)$$

- Assuming $\sigma_i > 0$ and $\delta_i > 0$ — **expected comovements** :

$$\begin{cases} \text{Supply shock } \varepsilon^s > 0 & : \Delta^+ Q & \& \Delta^- P & \text{Negative comovement} \\ \text{Demand shock } \varepsilon^d > 0 & : \Delta^+ Q & \& \Delta^+ P & \text{Positive comovement} \end{cases}$$

SVAR - Sign Restrictions

- Structural VAR for sector (i):

$$A^i \begin{bmatrix} \Delta Q_{i,t} \\ \Delta P_{i,t} \end{bmatrix} = \mu + \sum_{j=1}^p A_j^i \begin{bmatrix} \Delta Q_{i,t-j} \\ \Delta P_{i,t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,t}^s \\ \varepsilon_{i,t}^d \end{bmatrix}$$

- Structural shocks and Reduced-form VAR residuals: $\begin{bmatrix} \varepsilon_{i,t}^s \\ \varepsilon_{i,t}^d \end{bmatrix} = A^i \begin{bmatrix} \nu_{i,t}^q \\ \nu_{i,t}^p \end{bmatrix}$

- Assuming A^i satisfies $A^i \equiv \begin{pmatrix} 1 & -\alpha \\ \beta & 1 \end{pmatrix}$, $\alpha, \beta > 0$ we get :

$$\begin{cases} \nu^s & \propto \varepsilon^s + \alpha \cdot \varepsilon^d \\ \nu^d & \propto -\beta \cdot \varepsilon^s + \varepsilon^d \end{cases}$$

SVAR - Sign Restrictions & Classification rule

This leads to :

$$\begin{cases} \varepsilon^s > 0, \varepsilon^d > 0 & \Rightarrow \nu^s > 0 \\ \varepsilon^s < 0, \varepsilon^d < 0 & \Rightarrow \nu^s < 0 \\ \varepsilon^s < 0, \varepsilon^d > 0 & \Rightarrow \nu^d > 0 \\ \varepsilon^s > 0, \varepsilon^d < 0 & \Rightarrow \nu^d < 0 \end{cases}$$

And we can infer :

$$\begin{cases} \nu^s > 0 & \& \nu^d < 0 \Rightarrow \varepsilon^s > 0 & + \text{Supply shock} \\ \nu^s < 0 & \& \nu^d > 0 \Rightarrow \varepsilon^s < 0 & - \text{Supply shock} \\ \nu^s > 0 & \& \nu^d > 0 \Rightarrow \varepsilon^d > 0 & + \text{Demand shock} \\ \nu^s < 0 & \& \nu^d < 0 \Rightarrow \varepsilon^d < 0 & - \text{Demand shock} \end{cases}$$

\Rightarrow Assuming $A \equiv \begin{pmatrix} a_{11} > 0 & a_{12} < 0 \\ a_{21} > 0 & a_{22} > 0 \end{pmatrix}$ ensures expected structural shocks' effects on the covariates are replicated in the model.

Breakdown - baseline Shapiro

For a given country :

- Estimate sector-specific VAR models (lag selection via AIC criterion)
- Classify each month as demand or supply driven according to aforementioned rule

Compute MoM% overall inflation from individual classified inflation rates :

$$\pi_{t,t-1} = \sum_i \mathbb{1}_{i,sup}(t) \omega_{i,y_t} \pi_{i,t,t-1} + \sum_i \mathbb{1}_{i,dem}(t) \omega_{i,y_t} \pi_{i,t,t-1}$$

$$\pi_{t,t-1} = \pi_{t,t-1}^{sup} + \pi_{t,t-1}^{dem}$$

YoY% classified inflation :

$$\left\{ \begin{array}{l} \pi_{t,t-12}^{sup} = \sum_{k=0}^{11} \pi_{t-k,t-k-1}^{sup} \\ \pi_{t,t-12}^{dem} = \sum_{k=0}^{11} \pi_{t-k,t-k-1}^{dem} \end{array} \right.$$

