Web Appendix of:

# Empirical Investigation of a Sufficient Statistic for Monetary Policy Shocks

Fernando Alvarez, Hervé Le Bihan, Andrea Ferrara, Erwan Gautier, Francesco Lippi

## A Analytics of the generalized random menu cost model

We describe the price setting problem for a firm in steady state using the random menu cost model of Caballero and Engel (1999, 2007), which covers a vast class of sticky-price models.

**The firm's problem.** The firm maximizes the expected discounted value of profits and chooses the optimal times and size of price adjustment as a function of its state $x$, as encoded in the value function $v(x)$ defined below. A second order approximation of the profit function at the optimal price gives a quadratic period return $Bx^2$, where the constant term $B$ relates to the curvature of the profit function.[43] The firm's value function solves the following HJB equation

$$r\, v(x) = \min \left\{ Bx^2 + v'(x)\mu + \frac{\sigma^2}{2} v''(x) + \kappa \int_0^{\Psi} \min \left\{ \psi + \min_z v(z) - v(x) \,,\, 0 \right\} dG(\psi) \,,\, r\left( \Psi + \min_z v(z) \right) \right\}$$

The first argument in the curly bracket represents the continuation value with a flow cost $Bx^2$ and the usual expected change in the value function, which includes the possibility to adjust if the firm draws a sufficiently small menu cost. For a firm with a gap $x$ that draws a menu cost $\psi$ the net cost effect of adjusting is $\psi + \min_z v(z) - v(x)$, which is optimally chosen by the firm only when it is smaller than zero. The second argument in the curly bracket represents the firms' option to reset the gap at any moment by paying the fixed cost $\Psi$. The value function features the smooth pasting conditions: $v'(\underline{X}) = v'(\bar{X}) = v'(x^*) = 0$ where $x^* = \arg\min_{\tilde{x}} v(\tilde{x})$ is the optimal price gap chosen by a firm that adjusts and $\underline{X}$ and $\bar{X}$ delimit the state space so that $x \in [\underline{X}, \bar{X}]$, and value matching conditions $v(\underline{X}) = v(\bar{X}) = v(x^*) + \Psi$.

**Mapping the model to observables.** The density $f$ solves the following Kolmogorov forward equation:

$$f(x)\Lambda(x) = -\mu f'(x) + \frac{\sigma^2}{2} f''(x) \text{ for all } x \in (\underline{X}, \bar{X}) \,,\, x \neq x^* \tag{16}$$

with boundary conditions: $\lim_{x \downarrow x^*} f(x) = \lim_{x \uparrow x^*} f(x);\quad 1 = \int_{\underline{X}}^{\bar{X}} f(x)dx \quad \text{and} \quad \lim_{x \to \bar{X}} f(x) = \lim_{x \to \underline{X}} f(x) = 0 \,.$

Notice how the cross sectional distribution of price gaps $f(x)$ is fully determined by the generalized hazard function: Also, note that density is zero at the boundaries of the domain.[44]

[43] See Appendix B in Alvarez and Lippi (2014) for a detailed derivation of the approximation.

[44] This is an implication of $\underline{X}$ and $\bar{X}$ being exit points, for every model where $\mu/\sigma^2$ is finite. In the case where the domain of $x$ is unbounded, then the zero density is a requirement for integrability.

The distribution of price changes has density $q$ and two mass points at the boundaries of the inaction region:

$$q(x^* - x) = \frac{f(x)\Lambda(x)}{N} \text{ for all } x \in [\underline{X}, \bar{X}] \tag{17}$$
$$dQ(x^* - \bar{X}) = -\frac{\sigma^2}{2}\frac{f'(\bar{X})}{N} \quad , \quad dQ(x^* - \underline{X}) = +\frac{\sigma^2}{2}\frac{f'(\underline{X})}{N}$$

where the number of price changes satisfies:

$$N(\mu) = \int_{\underline{X}}^{\bar{X}} \Lambda(x) f(x) dx + \frac{\sigma^2}{2} f'(\underline{X}) - \frac{\sigma^2}{2} f'(\bar{X}) \tag{18}$$

and the notation emphasises the dependence of the frequency on the rate of steady state inflation $\mu$.

**Computation of CIR for the zero drift case ($\mu = 0$).** The contribution to the cumulative impulse response of a firm with price gap $x$ is

$$m(x) = -\mathbb{E}\left[\int_0^{\tau} e^{-\Lambda(x)t} x(t) dt \,|\, x(0) = x\right] \tag{19}$$

where $\tau$ is the stopping time defined as the first time the price gap hits the barriers $\pm\bar{X}$. In words, $m(x)$ is the expected (cumulative) price gap of a firm that starts with a gap $x$.[45]

The expectation in the right hand side of equation (19) is with respect to the process for $x$, a jump-diffusion with jump intensity $\Lambda(x)$, diffusion variance $\sigma^2$, and zero drift. The function $m : [-X, X] \to \mathbb{R}$ is once continuously differentiable, antisymmetric around $x = 0$, and satisfies:

$$m(x)\Lambda(x) = -x + \frac{\sigma^2}{2} m''(x) \text{ for all } x \text{ at which } \Lambda \text{ is continuous} \tag{20}$$
$$0 = m(X) \text{ if } X < \infty \text{ and } \lim_{x\to\infty} \frac{|m(x)|}{x} \leq \frac{1}{\inf_y \Lambda(y)} \text{ if } X = \infty \quad . \tag{21}$$

Now we can define the cumulative impulse response to a monetary shock of size $\delta$ as

$$CIR(\delta) = \int_{-\bar{X}}^{\bar{X}} m(x) f(x + \delta) dx \quad . \tag{22}$$

**The proof of sufficient statistic result, equation (6).** First note that the identity

$$N \cdot Var = \sigma^2 \tag{23}$$

holds in the model. Let $x(0) = 0$. Consider the process $z(t) \equiv x(t)^2 - \sigma^2 t$ for $t \geq 0$. Using Ito's lemma we can verify that the drift of $x^2$ is $\sigma^2$, and hence $z(t)$ is a Martingale. Let $\tau$ be a stopping time, i.e. an instant where a price adjustment occurs (anywhere in the state space, including the boundaries),

[45] The definition above uses the steady state decision rule $\Lambda(x)$, thus ignoring the general equilibrium feedback effect of the shock on the firm's decision. In Proposition 7 of Alvarez and Lippi (2014) it is shown that, given a combination of the general equilibrium setup in Golosov and Lucas (2007) and the lack of the strategic complementarities, these general equilibrium effects are of second order. In addition, we use the fact that after the first price change the expected contribution to output of each firm is zero, since positive and negative output contributions are equally likely, so $m(0) = 0$. This allows us to characterize the propagation of the monetary shocks without tracking the time evolution of the whole price gap distribution.

so that $x$ is reset at $x(0) = 0$. By the optional sampling theorem $z(\tau)$, the process stopped at $\tau$, is also a martingale. Then $\mathbb{E}\left[z(\tau) \;\middle|\; x(0)\right] = \mathbb{E}\left[x(\tau)^2 \;\middle|\; x(0)\right] - \sigma^2 \mathbb{E}\left[\tau \;\middle|\; x(0)\right] = x(0) = 0$. Since $N = 1/\mathbb{E}\left[\tau \;\middle|\; x(0)\right]$ and $Var = \mathbb{E}\left[x(\tau)^2 \;\middle|\; x(0)\right]$ we get the identity in equation (23).

For simplicity, we focus next on the case with unbounded support $\bar{X} \to \infty$ (the logic for the case with bounded support is identical but the equations are slightly more cumbersome). Using the definition of the density of price changes in equation (17) we can rewrite the identity as

$$\int_{-\infty}^{\infty} x^2 \Lambda(x) f(x) dx = \sigma^2 \tag{24}$$

it is then straightforward to write the formula for kurtosis over $6N$ as:

$$\frac{Kurt}{6N} = \frac{\int_{-\infty}^{\infty} x^4 \Lambda(x) f(x) dx}{6\left(\int_{-\infty}^{\infty} x^2 \Lambda(x) f(x) dx\right)^2} = \frac{\int_{-\infty}^{\infty} x^4 \Lambda(x) f(x) dx}{6\sigma^4}$$

where the last passage uses equation (24). Using the Kolmogorov forward equation,

$$\int_{-\infty}^{\infty} x^4 \Lambda(x) f(x) dx = \frac{\sigma^2}{2} \int_{-\infty}^{\infty} x^4 f''(x) dx$$

Integrating by parts twice gives

$$\int_{-\infty}^{\infty} x^4 \Lambda(x) f(x) dx = 6\sigma^2 \int_{-\infty}^{\infty} x^2 f(x) dx$$

This allows us to write

$$\frac{Kurt}{6N} = \frac{\int_{-\infty}^{\infty} x^2 f(x) dx}{\sigma^2} \tag{25}$$

Recall that we have a system of two equations:

$$\Lambda(x) f(x) = \frac{\sigma^2}{2} f''(x) \quad , \quad \Lambda(x) m(x) = \frac{\sigma^2}{2} m''(x) - x$$

Eliminate $\Lambda$ to get:

$$\frac{\sigma^2}{2} \frac{m(x) f''(x)}{f(x)} = -x + \frac{\sigma^2}{2} m''(x)$$

Multiply both sides by $f(x)x$ and rearrange:

$$\frac{\sigma^2}{2} [m(x) f''(x) - m''(x) f(x)] x = -x^2 f(x)$$

Integrate both sides from 0 to $\infty$:

$$\frac{\sigma^2}{2} \int_0^{\infty} [m(x) f''(x) - m''(x) f(x)] x dx = -\int_0^{\infty} x^2 f(x) dx$$

Perform integration by parts in the left-hand side using the fact that $[m(x)f'(x) - m'(x)f(x)]' = m(x)f''(x) -$

$m''(x)f(x)$:

$$\frac{\sigma^2}{2}\int_0^\infty [m(x)f''(x) - m''(x)f(x)]x dx = \frac{\sigma^2}{2}\left( [m(x)f'(x) - m'(x)f(x)]x\Big|_0^\infty - \int_0^\infty [m(x)f'(x) - m'(x)f(x)]dx \right)$$
$$= -\sigma^2 \int_0^\infty m(x)f'(x)dx$$

where the last equality uses integration by parts again. We used $\mathbb{E}[m(x)] < \infty$ and $m(\cdot)$ being almost linear at infinity to justify setting $f'(x)m(x)x$ and $f(x)m'(x)x$ at infinity to 0. Hence, we have

$$\sigma^2 \int_0^\infty m(x)f'(x)dx = \int_0^\infty x^2 f(x)dx$$

Plugging this result in equation (25) we have

$$\frac{Kurt}{6N} = \int_{-\infty}^{\infty} m(x)f'(x)dx$$

It appears from the CIR definition in equation (22) that the right hand side is just the first derivative of the CIR with respect to $\delta$, evaluated at $\delta = 0$, or $CIR'(0)$. This completes the proof. □

**Aggregation across heterogenous firms.** We briefly discuss how the above results can be applied to economies composed of heterogenous firms. Assume that there are $J$ groups of firms with different parameters, each with an expenditure weight $e_j > 0$, $N_j$ price changes per unit of time, and a distribution of price changes with kurtosis $Kur_j$. In this case, after repeating the arguments above for each group and aggregating, we obtain that the area under the IRF of *aggregate* output for a small monetary shock $\delta$ is

$$CIR(\delta) = \frac{\delta}{6\epsilon}\sum_{j\in J} e_j \frac{Kur_j}{N_j} + o(\delta^2) = \frac{\delta}{6\epsilon} D \sum_{j\in J} d_j\, Kur_j + o(\delta^2) \tag{26}$$

where $D$ is the expenditure-weighted average duration of prices $D \equiv \sum_{j\in J}\frac{e_j}{N_j}$, and $d_j \equiv \frac{e_j}{N_j D}$ are weights that take into account both relative expenditures and durations. When all groups have the same durations, then $d_j = e_j$ and the $CIR$ is proportional to the average of the kurtosis of the sectors.[46] However, if groups are heterogenous in duration (or expenditures), then the kurtoses of the groups with longer duration (or higher expenditures) receive a higher weight in the computation of the $CIR$.[47]

[46]The effect of heterogeneous $N$ is well known for the Calvo model: due to Jensen's inequality $D$ differs from the (reciprocal of) the average of $N$'s, see for example Carvalho (2006) and Nakamura and Steinsson (2010).

[47]Suppose for instance that a fraction of firms have flexible prices (zero duration in our model, or infinitely many price changes per unit of time), as in Dotsey and Wolman (2020). The above formula implies that the group of the flexible price firms are excluded (zero duration yields a zero weight), and that the cumulative impulse response (CIR) is computed on the mass of firms with sticky prices. Notice that this is different from computing the CIR as the ratio of the cross-sectional average kurtosis and the average frequency. Since the latter is diverging because of the firms with flexible prices, the CIR computed this way would be zero, while obviously it is not.

# B FAVAR estimation

The Factor Augmented Vector Autoregression (FAVAR) was originally developed by Bernanke, Boivin, and Eliasz (2005) and by Boivin, Giannoni, and Mihov (2009). Stock and Watson (2016) provide also a clear explanation of the model.

Let $i_t$ be a vector of observable economic variables with dimension $M$ x 1, $M \geq 1$, and let $\tilde{F}_t$ be a vector of unobserved factors with dimension $K$ x 1, $K \geq 1$.[48] Assume that the dynamics of the economy is driven by $(Y_t', \tilde{F}_t{}')$ which follows the transition equation:

$$\begin{bmatrix} \tilde{F}_t \\ i_t \end{bmatrix} = \Phi(L) \begin{bmatrix} \tilde{F}_{t-1} \\ i_{t-1} \end{bmatrix} + v_t \tag{27}$$

where $\Phi(L)$ is a lag polynomial of finite order and $v_t$ is an error term with zero mean and covariance matrix $Q$. While equation (27) has a VAR form, given that $F_t$ is unobserved we cannot directly estimate equation (27). However, the factors $\tilde{F}_t$ are interpreted as representing forces that potentially affect many economic variables from which we can estimate the factors. Indeed, assume that a large number of time series $X_t$, called informational time series, are related to the observed variables $i_t$ and to the unobservable factors $\tilde{F}_t$ by the following equation:

$$X_t = \Lambda F_t + e_t \tag{28}$$

where $F_t \equiv [\tilde{F}_t \; i_t]'$ and $e_t$ is a vector $N$ x 1 of error terms with zero mean.[49] Notice that the number of informational time series, $N$, must be large which means $N$ is much larger than the number of variables that drives the economy ($F_t$ and $i_t$), i.e. $N > K + M$, and potentially $N$ can be larger than the number of observations in the time dimension, $T$. Moreover, notice that $F_t$ can always capture arbitrary lags of fundamental factors, thus it is not restrictive to assume that $X_t$ depends only on the current values of the factors[50].

