# Supply and Demand breakdown of driven Inflation through Sign Restrictions

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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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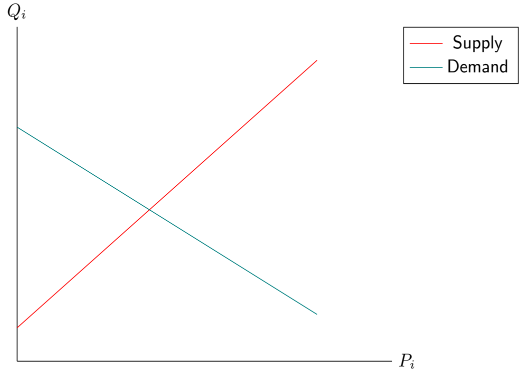
## Supply and Demand Curves




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

$$\begin{aligned} \text{Supply :} \quad & Q_i = \sigma_i . P_i + \alpha_i \\ \text{Demand :} \quad & P_i = -\delta_i . Q_i + \beta_i \end{aligned}$$

## Theoretical results

- Theoretical framework derived from Jump and Kohler (2022)[**?**].
- Shocks defined as:

$$
\begin{aligned}
\text{Supply shock} : \varepsilon_t^s = \Delta\alpha_i \ &= \Delta Q_{i,t} - \sigma_i \Delta P_{i,t} \\
\text{Demand shock} : \varepsilon_t^d = \Delta\beta_i \ &= \Delta P_{i,t} + \delta_i \Delta Q_{i,t} \\
\Rightarrow \Delta Q_{i,t} &= \frac{1}{1+\delta_i}(\varepsilon_t^s + \sigma_i.\varepsilon_t^d) \\
\Rightarrow \Delta P_{i,t} &= \frac{1}{\sigma_i(1+\delta_i)}(\sigma_i.\varepsilon_t^d - \delta_i.\varepsilon_t^s)
\end{aligned}
$$

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

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

# SVAR - Sign Restrictions

- Structural VAR for sector *(i)*:

$$A^i \begin{bmatrix} \Delta Q_{i,t} \\ \Delta P_{i,t} \end{bmatrix} = \mu + \sum_{j=1}^{p} A^i_j \begin{bmatrix} \Delta Q_{i,t-j} \\ \Delta P_{i,t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon^s_{i,t} \\ \varepsilon^d_{i,t} \end{bmatrix}$$

- Structural shocks and Reduced-form VAR residuals: $\begin{bmatrix} \varepsilon^s_{i,t} \\ \varepsilon^d_{i,t} \end{bmatrix} = A^i \begin{bmatrix} \nu^q_{i,t} \\ \nu^p_{i,t} \end{bmatrix}$
- Assuming $A^i$ satisfies $A^i \equiv \begin{pmatrix} 1 & -\alpha \\ \beta & 1 \end{pmatrix}$, $\alpha, \beta > 0$ we get :

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

# 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 :

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

$\Rightarrow$ 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 :

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

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

YoY% classified inflation :

$$\begin{cases} \pi^{sup}_{t,t-12} & = \sum_{k=0}^{11} \pi^{sup}_{t-k,t-k-1} \\ \pi^{dem}_{t,t-12} & = \sum_{k=0}^{11} \pi^{dem}_{t-k,t-k-1} \end{cases}$$

# France classification with baseline Shapiro

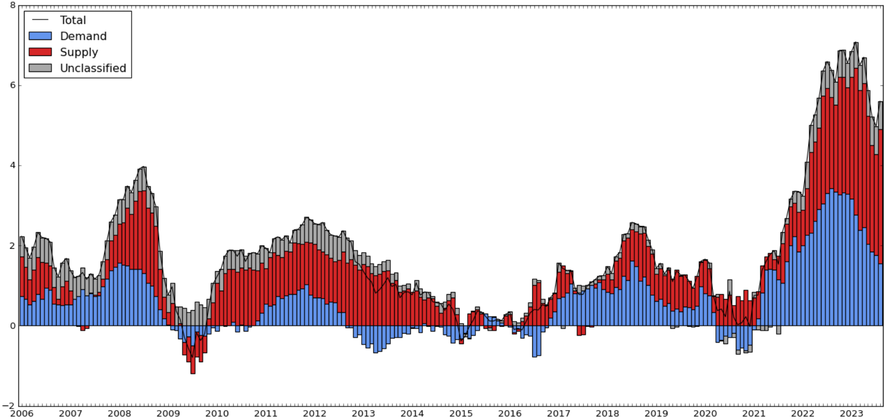



Figure: *Inflation breakdown in France using Shapiro Baseline Method*

## 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:

$$\mathbb{1}_{i,dem}(t) = \begin{cases} 1 & \text{if } (\pi_{i,t} - \tilde{\pi_i}).(c_{i,t} - \tilde{c_i}) > 0 \\ 0 & \text{otherwise} \end{cases}$$