France classification with baseline Shapiro

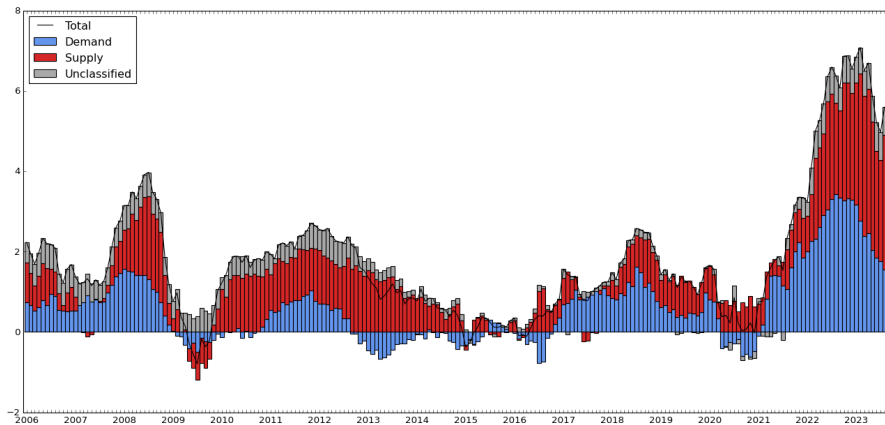


Figure: Inflation breakdown in France using Shapiro Baseline Method

Shapiro - Alternative classifications

Also implement alternative classifications tackling different issues:

- ▶ **Measurement errors:**

- ▶ Smoothed-error: rolling sum of residuals
- ▶ Probability Classification

- ▶ **Model Misspecification** (VAR lag). We solve this problem with:

- ▶ AIC
- ▶ BIC

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Persistent vs Transitory components

New Classification Rule:

$$\mathbb{1}_{i,dem}(t) = \begin{cases} 1 & \text{if } (\pi_{i,t} - \tilde{\pi}_i) \cdot (c_{i,t} - \tilde{c}_i) > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\mathbb{1}_{i,sup}(t) = 1 - \mathbb{1}_{i,dem}(t)$$

Classify the shock at month t as:

$$\text{Persistent Demand: } \mathbb{1}_{i,dem}^{pers}(t) = \begin{cases} 1 & \text{if } \sum_{k=0}^{11} \mathbb{1}_{i,dem}(t-k) \geq 11 \\ 0 & \text{otherwise} \end{cases}$$

$$\text{Persistent Supply: } \mathbb{1}_{i,sup}^{pers}(t) = \begin{cases} 1 & \text{if } \sum_{k=0}^{11} \mathbb{1}_{i,sup}(t-k) \geq 11 \\ 0 & \text{otherwise} \end{cases}$$

If neither condition is verified, month t is classified as **Transitory demand** or **Transitory supply**.

Sheremirov Classification

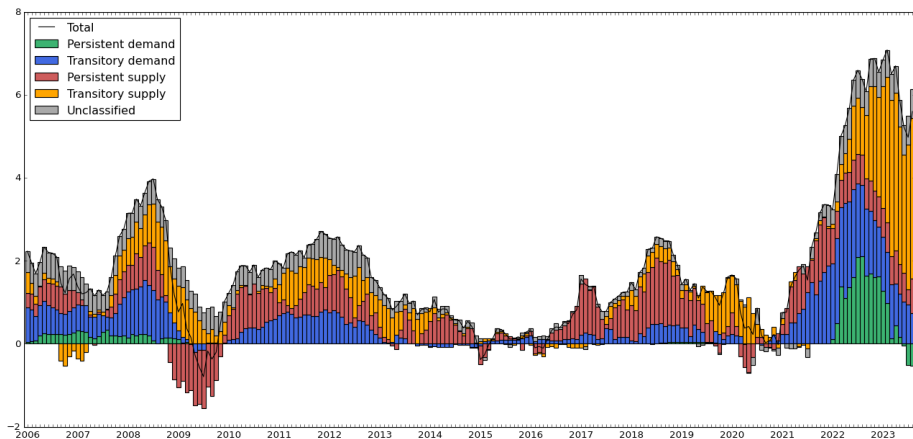


Figure: *HICP Sheremirov Classification*

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Our own Classification

Compute $\mathbb{1}_{i,sup}(t)$ and $\mathbb{1}_{i,dem}(t)$ using baseline Shapiro

Persistent demand

$$\mathbb{1}_{i,dem}^{pers}(t) = \begin{cases} 1 & \text{if } \mathbb{1}_{i,dem}(t) + \sum_{k=1}^3 \{\mathbb{1}_{i,dem}(t-k) + \mathbb{1}_{i,dem}(t+k)\} \geq 6 \\ 0 & \text{otherwise} \end{cases}$$

Persistent supply

$$\mathbb{1}_{i,sup}^{pers}(t) = \begin{cases} 1 & \text{if } \mathbb{1}_{i,sup}(t) + \sum_{k=1}^3 \{\mathbb{1}_{i,sup}(t-k) + \mathbb{1}_{i,sup}(t+k)\} \geq 6 \\ 0 & \text{otherwise} \end{cases}$$

\Rightarrow In the 7-month window at least 6 have been classified as demand/supply