Under the above assumptions, it is possible to estimate the model, using a two-step approach.[51] In the first step, the common factors are estimated extracting the first K principal components, $\hat{C}^{(0)}$, from the information variables, $X_t$. Indeed, as shown by Stock and Watson (2002), for $N$ large enough and if the number of principal components used is as least as large as the true number of factors, the principal components of $X_t$ span the space generated by the factors $\tilde{F}$ and the observable variables $i_t$; thus, the principal components represent independent but arbitrary linear combinations of $\tilde{F}_t$ and $i_t$. However, we want that these combinations do not depend on $i_t$ and that they are only independent combinations of the factors. For this reason, the factors are estimated as follow. Regress $X_t$ on $\hat{C}^{(0)}$ and $i_t$ to obtain $\hat{B}_r^{(0)}$, the coefficient of $i_t$. Then compute $\tilde{X}_t^{(0)} = X_t - \hat{B}_r^{(0)} i_t$ and estimate $\hat{C}^{(1)}$ as the first K principal components of $\tilde{X}_t^{(0)}$. Iterate until convergence of $\hat{B}_r^{(i)}$ to obtain the desired estimated factors, $\hat{\tilde{F}}_t$. The second step consists in estimating equation (27) as a structural VAR[52], replacing $F_t$ with their estimated counterpart $\hat{F}_t \equiv [\hat{\tilde{F}}_t \; i_t]'$. Indeed, we can rewrite equation (27) as

$$\hat{F}_t = \Phi(L)\hat{F}t - 1 + v_t \tag{29}$$

where $\hat{F}_t^{+} \equiv [\hat{F}_t \; i_t]'$. Assuming $v_t = H\epsilon_t$, it is clear that equation (29) can be treated as a structural VAR.

[48] We adopt the notation '$i_t$' as in our application the observable factor reduces to the interest rate.

[49] If factors are estimated using a principal components analysis, errors can display a small amount of cross-correlation that must vanish as $N$ goes to infinity. See Stock and Watson (2002) for a detailed discussion.

[50] For this reason Stock and Watson (1999) refer to equation (28) as a dynamic factor model.

[51] An alternative to estimate the model is to use a single-step Bayesian likelihood approach.

[52] In our application, we estimate the structural VAR using a Cholesky decomposition. However, any other approach can be used.

The final step we are interested in is to estimate the IRFs of $X_t$. Consider again equation (29) and assume that the MA representation exists. Denoting the MA coefficient with $\Psi(L)$, we obtain

$$\hat{F}_t = \Psi(L)H\epsilon_t \tag{30}$$

Moreover, using $\hat{F}_t$ instead of $F_t$ in equation (28) and replacing in this equation equation (30), we get

$$X_t = \Lambda\Psi(L)^{-1}H\epsilon_t + e_t \tag{31}$$

Equation (31) links the information variables, $X_t$, to the shocks and provides the theoretical framework to retrieve the IRFs of $X_t$. However, in practice, the IRFs of $X_t$ are not estimated using the MA representation and, thus, equation (31). Indeed, let $\widehat{IRF(A)}$ be the estimated IRFs of the time series $A_t$ to a given shock. The IRFs of $X_t$ is calculated as

$$\widehat{IRF(X)} = \widehat{\beta} * \widehat{IRF(\hat{F})} \tag{32}$$

where $\widehat{IRF(\hat{F})}$ is the VAR estimated IRF of $\hat{F}_t$ and $\widehat{\beta}$ is the estimated coefficient of the regression of $X_t$ on $\hat{F}_t$.

# C A Filter for the Euribor

For the purpose of our empirical test, we want the empirical monetary shock to capture a monetary policy shocks, characterized by a transient impact on inflation and output. We filter the 3-month Euribor so as to ensure this property, as with unfiltered data it is not fulfilled. One possible reason why it is not fulfilled (unlike in typical VAR) is because in our sample period, on the euro area, this variable is not stationary, as depicted in Figure A. We exploit two criteria to choose the value of the value of the HP filter, $\lambda^{HP}$. Both criterion are based on the behavior of the IRFs of PPI and CPI time series as $\lambda^{HP}$ varies. We estimated the FAVAR model, for alternative values of filtered Euribor rates letting $\lambda^{HP}$ vary from 6 to $10^5$.

One first criterion consists in considering the number of negative IRFs of PPI after two or three years, since our strong prior is that after a contractionary monetary shock, prices should decline as compared to the no-shock baseline. Thus, we are interested in estimating a FAVAR that is in line with this prediction. The top panel of Figure B shows our finding: the number of negative IRFs is maximized around the value of $\lambda^{HP}$ of 500. The number of PPI sectors included in the analysis are 118 and for $\lambda^{HP}$ =500 we have around 100 sectors with negative IRF. Moreover, this curve is very flat around 500, as for any value of $\lambda^{HP}$ in between 200 and 3000, more than the 60% of the sectors have a negative IRF after two years or three years.

As a second criterion to guide our choice of $\lambda^{HP}$, we consider the value of the *aggregate* IRF of PPI (or CPI) to the contractionary monetary shock as a function of $\lambda^{HP}$. For PPI, these responses are reported in the bottom panel of Figure B. This panel shows four different lines: we consider the response of an aggregate time series of PPI after 24 or 36 months; and that of the arithmetic average of the sectoral response of PPIs in addition to the response of the aggregate price index. In all cases, the minimum response is found $\lambda^{HP}$ equal to a value around 1000. Developing the same criteria for CPI, we obtain very similar results, as depicted by Figure C. The only difference is that in the bottom panel for value of $\lambda^{HP}$ bigger than $10^4$, the aggregate responses after two or three years become positive, implying that large values of $\lambda^{HP}$ would defeat our purpose. Overall, based on the above results, we select as our benchmark to filter the 3-month Euribor an HP filter with $\lambda = 1000$.

## Some additional figures: Filtering of interest rate, Identification of monetary policy shock

Figure A: 3-month Euribor: period 2005-2019

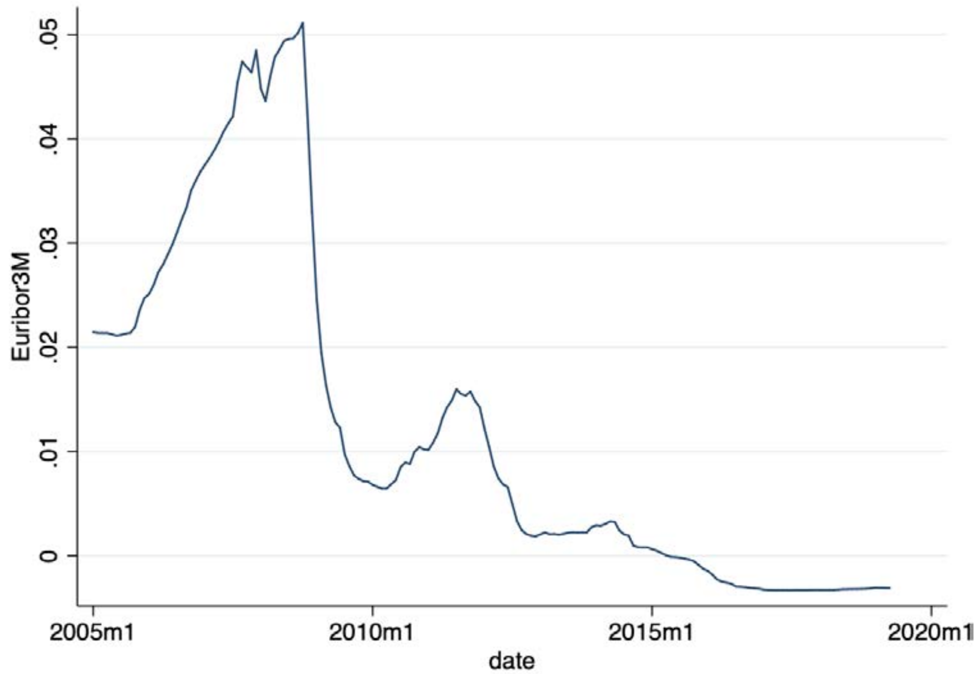
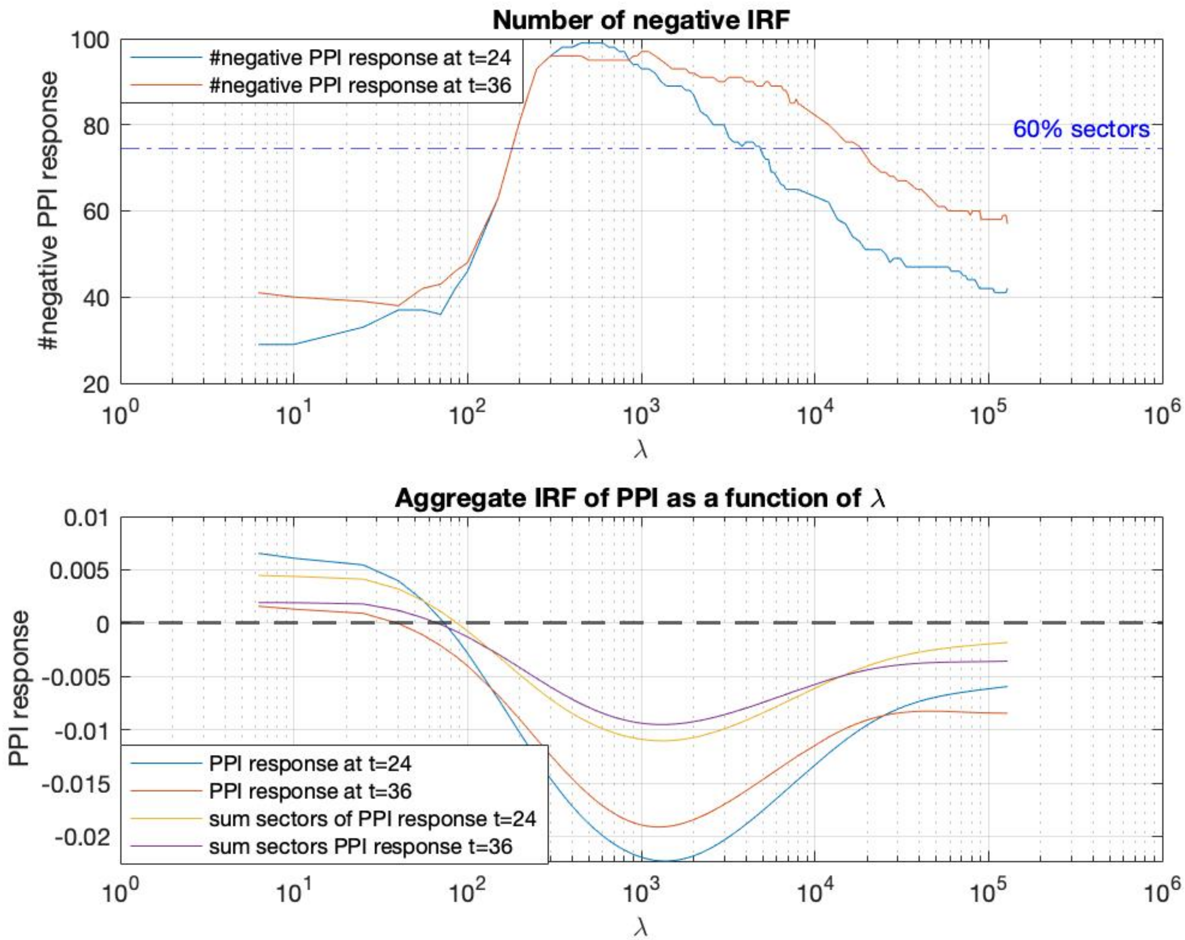
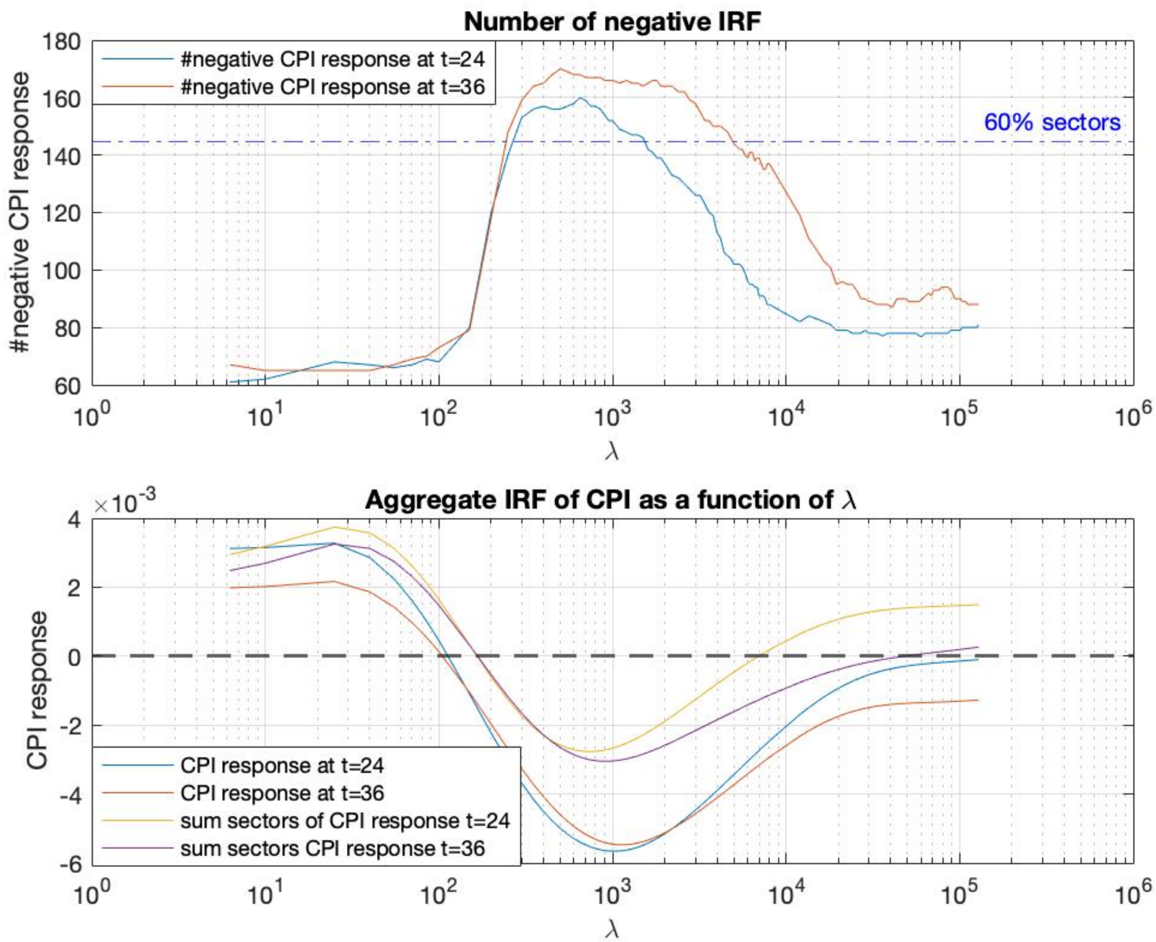


Figure B: Response of sectoral PPI as a function of $\lambda$




Top panel: number of PPI sectors with a negative IRF after two or three years to a contractionary monetary shock of 25 bp as a function of the HP filter parameter, $\lambda^{HP}$. Bottom panel: sectoral IRF of production prices to a contractionary monetary shock of 25 bp as a function of the HP filter parameter, $\lambda^{HP}$; blue and red lines represent the IRF of the aggregate production price index after two and three years, respectively. Yellow and purple lines show the IRF of the arithmetic average of all the production price sectors after two and three years, respectively.