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

Classify the shock at month $t$ as:

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

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

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

# Sheremirov Classification

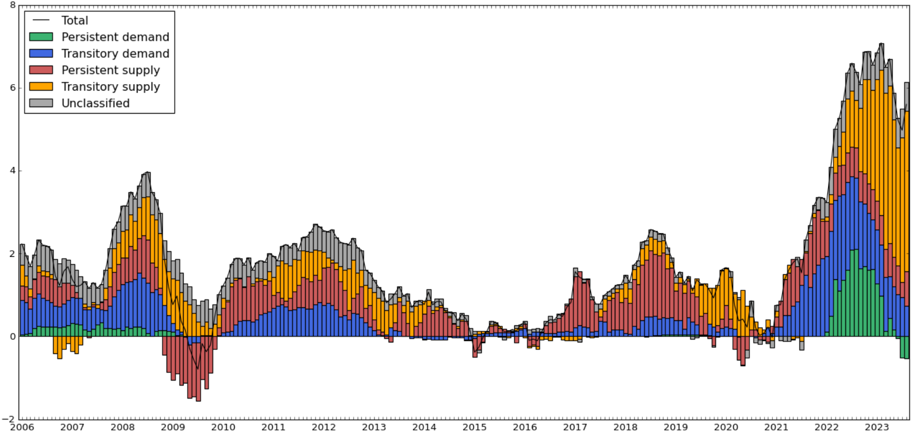


Figure: *HICP Sheremirov Classification*

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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