Our own Classification

Ambiguous demand

⇒ For month $t = T - 2$ checks if in the range: previous 3 months + current month + next $T - (T - 2) = 2$ available months — at least $3 + (T - (T - 2)) = 5$ were classified as demand

$$\mathbb{1}_{i,dem}^{abg}(t) = \begin{cases} 1 & \text{if } t \in [T - 2, T] \text{ and :} \\ & \mathbb{1}_{i,dem}(t) + \sum_{k=1}^3 \mathbb{1}_{i,dem}(t - k) + \mathbb{1}_{t \neq T} \sum_{k=1}^{T-t} \mathbb{1}_{i,dem}(t + k) \geq 3 + (T - t) \\ & \text{i.e almost satisfies pers. but some date ' } t + k \text{ ' is unobserved} \\ 0 & \text{otherwise} \end{cases}$$

Same for *Ambiguous* supply

Our own Classification

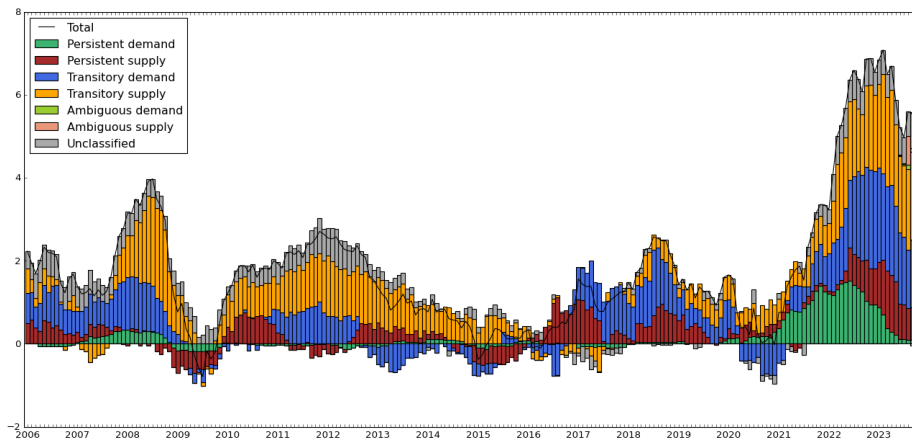


Figure: Proposed HICP classification for France

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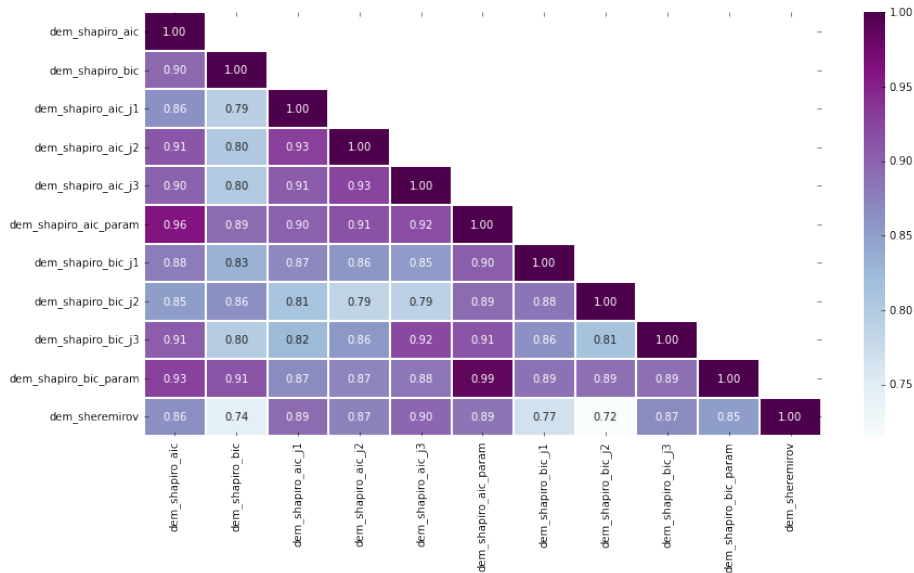
Shapiro classification method