Figure C: Response of sectoral CPI as a function of $\lambda$

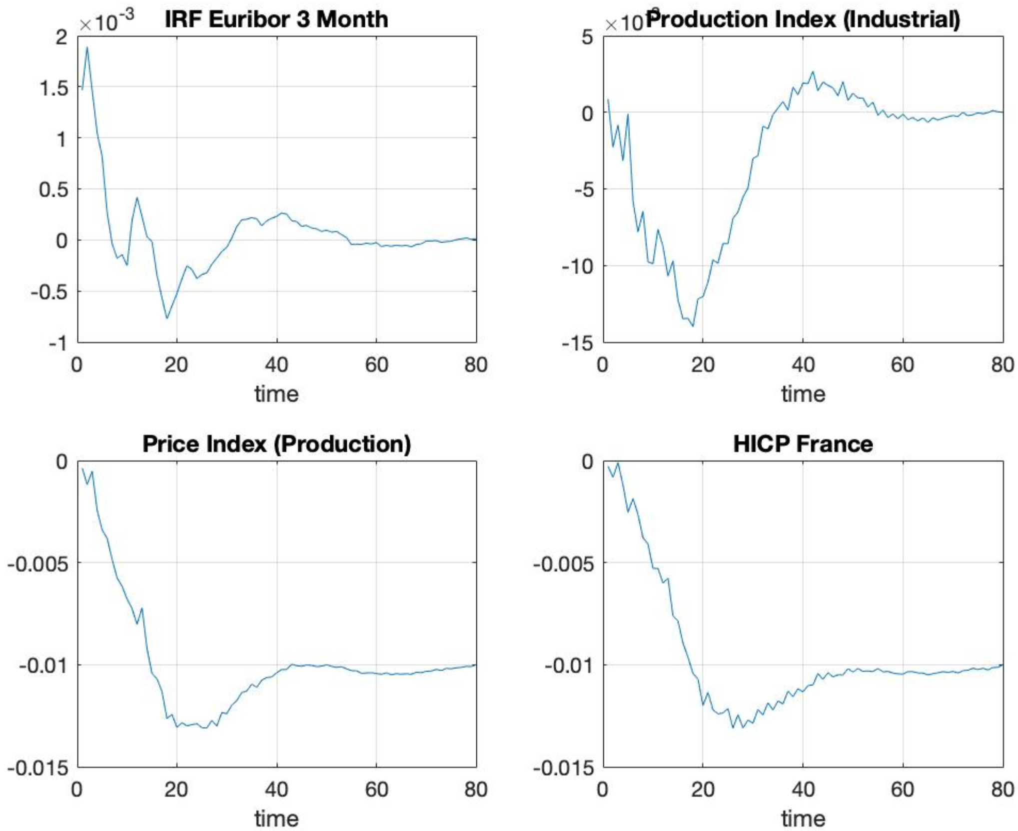



Top panel: number of CPI sectors with a negative IRF after two or three years to a contractionary monetary shock of 25 bp as a function of the HP filter parameter, $\lambda^{HP}$. Bottom panel: sectoral IRF of consumer prices to a contractionary monetary shock of 25 bp as a function of the HP filter parameter, $\lambda^{HP}$; blue and red lines represent the IRF of the harmonized index of consumer prices after two and three years, respectively. Yellow and purple lines show the IRF of the arithmetic average of all the consumer price sectors after two and three years, respectively.

# D Additional FAVAR Results

## Cholesky - Long-run restriction

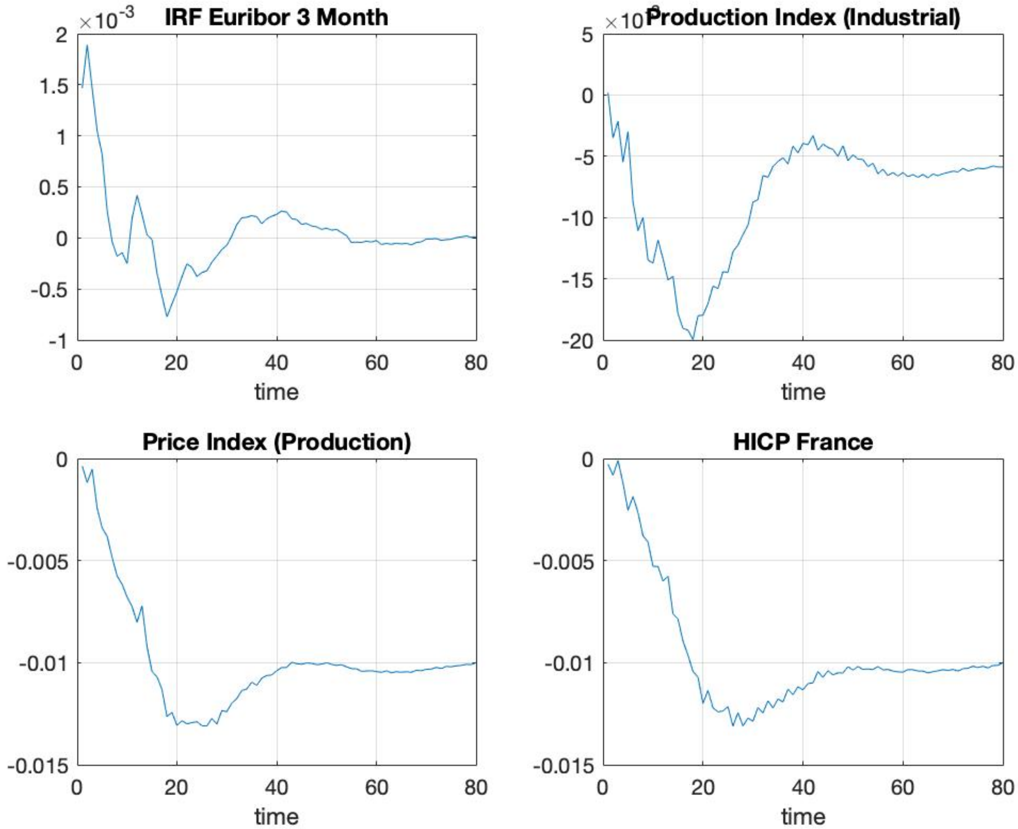
Figure D: Aggregate response to a contractionary monetary policy shock




y-axis: log points in deviation from the ”steady state”.
Top panel: 3-month Euribor IRF. Top right panel: production index IRF. Bottom left panel: production price index IRF. Bottom right panel: IRF of the harmonized index of consumer prices

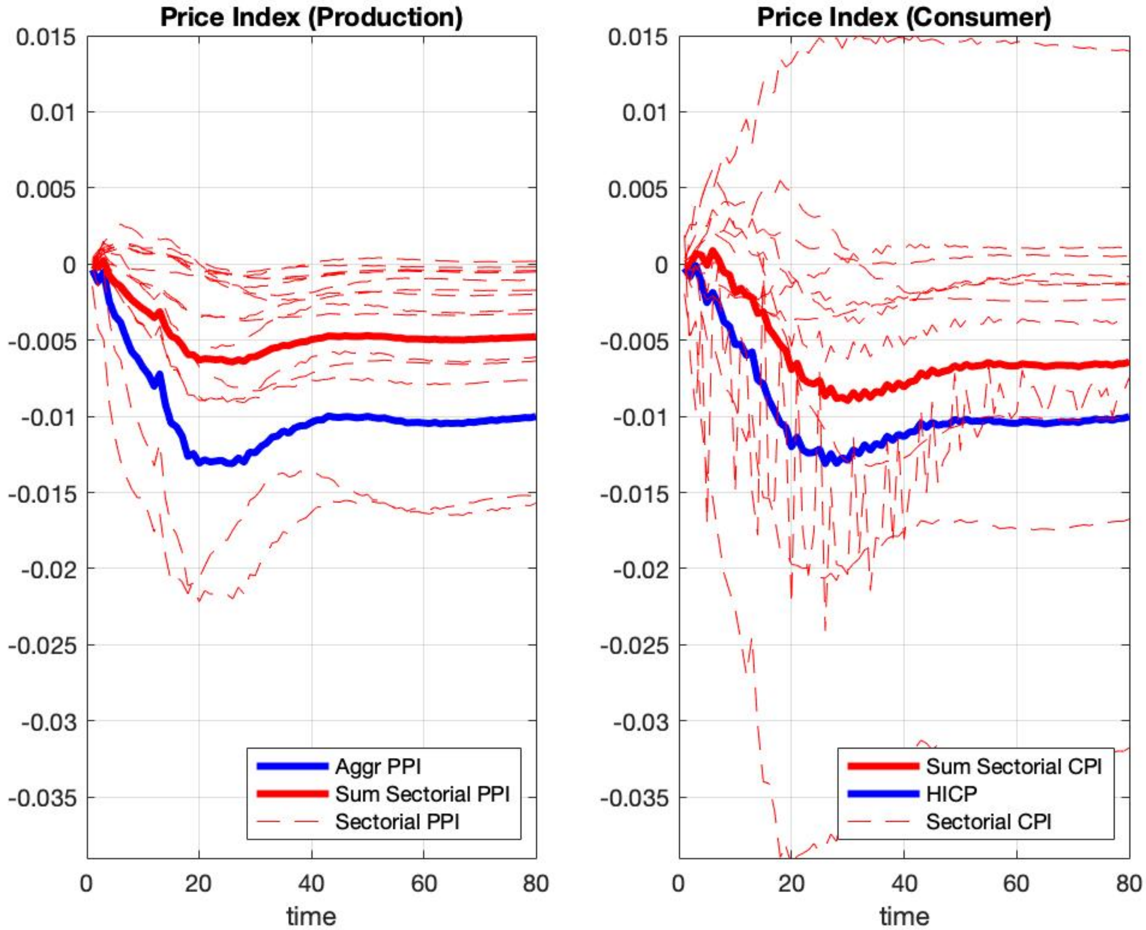
## Cholesky - No Long-run restriction

Figure E: Aggregate response to a contractionary monetary policy shock




y-axis: log points in deviation from the ”steady state”.
Top panel: 3-month Euribor IRF. Top right panel: production index IRF. Bottom left panel: production price index IRF. Bottom right panel: IRF of the harmonized index of consumer prices

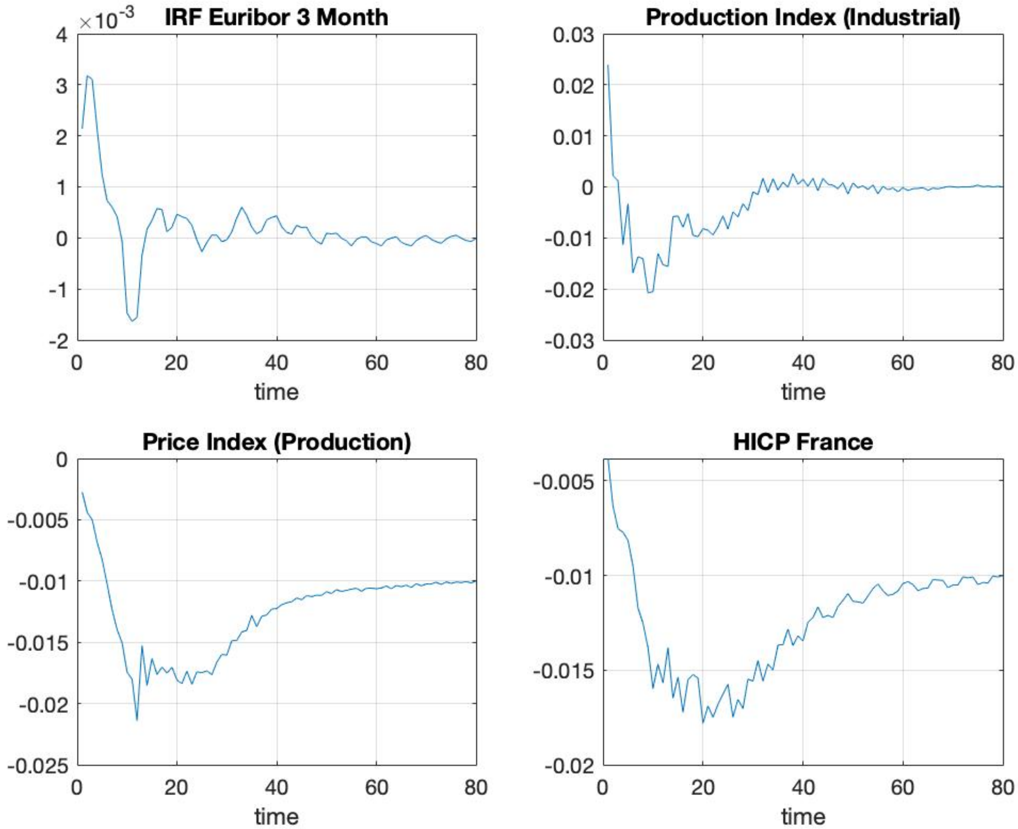
Figure F: Sectoral Responses of PPI and CPI to a Contractionary Monetary Shock




y-axis: log points in deviation from the "steady state". Left panel sectoral IRFs of PPI, right panel sectoral IRFs of CPI. In both panel: blue line IRF of aggregate time series, dashed red lines sectoral IRFs, thick red line arithmetic average of sectoral IRFs.