$\Rightarrow$ *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*

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

Same for *Ambiguous* supply

# Our own Classification

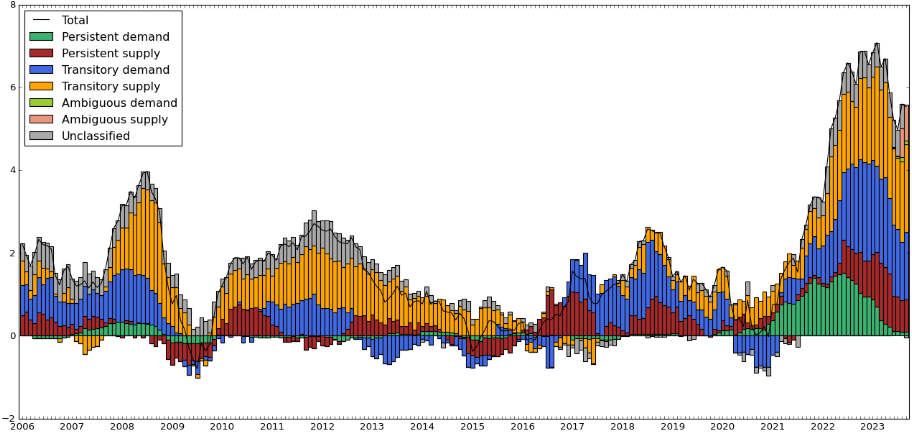


Figure: *Proposed HICP classification for France*

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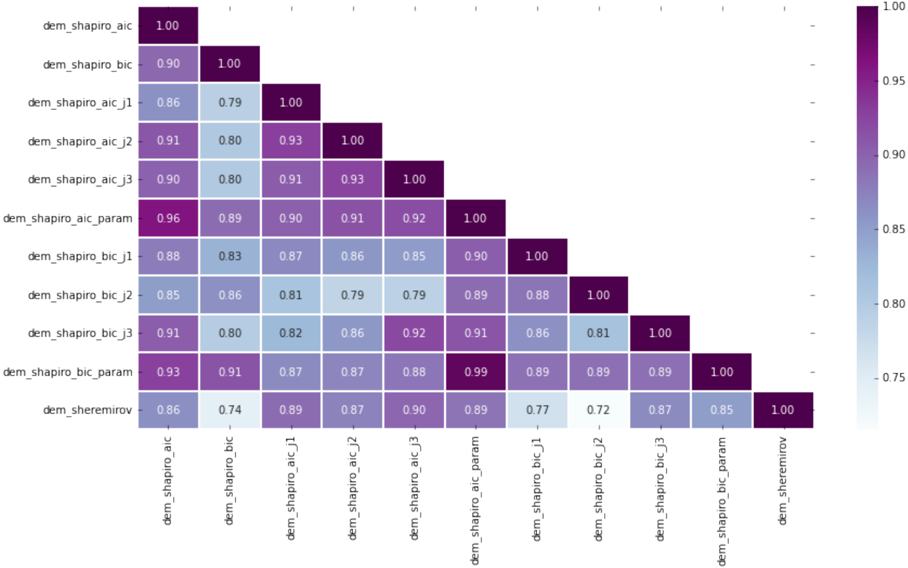
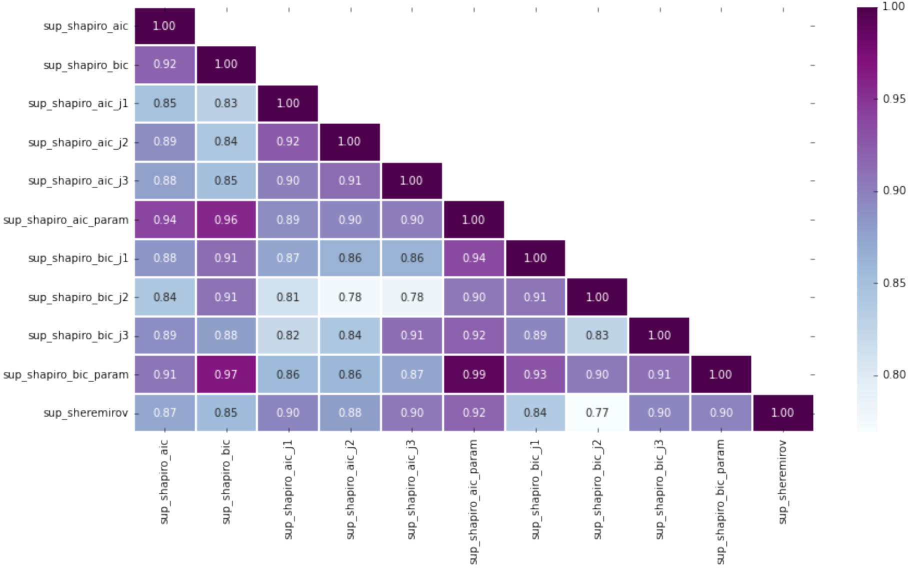
# Demand Results Comparison



# Supply Results Comparison



# Our own Classification: analysis

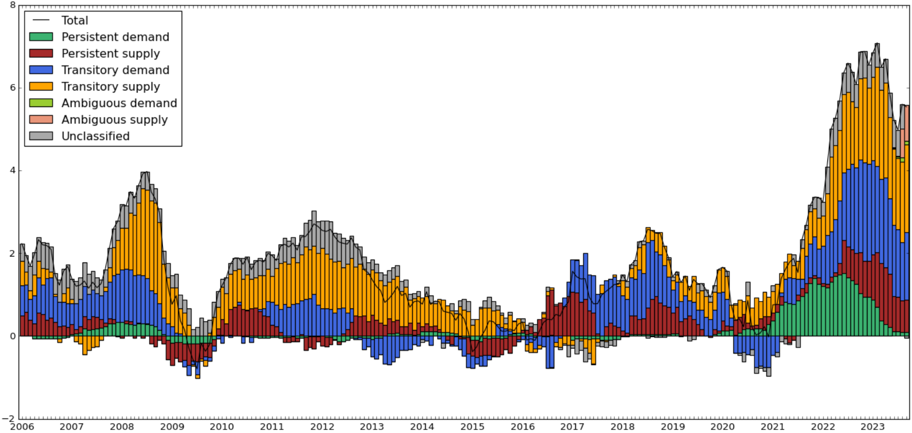



Figure: *Proposed HICP classification for France*

# Our own Classification: comparison with FCE

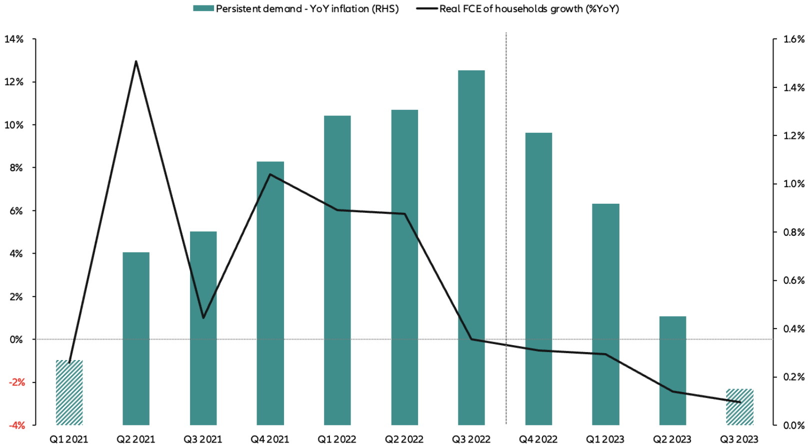



Figure: *Comaprison between real FCE of households growth and persistent demand in our classification*

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# Thanks!

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