Sheremirov's classification method

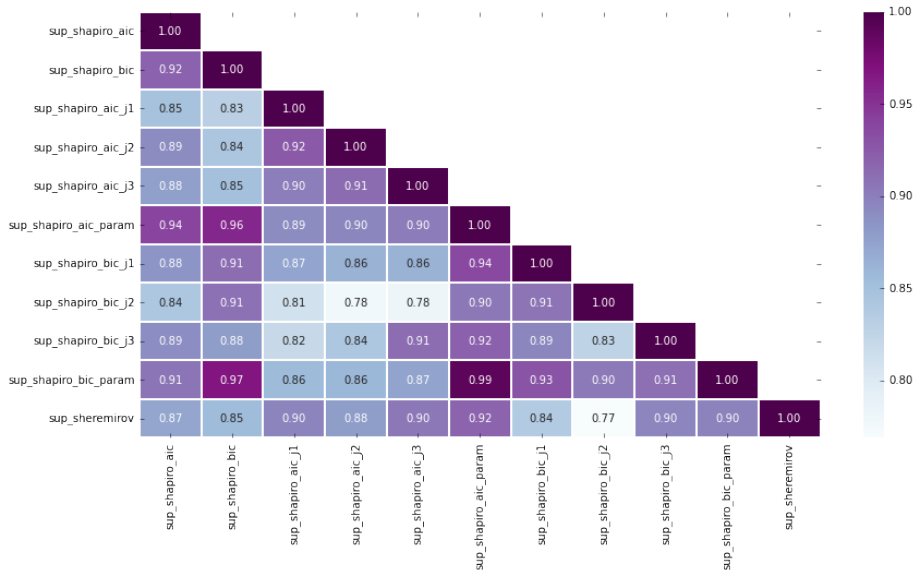
Proposed classification rule

Results

Demand Results Comparison



Supply Results Comparison



Our own Classification: analysis

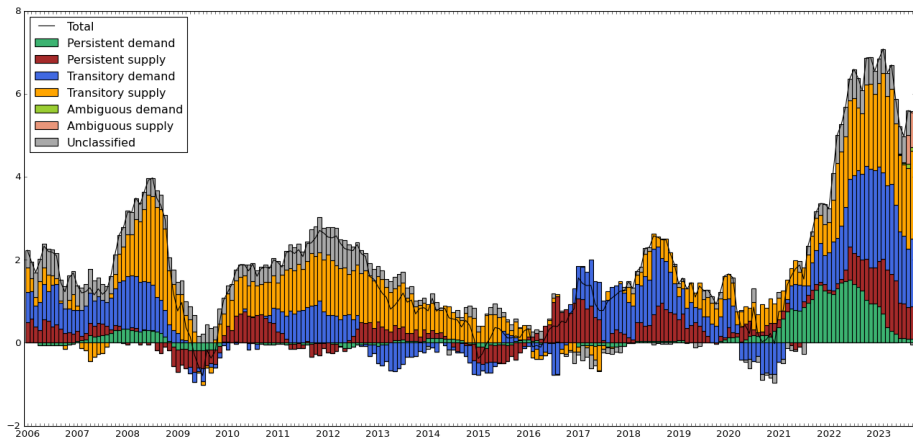


Figure: *Proposed HICP classification for France*

Our own Classification: comparison with FCE

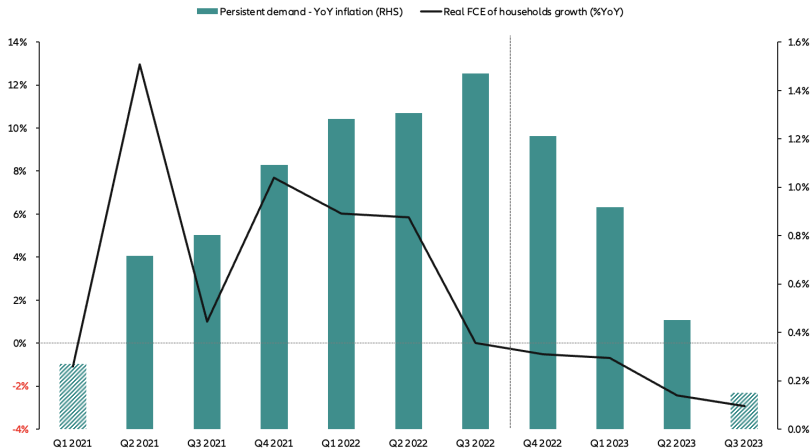


Figure: Comparison between real FCE of households growth and persistent demand in our classification

References

- ▶ Decomposing Supply and Demand Driven Inflation, Adam Hale Shapiro, *Federal Reserve Bank of San Francisco Working Paper Series* (2022)
- ▶ A History of aggregate demand and supply shocks for the United Kingdom, 1900 to 2016, Jump, R. C., and K. Kohler, *Explorations in Economic History* (2022)
- ▶ Are the Demand and Supply Channels of Inflation Persistent? Evidence from a Novel Decomposition of PCE Inflation, Viacheslav Sheremirov, *Current Policy Perspectives, Federal Reserve Bank of Boston* (2022)
- ▶ The role of demand and supply in underlying inflation – decomposing HICPX inflation into components, Eduardo Goncalves and Gerrit Koester, *ECB Economic Bulletin*, (2022)

Thanks!

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