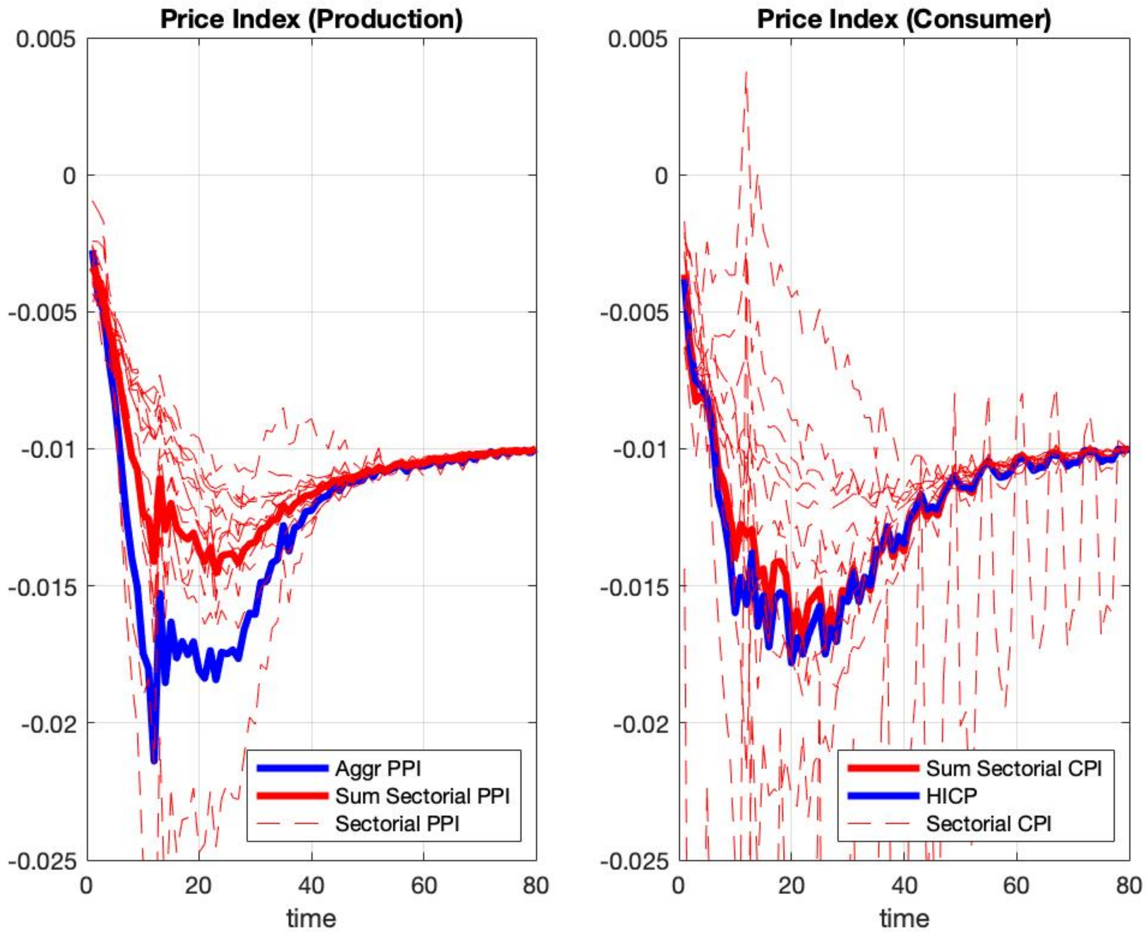
## High-Freq. IV - Long-run restriction

Figure G: Aggregate response to a contractionary monetary policy shock




y-axis: log points in deviation from the ”steady state”.
Top panel: 3-month Euribor IRF. Top right panel: production index IRF. Bottom left panel: production price index IRF. Bottom right panel: IRF of the harmonized index of consumer prices

Figure H: Sectoral Responses of PPI and CPI to a Contractionary Monetary Shock




y-axis: log points in deviation from the "steady state". Left panel sectoral IRFs of PPI, right panel sectoral IRFs of CPI. In both panel: blue line IRF of aggregate time series, dashed red lines sectoral IRFs, thick red line arithmetic average of sectoral IRFs.

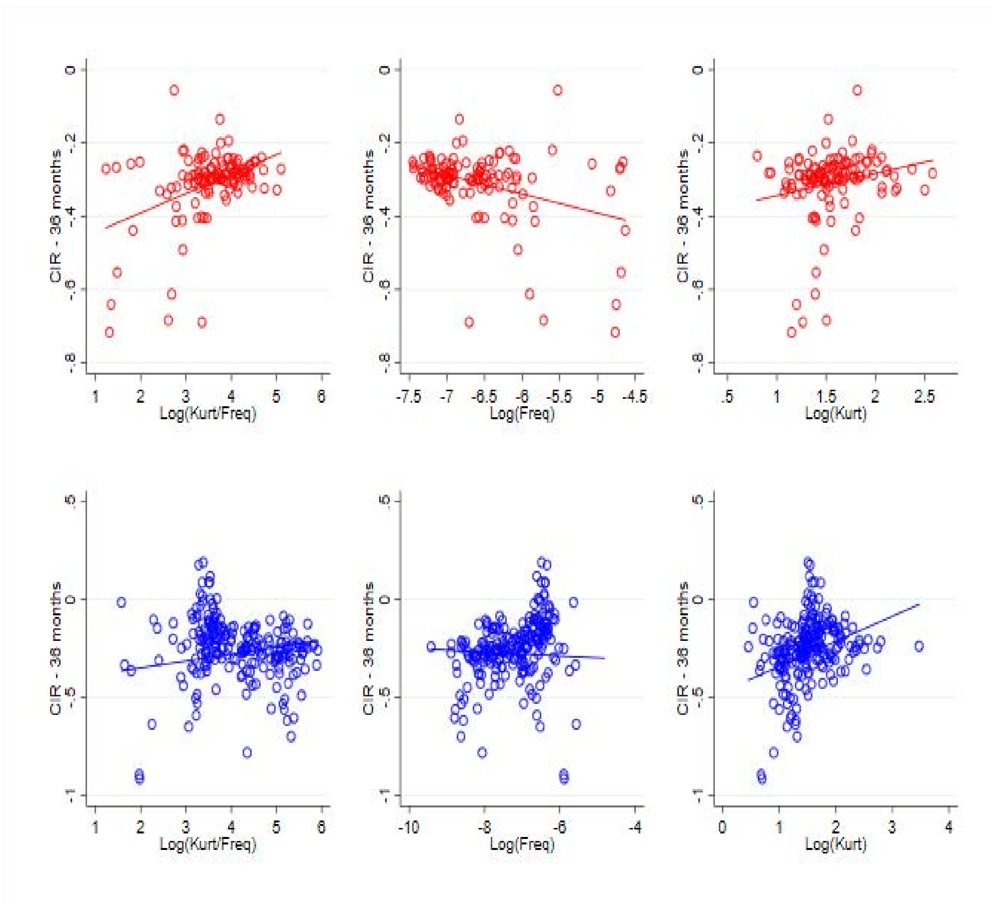
Table A: Product-specific $CIR^P$ : Descriptive Statistics

| | *Moments of the CIR distribution* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | min | 5% | 25% | 50% | 75% | 95% | max |
| *PANEL A: PRODUCER PRICES* | | | | | | | | | |
| *Cholesky - Long-run restriction* | | | | | | | | | |
| 24 months | -0.18 | 0.09 | -0.64 | -0.39 | -0.18 | -0.16 | -0.14 | -0.09 | 0.12 |
| 36 months | -0.31 | 0.10 | -0.72 | -0.55 | -0.32 | -0.29 | -0.27 | -0.22 | -0.06 |
| *Cholesky - No long-run restriction* | | | | | | | | | |
| 24 months | -0.09 | 0.27 | -1.73 | -0.71 | -0.07 | -0.01 | 0.02 | 0.10 | 0.17 |
| 36 months | -0.16 | 0.41 | -2.77 | -0.82 | -0.16 | -0.03 | 0.01 | 0.13 | 0.27 |
| *High Frequency Instrument - Long-run restriction* | | | | | | | | | |
| 24 months | -0.26 | 0.15 | -1.21 | -0.50 | -0.27 | -0.21 | -0.19 | -0.11 | -0.01 |
| 36 months | -0.42 | 0.20 | -1.58 | -0.80 | -0.44 | -0.36 | -0.32 | -0.23 | 0.11 |
| *PANEL B: CONSUMER PRICES* | | | | | | | | | |
| *Cholesky - Long-run restriction* | | | | | | | | | |
| 24 months | -0.13 | 0.22 | -1.92 | -0.38 | -0.20 | -0.12 | -0.04 | 0.15 | 0.49 |
| 36 months | -0.28 | 0.25 | -2.44 | -0.61 | -0.32 | -0.24 | -0.16 | -0.01 | 0.19 |
| *Cholesky - No long-run restriction* | | | | | | | | | |
| 24 months | -0.07 | 0.50 | -4.76 | -0.42 | -0.09 | 0.01 | 0.09 | 0.24 | 0.91 |
| 36 months | -0.17 | 0.80 | -7.83 | -0.74 | -0.22 | -0.04 | 0.10 | 0.32 | 1.27 |
| *High Frequency Instrument - Long-run restriction* | | | | | | | | | |
| 24 months | -0.30 | 0.29 | -2.50 | -0.84 | -0.32 | -0.23 | -0.17 | -0.07 | 0.02 |
| 36 months | -0.48 | 0.38 | -3.28 | -1.22 | -0.51 | -0.39 | -0.30 | -0.16 | -0.03 |

Note: this table reports descriptive statistics on the distribution of the product-specific CIR for the different specifications and at two horizons (24 and 36 months). These statistics are computed over 118 products for PPI and 223 products for CPI.

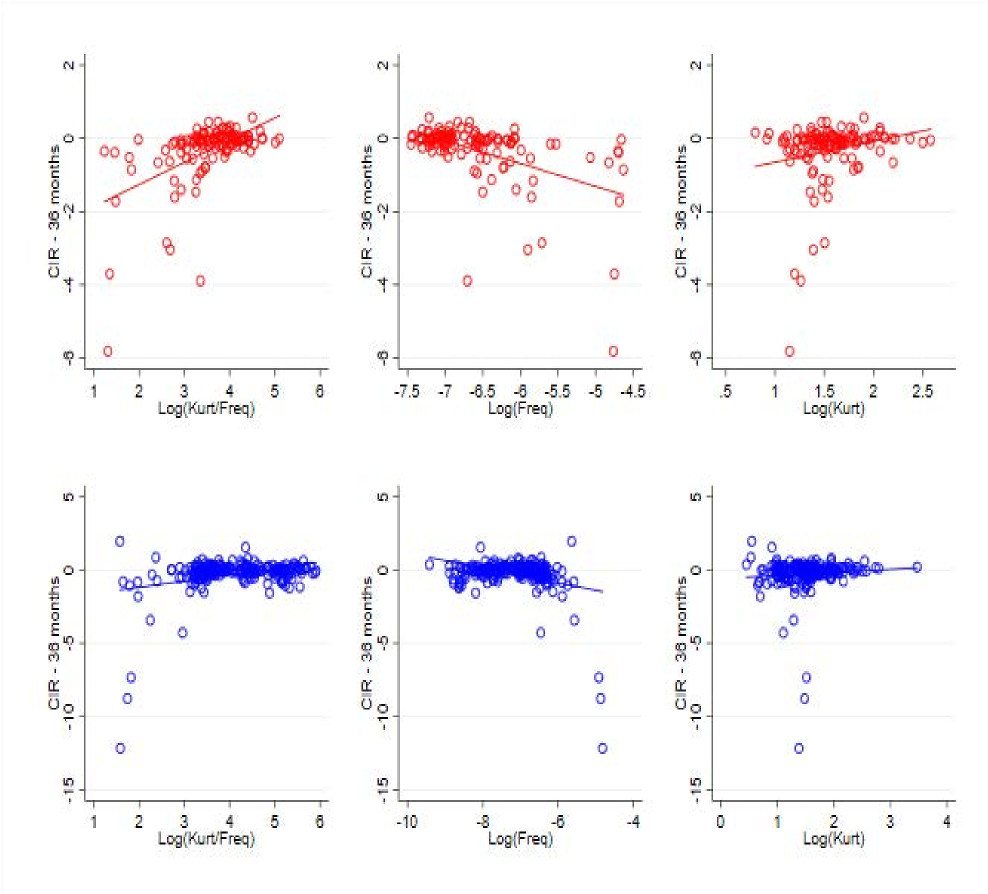
## Additional Scatter Plots $CIR^P$ - moments

Figure I: Correlation $CIR^P$ - Log ratio $\frac{Kurt}{Freq}$ - Cholesky Long-run restriction



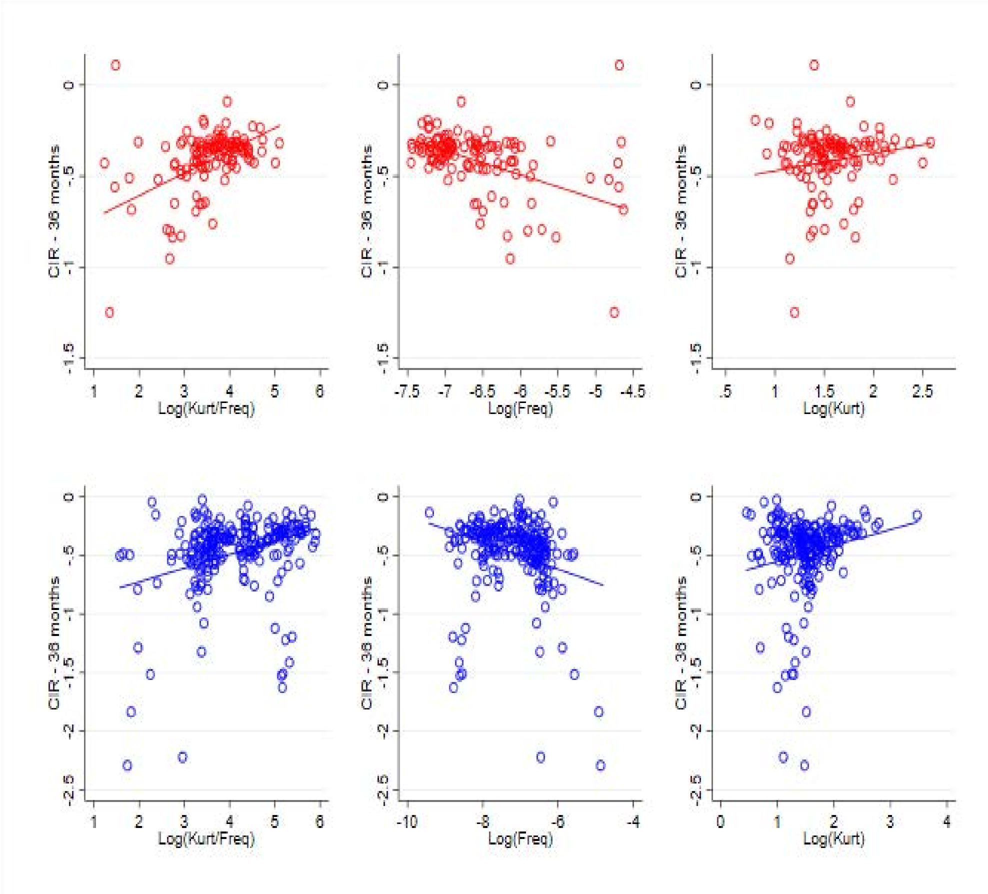

Note: the figure plots the product-specific CIR (at the horizon 36 months) obtained in the FAVAR specification using a Cholesky decomposition and imposing a long-run restriction and the log of the ratio kurtosis over frequency of price changes (left panel), the log of frequency of price changes (center panel), the log of kurtosis of price changes (right panel). The top panel reports results for PPI products whereas the bottom panel reports results for CPI products.

Figure J: Correlation $CIR^P$ - Log ratio $\frac{Kurt}{Freq}$ - Cholesky No Long-run restriction




Note: the figure plots the product-specific CIR (at the horizon 36 months) obtained in the FAVAR specification using a Cholesky decomposition without imposing any long-run restriction and the log of the ratio kurtosis over frequency of price changes (left panel), the log of frequency of price changes (center panel), the log of kurtosis of price changes (right panel). The top panel reports results for PPI products whereas the bottom panel reports results for CPI products.

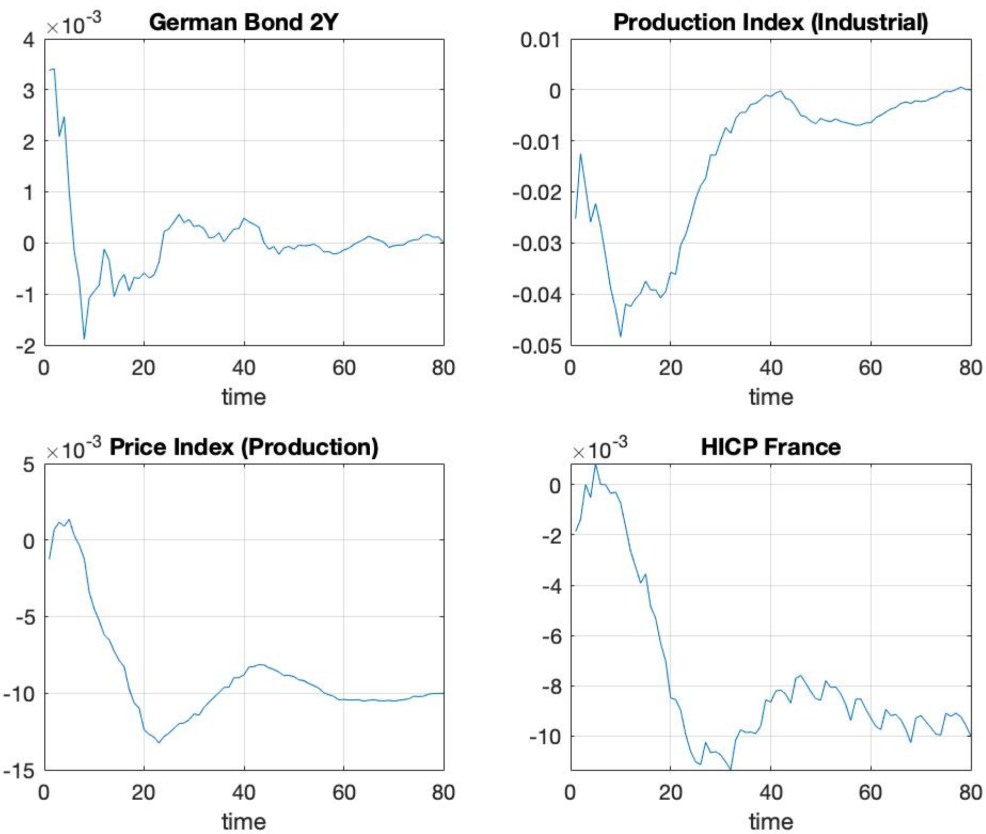
Figure K: Correlation $CIR^P$ - Log ratio $\frac{Kurt}{Freq}$ - HFI Long-run restriction




Note: the figure plots the product-specific CIR (at the horizon 36 months) obtained in the FAVAR specification using a high-frequency instrument variable and imposing a long-run restriction and the log of the ratio kurtosis over frequency of price changes (left panel), the log of frequency of price changes (center panel), the log of kurtosis of price changes (right panel). The top panel reports results for PPI products whereas the bottom panel reports results for CPI products.

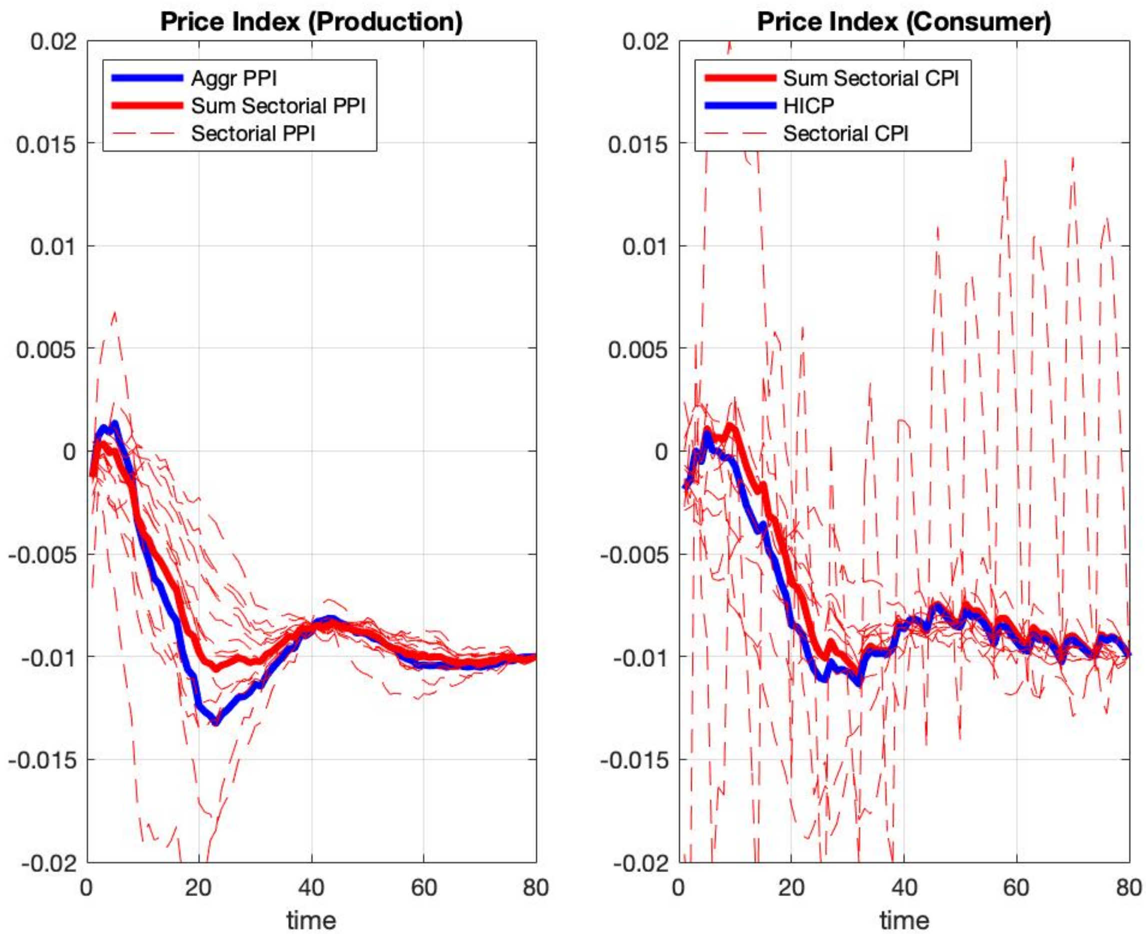
## FAVAR - High-Freq. IV - German bond rate - Long-run restriction

Figure L: Aggregate response to a contractionary monetary policy shock Updated (nothing should change)



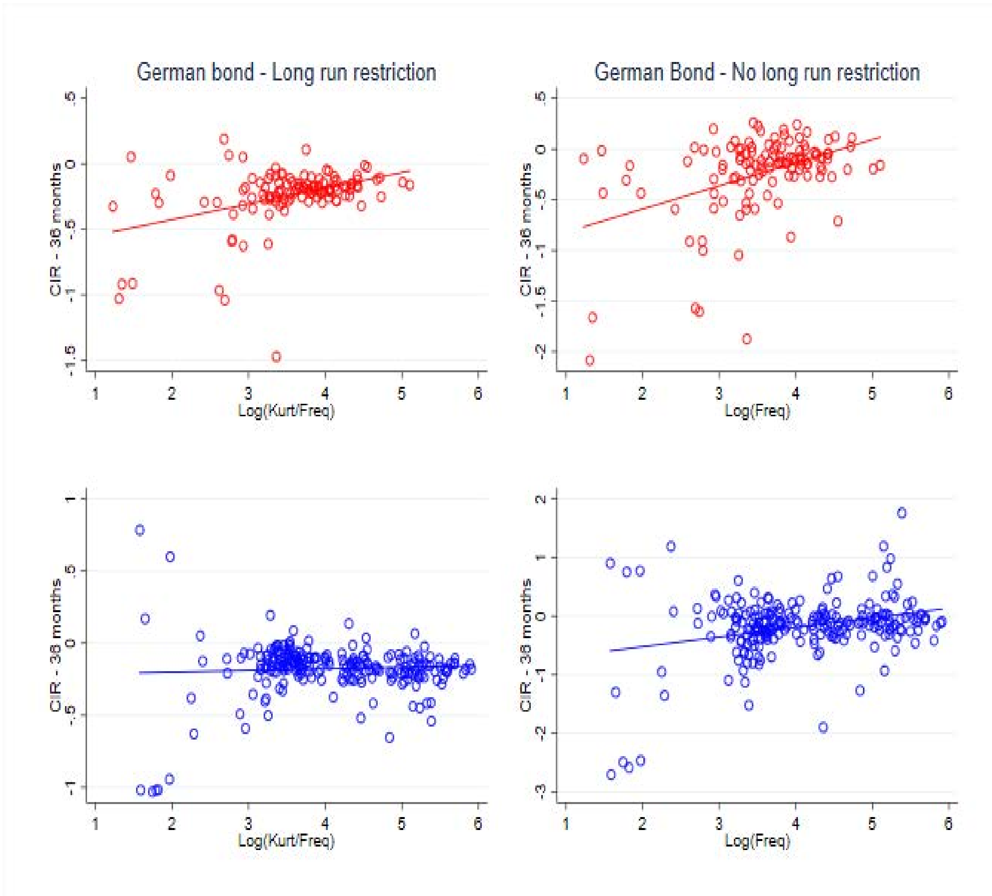

y-axis: log points in deviation from the "steady state".
Top panel: 3-month Euribor IRF. Top right panel: production index IRF. Bottom left panel: production price index IRF. Bottom right panel: IRF of the harmonized index of consumer prices

Figure M: Sectoral Responses of PPI and CPI to a Contractionary Monetary Shock



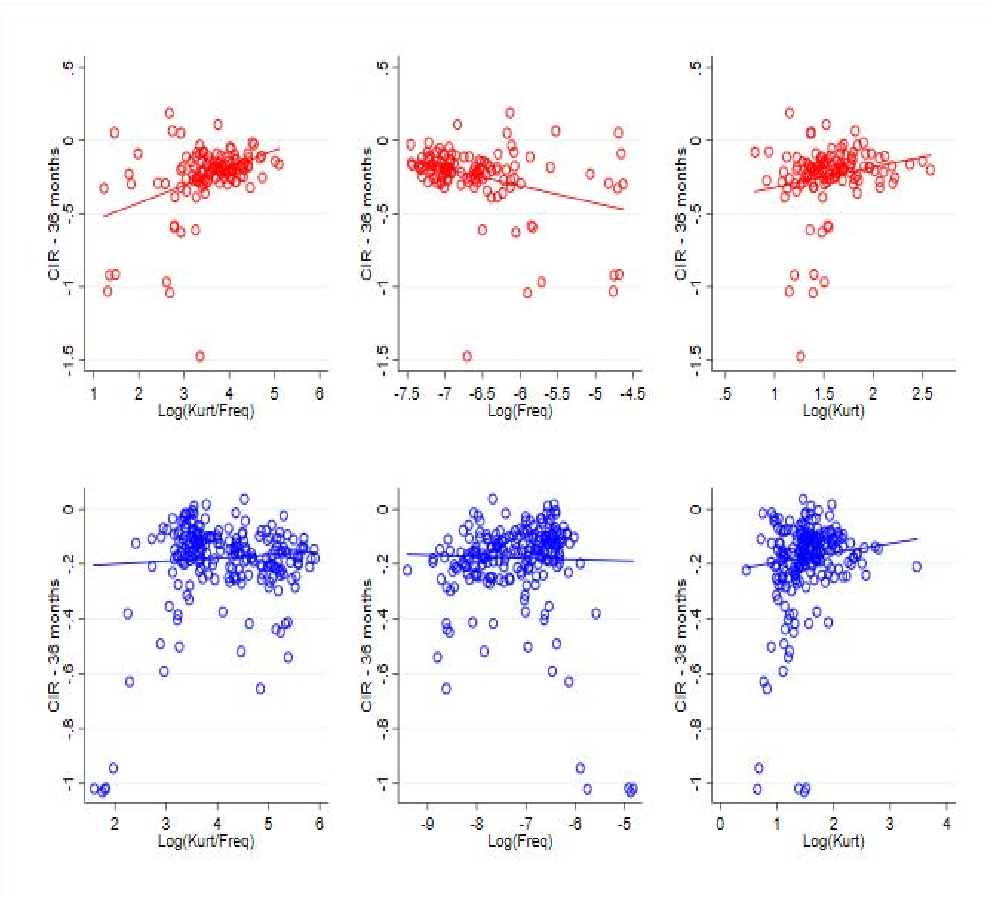

y-axis: log points in deviation from the "steady state". Left panel sectoral IRFs of PPI, right panel sectoral IRFs of CPI. In both panel: blue line IRF of aggregate time series, dashed red lines sectoral IRFs, thick red line arithmetic average of sectoral IRFs.

Figure N: Correlation $CIR^P$ - Log ratio $\frac{Kurt}{Freq}$ - HFI 2-year German Bond Rate




Note: the figure plots for each FAVAR specification the product-specific CIR (at the horizon 36 months) and the log of the ratio kurtosis over frequency of price changes. The top panel reports result for PPI products whereas the bottom panel reports results for CPI products.

Figure O: Correlation $CIR^P$ - Log ratio $\frac{Kurt}{Freq}$, $log(Kurt)$ and $log(Freq)$ - HFI 2-year German Bond Rate




Note: the figure plots the product-specific CIR (at the horizon 36 months) obtained in the FAVAR specification using a high-frequency instrument variable and imposing a long-run restriction and the log of the ratio kurtosis over frequency of price changes (left panel), the log of frequency of price changes (center panel), the log of kurtosis of price changes (right panel). The top panel reports results for PPI products whereas the bottom panel reports results for CPI products.

# E Kurtosis Measurement with Unobserved Heterogeneity

The measure of Kurtosis is particularly sensitive to unobserved heterogeneity. Measured kurtosis is in particular known to suffer from an upward bias when a sample is composed of two (or more) sub-populations with different variances. To investigate the robustness of our results with respect to such a concern, we use an alternative measure of kurtosis derived along the lines of Alvarez, Lippi, and Oskolkov (2021). The assumption underlying this correction, is that within a given product category, there are several varieties (indexed by $i = 1, ..., I$) that are pooled. For instance, one could have various brands of soda, in the case the brand of soda is not collected by the statistical office, or not disclosed to the researcher. At a given date $t$, the price change for all varieties is driven by a common factor $\Delta\tilde{p}_t$, but the variance differs across varieties, according to a scaling factor $b_i$.

$$\Delta p_{it} = b_i \Delta\tilde{p}_t \text{ for } i \in I \text{ and } t \in T(i)$$

where $T(i)$ is the set of adjustment instances for variety $i$. Under the assumption that $\Delta\tilde{p}_t$ is serially uncorrelated, and some other general assumptions, Alvarez, Lippi, and Oskolkov (2021) show that the following property then holds:

$$Kurt(\Delta\tilde{p}_t) = Kurt(\Delta p_{it}) \frac{E[(\Delta p_{it}^2)]^2}{E[(\Delta p_{it}^2)(\Delta p_{is}^2)]} \text{ for } t \neq s$$

or equivalently

$$Kurt(\Delta\tilde{p}_t) = \frac{Kurt(\Delta p_{it})}{1 + corr(\Delta p_{it}^2, \Delta p_{is}^2) CV(\Delta p_{it}^2) CV(\Delta p_{is}^2)} \text{ for } t \neq s$$

where CV(.) denotes the coefficient of variation and corr(.,.) the correlation coefficient.

We use these equations to compute a measure of kurtosis robust to unobserved heterogeneity. In practice, we want to use information from several possible lags (the $s$'s as different from $t$), rather than picking up a single particular lag $s$.

To compute the covariance terms in the expression above we as use an estimator of $E = E[(\Delta p_{it}^2)(\Delta p_{is}^2)]$ the following expression:

$$E = (1/\#Terms) \sum_{t,s \in T(i), t \neq s} (\Delta p_{it})^2 (\Delta p_{is})^2 \tag{33}$$

In practice, we consider the first $K$ lags of squared price changes. So, the numerator of the formula (33) above is computed as:

$$S = 2 * [\sum_{t=2}^{T} (\Delta p_t)^2 (\Delta p_{t-1})^2 + \sum_{t=3}^{T} (\Delta p_t)^2 (\Delta p_{t-2})^2 + ... + \sum_{t=K+1}^{T} (\Delta p_t)^2 (\Delta p_{t-K})^2] \tag{34}$$

Denotig by $NN$ the number of terms in equation ( 34), then $\#Terms = 2 * NN$, where:

$$NN = (T-1) + (T-2) + ... + (T-k) = T(T-1)/2 - (T-K-1) * (T-K)/2 \tag{35}$$

So when $K = T - 1$ , $\#Terms = 2 * T(T-1)/2 = T(T-1)$ Then we recover

$$E = \frac{S}{T(T-1)}$$

# F Measurement Error

This appendix assesses the impact of (one form of) measurement errors on the micro moments of price adjustment and their ratio $Kurt/Freq$.

Assume measurement errors are of the following type: for a given store, measurement errors materialize at some points by extra spurious price changes, and these spurious price changes are small. Such patterns of error is plausible (as discussed in Alvarez, Le Bihan, and Lippi (2016) ), both for CPI data because small coding error can stay undetected by the error checking procedures of the statistical institute, and for scanner data as the price in typically computed as the ratio of value purchased to quantity sold (and the numerator can vary reflecting e.g. coupons). These spurious price changes will increase both the measured Kurtosis, as well as the measured Frequency of price changes - with the size of the bias being a function of the fraction of spurious price changes. However, as is formally shown below, such measurement errors will leave ratio Kurtosis/Frequency unchanged. As a result, not only theory indicates that the ratio Kurtosis/Frequency is the relevant covariate, but it is also the case that this ratio should be more robust to measurement errors than each of the moments taken separately.

Formally, let $N_{\Delta p}$ be the number of "true" price changes per period (i.e. the frequency of price changes). Assume $\Delta p$, the price changes, have mean zero, variance $Var(\Delta p) = \sigma^2_{\Delta p}$ and Kurtosis $Kurt(\Delta p) = m_{4,\Delta p}/\sigma^4_{\Delta p}$, where $m_{4,\Delta p}$ is the fourth moment of variable $\Delta p$ . Let $N_e$ denote the number of spurious price changes per unit of time. Assume that spurious price changes, denoted $e$, have mean zero and variance $Var(e) = \sigma^2_e$, and kurtosis $Kurt(e) = m_{4,e}/\sigma^4_e$. Aume spurious and true price changes to be statistically independent. Then the observed (measured) frequency of price changes will be $\tilde{N} = N_{\Delta p} + N_e$. The distribution of the observed price changes, denoted $\tilde{\Delta} p$'s , will have mean zero and its Kurtosis will be

$$Kurt(\tilde{\Delta} p) = \frac{\theta Kurt(\Delta p)\sigma^4_{\Delta p} + (1-\theta)Kurt(e)\sigma^4_e}{\left(\theta\sigma^2_{\Delta p} + (1-\theta)\sigma^2_e\right)^2}$$

with $\theta \equiv \frac{N_{\Delta p}}{\tilde{N}}$ the fraction of "true" price changes. We consider the case of arbitrarily small measurement errors . From the above it results that $\lim_{\sigma^2_e \to 0} Kurt(\tilde{\Delta} p) = \frac{Kurt(\Delta p)}{\theta}$. Then we have $\lim_{\sigma^2_e \to 0} \frac{Kurt(\tilde{\Delta} p)}{\tilde{N}} = \frac{Kurt(\Delta p)}{N_{\Delta p}}$. Thus, the ratio Kurtosis over Frequency is unaffected by these presence of small measurement error.

# G OLS regressions - Additional results and robustness

Table B: Testing Model's Predictions

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: PRODUCER PRICES* | | | | | | |
| *Constrained model* | | | | | | |
| P-val $\beta = 1/6$ | 0.003 | 0.053 | 0.125 | 0.025 | 0.681 | 0.351 |
| P-val $\alpha = -T$ | 0.111 | 0.702 | 0.042 | 0.763 | 0.006 | 0.000 |
| Ratio $\alpha/\beta$ | -307.6 | -360.9 | -69.58 | -72.82 | -178.5 | -216.0 |
| *Unconstrained model* | | | | | | |
| P-val $\beta_f = -\beta_k$ | 0.566 | 0.457 | 0.648 | 0.643 | 0.819 | 0.857 |
| P-val $\beta_f = -\frac{\bar{K}}{6\bar{F}}$ | 0.130 | 0.325 | 0.111 | 0.047 | 0.577 | 0.460 |
| P-val $\beta_k = \frac{\bar{K}}{6\bar{F}}$ | 0.679 | 0.915 | 0.098 | 0.044 | 0.477 | 0.389 |
| P-val $\gamma = -T + \frac{\bar{K}}{6\bar{F}}$ | 0.743 | 0.687 | 0.161 | 0.170 | 0.100 | 0.007 |
| *PANEL B: CONSUMER PRICES* | | | | | | |
| *Constrained model* | | | | | | |
| P-val $\beta = 1/6$ | 0.000 | 0.000 | 0.030 | 0.802 | 0.000 | 0.003 |
| P-val $\alpha = -T$ | 0.000 | 0.009 | 0.001 | 0.630 | 0.003 | 0.000 |
| Ratio $\alpha/\beta$ | 685.5 | 11,160 | -184.4 | -205.0 | -696.0 | -759.4 |
| *Unconstrained model* | | | | | | |
| P-val $\beta_f = -\beta_k$ | 0.877 | 0.492 | 0.001 | 0.000 | 0.049 | 0.039 |
| P-val $\beta_f = -\frac{\bar{K}}{6\bar{F}}$ | 0.281 | 0.860 | 0.003 | 0.000 | 0.032 | 0.006 |
| P-val $\beta_k = \frac{\bar{K}}{6\bar{F}}$ | 0.124 | 0.377 | 0.208 | 0.591 | 0.710 | 0.664 |
| P-val $\gamma = -T + \frac{\bar{K}}{6\bar{F}}$ | 0.352 | 0.433 | 0.000 | 0.000 | 0.340 | 0.202 |

Note: we report p-values of Wald tests performed on the parameters of our baseline OLS regressions presented in Table 2 and Table 2. These tests correspond to model's predictions presented in equation (10) and equation (11). We perform four different tests: (i) in the constrained version of the model we test whether $\beta$ (parameter associated with the ratio $Kurt/Freq$ is equal to $-\delta/6$ (where $\delta$ is the MP shock here normalised to 1%); (ii) we test whether the constant of the constrained model ($\alpha$) is equal to $-T$ and in the unconstrained model, whether $\gamma$ is equal to $-T + \frac{\bar{K}}{6\bar{F}}$ and (iii) in the unconstrained model, we test whether the parameter associated with frequency ($\beta_f$) is equal to minus the parameter associated with kurtosis ($-\beta_k$); (iv) in the unconstrained version, we also perform tests on the parameter associated with frequency and kurtosis, they are predicted to be equal to $\frac{\bar{K}}{6\bar{F}}$ where $\bar{K}$ and $\bar{F}$ are sample averages of kurtosis and frequency. We also report the ratio of the estimated coefficients in OLS regressions.

Table C: Regression Results: Alternative Specifications - Log

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Producer prices - Constrained model* | | | | | | |
| Log(Ratio) | 3.948** | 5.301*** | 18.01*** | 28.84*** | 10.07*** | 12.39*** |
| | (1.649) | (1.723) | (5.377) | (8.383) | (3.398) | (4.541) |
| Constant | -31.63*** | -49.67*** | -72.29*** | -117.7*** | -61.54*** | -85.53*** |
| | (6.440) | (6.681) | (20.67) | (32.13) | (12.97) | (17.35) |
| $R^2$ | 0.103 | 0.175 | 0.255 | 0.282 | 0.259 | 0.223 |
| *PANEL B: Producer prices - Unconstrained model* | | | | | | |
| Log(Freq) | -3.748** | -5.155*** | -18.23*** | -29.39*** | -10.56*** | -13.11*** |
| | (1.833) | (1.873) | (5.589) | (8.676) | (3.582) | (4.845) |
| Log(Kurt) | 4.834** | 5.948** | 17.05** | 26.39** | 7.895* | 9.189* |
| | (2.291) | (2.414) | (7.033) | (10.72) | (4.061) | (5.274) |
| Constant | -15.37*** | -26.66*** | 12.74 | 20.39 | -10.47 | -21.55** |
| | (4.982) | (4.836) | (12.09) | (17.77) | (7.124) | (9.852) |
| $R^2$ | 0.104 | 0.176 | 0.255 | 0.282 | 0.262 | 0.226 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |
| *PANEL C: Consumer prices - Constrained model* | | | | | | |
| Log(Ratio) | 1.354 | 3.509 | 15.97** | 27.98** | 8.643** | 11.63** |
| | (2.289) | (2.877) | (7.563) | (12.05) | (3.580) | (4.539) |
| Constant | -18.72* | -41.94*** | -72.36** | -131.7** | -65.36*** | -95.81*** |
| | (10.50) | (13.07) | (33.78) | (53.77) | (15.72) | (19.89) |
| $R^2$ | 0.003 | 0.017 | 0.092 | 0.111 | 0.082 | 0.086 |
| *PANEL D: Consumer prices - Unconstrained model* | | | | | | |
| Log(Freq) | 1.460 | -0.824 | -17.54* | -32.62** | -8.005* | -11.23* |
| | (2.715) | (3.442) | (9.270) | (14.71) | (4.559) | (5.792) |
| Log(Kurt) | 11.07*** | 12.77*** | 10.57** | 11.94 | 10.84*** | 12.99*** |
| | (3.020) | (3.338) | (4.800) | (7.711) | (3.289) | (4.426) |
| Constant | -32.83*** | -45.19*** | 12.52 | 30.70 | -30.17*** | -45.12*** |
| | (5.901) | (7.093) | (16.42) | (26.61) | (10.52) | (13.88) |
| $R^2$ | 0.051 | 0.050 | 0.095 | 0.121 | 0.084 | 0.087 |
| Observations | 223 | 223 | 223 | 223 | 223 | 223 |

Note: this table reports results of OLS regressions (equation (10)) where the endogenous variable is the product-specific $CIR_T^{P_j}$ (expressed in %) and the RHS variables include the log of the product-specific ratio $Kurt/freq$ in the constrained model and the log of product specific frequency and the log of product-specific kurtosis. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table D: Regression Results - Placebo Unconstrained Specification

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: PRODUCER PRICES* | | | | | | |
| $Freq/\bar{F}$ | -2.865* | -3.337** | -11.50** | -17.79** | -5.488* | -6.347 |
| | (1.454) | (1.491) | (4.922) | (7.743) | (3.258) | (4.406) |
| $Kurt/\bar{K}$ | 3.026 | 4.066 | 10.13* | 15.95* | 5.823* | 7.153 |
| | (3.048) | (2.796) | (5.749) | (8.154) | (3.177) | (4.673) |
| Mean | -0.254 | -0.186 | -2.353 | -3.699 | -0.855 | -0.927 |
| | (0.792) | (0.851) | (2.242) | (3.486) | (1.285) | (1.699) |
| Skewness | 1.798 | 0.793 | -2.645 | -6.643 | -4.708* | -7.159* |
| | (3.359) | (2.989) | (7.065) | (9.668) | (2.589) | (3.855) |
| Standard dev. | -0.916 | -0.625 | -2.533 | -3.331 | 0.245 | 0.837 |
| | (1.297) | (1.306) | (4.158) | (6.425) | (2.460) | (3.229) |
| Constant | -13.33* | -28.68*** | 4.485 | 1.130 | -27.87* | -47.18** |
| | (7.379) | (7.539) | (22.87) | (35.69) | (14.08) | (18.59) |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |
| $R^2$ | 0.118 | 0.164 | 0.246 | 0.264 | 0.228 | 0.195 |
| *PANEL B: CONSUMER PRICES* | | | | | | |
| $Freq/\bar{F}$ | -6.170* | -10.12*** | -37.39*** | -62.37*** | -17.81*** | -23.07*** |
| | (3.170) | (3.640) | (9.143) | (13.96) | (3.969) | (4.877) |
| $Kurt/\bar{K}$ | -4.732* | -2.640 | 6.454 | 16.08 | 7.629 | 11.55* |
| | (2.733) | (3.216) | (6.959) | (11.74) | (4.688) | (6.434) |
| Mean | 0.0898 | -0.366 | -3.328** | -6.085*** | -1.505** | -2.092** |
| | (0.783) | (0.822) | (1.451) | (2.258) | (0.718) | (0.956) |
| Skewness | 5.111 | 7.162 | 9.659* | 14.77 | 8.489** | 10.98** |
| | (4.335) | (4.393) | (5.724) | (9.326) | (3.586) | (4.974) |
| Standard dev. | -2.972*** | -2.767** | 0.0440 | 2.281 | -0.00409 | 0.554 |
| | (1.078) | (1.248) | (2.524) | (3.908) | (1.211) | (1.571) |
| Constant | 21.50* | 8.500 | 30.21 | 23.08 | -15.71 | -35.47* |
| | (11.82) | (13.60) | (29.17) | (45.66) | (14.13) | (18.48) |
| Observations | 223 | 223 | 223 | 223 | 223 | 223 |
| $R^2$ | 0.108 | 0.165 | 0.509 | 0.572 | 0.383 | 0.380 |

Note: this table reports results of OLS regressions ( equation (11)) where the endogenous variable is the product-specific $CIR_T^{P_j}$ (expressed in %) and the RHS variables include the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$, but also three other moments of the product-specific price change distribution: the average price change $Mean$, the skewness of price changes $Skewness$, and the standard deviation of price changes $StandardDev.$. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table E: Regression Results: Outliers - Constrained - Producer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: CIR* | | | | | | |
| Kurt/Freq | 0.0451* | 0.0713** | 0.200*** | 0.331*** | 0.131*** | 0.172*** |
| | (0.0230) | (0.0275) | (0.0632) | (0.0916) | (0.0341) | (0.0452) |
| Constant | -19.18*** | -33.53*** | -14.56*** | -26.00*** | -30.61*** | -48.11*** |
| | (1.490) | (1.680) | (3.956) | (5.648) | (2.039) | (2.711) |
| $R^2$ | 0.042 | 0.087 | 0.111 | 0.135 | 0.144 | 0.138 |
| *PANEL B: Ratio* | | | | | | |
| Kurt/Freq | 0.0762* | 0.108*** | 0.320*** | 0.517*** | 0.181*** | 0.226*** |
| | (0.0392) | (0.0352) | (0.0824) | (0.116) | (0.0444) | (0.0668) |
| Constant | -20.39*** | -34.85*** | -19.84*** | -33.92*** | -32.18*** | -49.54*** |
| | (2.388) | (2.146) | (5.050) | (7.031) | (2.580) | (3.861) |
| $R^2$ | 0.039 | 0.086 | 0.121 | 0.149 | 0.146 | 0.116 |
| *PANEL C: Kurtosis* | | | | | | |
| Kurt/Freq | 0.0933** | 0.134*** | 0.439*** | 0.713*** | 0.261*** | 0.328*** |
| | (0.0404) | (0.0419) | (0.123) | (0.189) | (0.0714) | (0.0942) |
| Constant | -21.63*** | -36.67*** | -27.37*** | -46.28*** | -37.23*** | -55.95*** |
| | (2.452) | (2.479) | (7.198) | (10.94) | (4.073) | (5.406) |
| $R^2$ | 0.057 | 0.112 | 0.151 | 0.172 | 0.176 | 0.158 |
| *PANEL D: Frequency* | | | | | | |
| Kurt/Freq | 0.0491 | 0.0866** | 0.321*** | 0.542*** | 0.215*** | 0.281*** |
| | (0.0308) | (0.0369) | (0.113) | (0.179) | (0.0679) | (0.0865) |
| Constant | -19.54*** | -34.53*** | -22.12*** | -38.86*** | -35.46*** | -54.31*** |
| | (2.049) | (2.281) | (6.795) | (10.55) | (3.839) | (4.886) |
| $R^2$ | 0.023 | 0.064 | 0.107 | 0.128 | 0.153 | 0.155 |
| Observations | 112 | 112 | 112 | 112 | 112 | 112 |

Note: this table reports results of OLS regressions (equation (10)) for PPI products relating the product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$. For each of the 4 regressions, we remove products with "extreme" values of CIR (Panel A); ratio $Kurt/Freq$ (Panel B), kurtosis (Panel C), frequency of price changes (Panel D). "Extreme values" are defined as products below the 2.5th percentile or above the 97.5th percentile of the distribution of each statistic (10 products for CPI and 6 for PPI). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table F: Regression Results: Outliers - Constrained - Consumer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: CIR* | | | | | | |
| Kurt/Freq | -0.0320*** | -0.0302** | 0.00321 | 0.0366* | 0.0212 | 0.0384* |
| | (0.0108) | (0.0117) | (0.0139) | (0.0221) | (0.0160) | (0.0220) |
| Constant | -9.067*** | -22.80*** | -1.922 | -12.32*** | -29.25*** | -48.51*** |
| | (1.654) | (1.616) | (1.878) | (2.903) | (1.631) | (2.361) |
| $R^2$ | 0.036 | 0.029 | 0.000 | 0.012 | 0.009 | 0.015 |
| *PANEL B: Ratio* | | | | | | |
| Kurt/Freq | -0.0353* | -0.0244 | 0.0317 | 0.0876* | 0.0247 | 0.0419 |
| | (0.0184) | (0.0214) | (0.0312) | (0.0481) | (0.0248) | (0.0330) |
| Constant | -9.372*** | -24.45*** | -6.259 | -19.24*** | -30.66*** | -50.04*** |
| | (2.811) | (3.135) | (4.480) | (6.824) | (2.668) | (3.514) |
| $R^2$ | 0.015 | 0.006 | 0.005 | 0.017 | 0.006 | 0.010 |
| *PANEL C: Kurtosis* | | | | | | |
| Kurt/Freq | -0.0170 | -0.00270 | 0.0786* | 0.157** | 0.0429 | 0.0630* |
| | (0.0187) | (0.0226) | (0.0475) | (0.0757) | (0.0276) | (0.0359) |
| Constant | -11.68*** | -27.53*** | -14.62** | -32.45*** | -34.42*** | -54.70*** |
| | (2.988) | (3.505) | (7.360) | (11.67) | (3.681) | (4.734) |
| $R^2$ | 0.003 | 0.000 | 0.014 | 0.022 | 0.013 | 0.016 |
| *PANEL D: Frequency* | | | | | | |
| Kurt/Freq | -0.0326** | -0.0230 | 0.00332 | 0.0371 | 0.0270 | 0.0450* |
| | (0.0153) | (0.0172) | (0.0193) | (0.0285) | (0.0172) | (0.0230) |
| Constant | -8.829*** | -23.48*** | -1.463 | -11.16*** | -29.32*** | -48.33*** |
| | (2.553) | (2.774) | (2.925) | (4.180) | (2.046) | (2.747) |
| $R^2$ | 0.016 | 0.007 | 0.000 | 0.007 | 0.012 | 0.017 |
| Observations | 213 | 213 | 213 | 213 | 213 | 213 |

Note: this table reports results of OLS regressions ( equation (10)) for CPI products relating the product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$. For each of the 4 regressions, we remove products with "extreme" values of CIR (Panel A), ratio $Kurt/Freq$ (Panel B), kurtosis (Panel C), frequency of price changes (Panel D). "Extreme values" are defined as products below the 2.5th percentile or above the 97.5th percentile of the distribution of each statistic (10 products for CPI and 6 for PPI). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table G: Regression Results: Outliers - Unconstrained - Producer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: CIR* | | | | | | |
| $Freq/\bar{F}$ | -1.226 | -2.415** | -5.927*** | -9.038*** | -3.461*** | -4.898*** |
| | (0.868) | (1.169) | (2.229) | (2.717) | (1.136) | (1.560) |
| $Kurt/\bar{K}$ | 1.615 | 2.547* | 6.249** | 9.878** | 4.014** | 4.302* |
| | (1.168) | (1.431) | (2.680) | (3.938) | (1.946) | (2.419) |
| Constant | -17.64*** | -30.59*** | -6.404* | -12.74** | -25.66*** | -40.28*** |
| | (1.253) | (1.480) | (3.261) | (5.072) | (2.502) | (3.124) |
| $R^2$ | 0.047 | 0.156 | 0.140 | 0.146 | 0.129 | 0.134 |
| *PANEL B: Ratio* | | | | | | |
| $Freq/\bar{F}$ | -1.984 | -2.240* | -7.069*** | -10.75*** | -2.874 | -3.162 |
| | (1.547) | (1.164) | (2.564) | (3.161) | (1.772) | (2.990) |
| $Kurt/\bar{K}$ | 4.770* | 5.526** | 12.71** | 18.81*** | 4.710* | 4.962 |
| | (2.431) | (2.116) | (5.138) | (7.113) | (2.702) | (4.070) |
| Constant | -20.04*** | -33.65*** | -12.35** | -20.77** | -26.57*** | -42.02*** |
| | (2.445) | (2.274) | (6.041) | (8.624) | (2.887) | (3.999) |
| $R^2$ | 0.062 | 0.088 | 0.118 | 0.127 | 0.071 | 0.043 |
| *PANEL C: Kurtosis* | | | | | | |
| $Freq/\bar{F}$ | -2.514** | -3.146** | -11.23*** | -17.74*** | -5.924** | -7.117* |
| | (1.264) | (1.294) | (4.168) | (6.550) | (2.761) | (3.754) |
| $Kurt/\bar{K}$ | 6.798** | 8.448*** | 23.34*** | 36.12*** | 11.90** | 14.06** |
| | (2.865) | (2.899) | (8.291) | (12.52) | (4.575) | (5.991) |
| Constant | -21.80*** | -36.09*** | -20.32** | -33.63*** | -31.89*** | -48.71*** |
| | (3.010) | (2.882) | (8.236) | (12.06) | (3.969) | (5.237) |
| $R^2$ | 0.125 | 0.186 | 0.259 | 0.277 | 0.235 | 0.192 |
| *PANEL D: Frequency* | | | | | | |
| $Freq/\bar{F}$ | -1.929 | -3.319* | -14.06** | -23.62** | -9.641*** | -12.52*** |
| | (1.512) | (1.881) | (6.139) | (9.670) | (3.484) | (4.261) |
| $Kurt/\bar{K}$ | 3.094* | 4.156** | 11.69** | 18.55** | 6.122** | 7.471** |
| | (1.744) | (1.841) | (5.030) | (7.579) | (2.860) | (3.703) |
| Constant | -18.73*** | -31.88*** | -7.005 | -12.26 | -23.44*** | -38.15*** |
| | (2.184) | (2.140) | (6.097) | (9.007) | (3.227) | (4.255) |
| $R^2$ | 0.058 | 0.132 | 0.251 | 0.295 | 0.362 | 0.358 |
| Observations | 112 | 112 | 112 | 112 | 112 | 112 |

Note: This table reports results of OLS regressions ( equation (11)) relating the product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. For each of the 4 regressions, we remove products with "extreme" values of CIR (Panel A); ratio $Kurt/Freq$ (Panel B), kurtosis (Panel C), frequency of price changes (Panel D). "Extreme values" are defined as products below the 2.5th percentile or above the 97.5th percentile of the distribution of each statistic. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table H: Regression Results: Outliers - Unconstrained - Consumer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: CIR* | | | | | | |
| $Freq/\bar{F}$ | 4.572** | 4.832** | -3.749 | -10.71*** | -5.233* | -8.578** |
| | (2.110) | (2.450) | (2.512) | (3.456) | (2.703) | (3.670) |
| $Kurto/\bar{K}$ | 3.575* | 4.757** | 5.826*** | 8.653*** | 6.617*** | 8.495*** |
| | (1.872) | (2.031) | (2.022) | (2.610) | (1.700) | (2.170) |
| Constant | -19.77*** | -34.72*** | -4.218 | -8.168* | -29.19*** | -45.70*** |
| | (2.289) | (2.855) | (3.138) | (4.730) | (3.755) | (5.075) |
| $R^2$ | 0.067 | 0.082 | 0.063 | 0.100 | 0.091 | 0.097 |
| *PANEL B: Ratio* | | | | | | |
| $Freq/\bar{F}$ | 0.207 | -2.562 | -20.52** | -37.25*** | -10.28*** | -14.15*** |
| | (4.469) | (4.697) | (9.468) | (13.28) | (3.494) | (4.012) |
| $Kurto/\bar{K}$ | 8.072*** | 10.01*** | 9.452*** | 12.32** | 10.67*** | 13.37*** |
| | (2.779) | (3.040) | (3.312) | (5.105) | (2.700) | (3.586) |
| Constant | -20.49*** | -33.98*** | 6.168 | 10.64 | -29.47*** | -46.43*** |
| | (4.440) | (4.756) | (8.615) | (12.53) | (4.981) | (6.418) |
| $R^2$ | 0.031 | 0.047 | 0.249 | 0.327 | 0.153 | 0.152 |
| *PANEL C: Kurtosis* | | | | | | |
| $Freq/\bar{F}$ | -5.606** | -9.607*** | -38.46*** | -64.60*** | -17.86*** | -23.21*** |
| | (2.758) | (3.162) | (8.108) | (12.46) | (3.666) | (4.536) |
| $Kurto/\bar{K}$ | 12.83*** | 15.14*** | 14.20** | 17.43* | 13.23*** | 16.00*** |
| | (3.347) | (3.757) | (5.638) | (9.197) | (3.855) | (5.120) |
| Constant | -19.94*** | -32.85*** | 16.23* | 27.69** | -25.88*** | -41.83*** |
| | (4.172) | (4.782) | (8.592) | (13.67) | (5.801) | (7.637) |
| $R^2$ | 0.108 | 0.181 | 0.554 | 0.607 | 0.388 | 0.376 |
| *PANEL D: Frequency* | | | | | | |
| $Freq/\bar{F}$ | 6.723** | 5.051 | -1.024 | -7.915 | -4.369* | -7.549** |
| | (2.839) | (3.094) | (4.345) | (6.509) | (2.587) | (3.423) |
| $Kurto/\bar{K}$ | 4.587* | 5.874** | 5.296** | 7.061** | 6.992*** | 8.912*** |
| | (2.507) | (2.731) | (2.313) | (3.045) | (1.937) | (2.428) |
| Constant | -22.50*** | -36.09*** | -5.618 | -7.837 | -30.05*** | -46.52*** |
| | (2.988) | (3.240) | (3.679) | (5.820) | (3.737) | (5.023) |
| $R^2$ | 0.055 | 0.042 | 0.019 | 0.035 | 0.067 | 0.073 |
| Observations | 213 | 213 | 213 | 213 | 213 | 213 |

Note: This table reports results of OLS regressions ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. For each of the 4 regressions, we remove products with "extreme" values of CIR (Panel A); ratio $Kurt/Freq$ (Panel B), kurtosis (Panel C), frequency of price changes (Panel D). "Extreme values" are defined as products below the 2.5th percentile or above the 97.5th percentile of the distribution of each statistic. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table I: Regression Results: Kurtosis Measurement - Heterogeneity

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Producer Prices - Constrained model* | | | | | | |
| Kurt/Freq | 0.0837** | 0.115*** | 0.348*** | 0.557*** | 0.190*** | 0.234*** |
| | (0.0345) | (0.0384) | (0.112) | (0.175) | (0.0662) | (0.0862) |
| Constant | -20.49*** | -34.79*** | -20.30*** | -34.47*** | -32.33*** | -49.60*** |
| | (1.807) | (1.917) | (5.699) | (8.772) | (3.278) | (4.293) |
| $R^2$ | 0.045 | 0.080 | 0.093 | 0.103 | 0.090 | 0.078 |
| *PANEL B: Producer Prices - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -2.408* | -3.066** | -11.16** | -17.71** | -6.048** | -7.328* |
| | (1.280) | (1.327) | (4.341) | (6.821) | (2.822) | (3.803) |
| $Kurt/\bar{K}$ | 4.458** | 4.376** | 6.163*** | 7.230** | -0.641 | -2.262 |
| | (2.027) | (1.746) | (2.263) | (3.135) | (2.236) | (3.571) |
| Constant | -19.71*** | -32.22*** | -3.540 | -5.158 | -19.21*** | -32.08*** |
| | (2.272) | (1.985) | (3.317) | (4.669) | (2.556) | (3.995) |
| $R^2$ | 0.146 | 0.185 | 0.220 | 0.231 | 0.192 | 0.162 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |
| *PANEL C: Consumer Prices - Constrained model* | | | | | | |
| Kurt/Freq | -0.0152 | -0.00274 | 0.0675* | 0.136** | 0.0446* | 0.0646** |
| | (0.0148) | (0.0175) | (0.0400) | (0.0666) | (0.0228) | (0.0303) |
| Constant | -12.21*** | -27.40*** | -11.26** | -25.81*** | -32.81*** | -52.32*** |
| | (2.264) | (2.634) | (5.598) | (8.930) | (2.792) | (3.616) |
| $R^2$ | 0.003 | 0.000 | 0.010 | 0.015 | 0.013 | 0.016 |
| *PANEL D: Consumer Prices - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -4.959* | -8.601** | -34.89*** | -58.69*** | -16.44*** | -21.39*** |
| | (2.820) | (3.344) | (8.873) | (13.73) | (3.911) | (4.832) |
| $Kurt/\bar{K}$ | 3.637* | 4.424** | 3.393 | 4.015 | 5.771*** | 7.303*** |
| | (2.084) | (2.225) | (2.672) | (4.153) | (1.827) | (2.337) |
| Constant | -11.85*** | -23.40*** | 24.53*** | 37.49*** | -19.31*** | -34.12*** |
| | (3.538) | (4.079) | (8.622) | (13.35) | (4.801) | (6.128) |
| $R^2$ | 0.061 | 0.126 | 0.476 | 0.528 | 0.342 | 0.335 |
| Observations | 223 | 223 | 223 | 223 | 223 | 223 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. The measure of kurtosis takes into account for possible product heterogeneity following the methodology presented in Appendix E and using $S = 5$. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table J: Regression Results: Kurtosis Measurement - Producer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Outlier threshold - small price changes - Constrained model* | | | | | | |
| Kurt/Freq | 0.0554* | 0.0806** | 0.271*** | 0.441*** | 0.158*** | 0.199*** |
| | (0.0283) | (0.0323) | (0.0933) | (0.146) | (0.0561) | (0.0728) |
| Constant | -19.78*** | -33.99*** | -18.89*** | -32.51*** | -31.95*** | -49.28*** |
| | (1.801) | (1.878) | (5.404) | (8.261) | (3.075) | (4.048) |
| $R^2$ | 0.031 | 0.062 | 0.088 | 0.101 | 0.098 | 0.088 |
| *PANEL B: Outlier threshold - small price changes - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -2.417* | -3.037** | -10.90** | -17.23** | -5.819** | -7.011* |
| | (1.298) | (1.327) | (4.266) | (6.675) | (2.767) | (3.743) |
| $Kurt/\bar{K}$ | 2.490 | 3.403* | 10.32** | 16.51** | 5.349* | 6.565* |
| | (1.760) | (1.954) | (5.048) | (7.618) | (2.852) | (3.670) |
| Constant | -17.73*** | -31.28*** | -7.961 | -14.92 | -25.43*** | -41.23*** |
| | (2.321) | (2.331) | (6.351) | (9.352) | (3.310) | (4.402) |
| $R^2$ | 0.096 | 0.147 | 0.227 | 0.245 | 0.209 | 0.173 |
| *PANEL C: Outlier threshold - large price changes - Constrained model* | | | | | | |
| Kurt/Freq | 0.0273 | 0.0415* | 0.148** | 0.244** | 0.0881* | 0.112* |
| | (0.0193) | (0.0245) | (0.0701) | (0.112) | (0.0453) | (0.0587) |
| Constant | -19.49*** | -33.69*** | -18.46*** | -31.96*** | -31.81*** | -49.18*** |
| | (1.906) | (2.116) | (6.073) | (9.448) | (3.652) | (4.786) |
| $R^2$ | 0.023 | 0.050 | 0.081 | 0.094 | 0.093 | 0.085 |
| *PANEL D: Outlier threshold - large price changes - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -2.521* | -3.181** | -11.34*** | -17.94*** | -6.053** | -7.298* |
| | (1.306) | (1.345) | (4.308) | (6.752) | (2.806) | (3.794) |
| $Kurt/\bar{K}$ | 1.062 | 1.653 | 6.948 | 11.50* | 4.095 | 5.210 |
| | (1.267) | (1.513) | (4.257) | (6.687) | (2.812) | (3.647) |
| Constant | -16.20*** | -29.38*** | -4.141 | -9.199 | -23.94*** | -39.59*** |
| | (1.623) | (1.675) | (4.776) | (7.203) | (2.774) | (3.682) |
| $R^2$ | 0.089 | 0.137 | 0.223 | 0.243 | 0.210 | 0.176 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) for PPI products relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. In Panels A and B, we have modified the thresholds defining very small price changes for the calculation of kurtosis: we have removed all price changes below 0.5% in absolute values (instead 0.1% in our baseline). In Panels C and D, we have modified thresholds defining very large price changes for the calculation of kurtosis (25% for instead of 15% in the baseline). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table K: Regression Results: Kurtosis Measurement - Consumer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Outlier threshold - small price changes - Constrained model* | | | | | | |
| Kurt/Freq | -0.0144 | 0.00129 | 0.0811* | 0.161** | 0.0542** | 0.0781** |
| | (0.0166) | (0.0199) | (0.0423) | (0.0673) | (0.0240) | (0.0312) |
| Constant | -11.86*** | -27.59*** | -13.77** | -30.79*** | -34.59*** | -54.89*** |
| | (2.758) | (3.226) | (6.820) | (10.80) | (3.369) | (4.337) |
| $R^2$ | 0.003 | 0.000 | 0.016 | 0.025 | 0.022 | 0.027 |
| *PANEL B: Outlier threshold - small price changes - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -4.956* | -8.610** | -35.32*** | -59.42*** | -16.46*** | -21.42*** |
| | (2.845) | (3.372) | (8.879) | (13.73) | (3.953) | (4.886) |
| $Kurt/\bar{K}$ | 4.087* | 5.031* | 1.675 | 0.994 | 5.693*** | 7.245*** |
| | (2.381) | (2.557) | (2.554) | (4.235) | (1.950) | (2.490) |
| Constant | -12.22*** | -23.90*** | 26.86*** | 41.50*** | -19.16*** | -34.00*** |
| | (3.881) | (4.449) | (8.872) | (13.78) | (5.045) | (6.433) |
| $R^2$ | 0.065 | 0.132 | 0.482 | 0.534 | 0.345 | 0.337 |
| *PANEL C: Outlier threshold - large price changes - Constrained model* | | | | | | |
| Kurt/Freq | -0.00911 | 0.00346 | 0.0639* | 0.126** | 0.0441** | 0.0632*** |
| | (0.0128) | (0.0154) | (0.0329) | (0.0525) | (0.0183) | (0.0238) |
| Constant | -12.17*** | -27.96*** | -14.00** | -31.01*** | -34.83*** | -55.16*** |
| | (2.744) | (3.206) | (6.789) | (10.77) | (3.340) | (4.299) |
| $R^2$ | 0.002 | 0.000 | 0.017 | 0.025 | 0.024 | 0.029 |
| *PANEL D: Outlier threshold - large price changes - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -4.922* | -8.546** | -34.81*** | -58.57*** | -16.39*** | -21.34*** |
| | (2.783) | (3.301) | (8.831) | (13.68) | (3.867) | (4.780) |
| $Kurt/\bar{K}$ | 4.246* | 5.404* | 5.016* | 6.692* | 6.289*** | 7.988*** |
| | (2.540) | (2.854) | (2.713) | (3.727) | (2.198) | (2.696) |
| Constant | -12.50*** | -24.44*** | 22.83*** | 34.69*** | -19.86*** | -34.85*** |
| | (3.682) | (4.268) | (8.103) | (12.43) | (4.708) | (5.972) |
| $R^2$ | 0.069 | 0.137 | 0.479 | 0.530 | 0.351 | 0.343 |
| Observations | 223 | 223 | 223 | 223 | 223 | 223 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) for CPI products relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. In Panels A and B, we have modified the thresholds defining very small price changes for the calculation of kurtosis: we have removed all price changes below 0.5% in absolute values (instead 0.1% in our baseline). In Panels C and D, we have modified thresholds defining very large price changes for the calculation of kurtosis (35% for instead of 25% in the baseline). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table L: Reverse OLS Regression Results

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: PRODUCER PRICES* | | | | | | |
| $CIR_T^{P_j}$ | 0.612*** | 0.845*** | 0.358*** | 0.252*** | 0.681*** | 0.488*** |
| | (0.220) | (0.186) | (0.0672) | (0.0477) | (0.130) | (0.103) |
| Constant | 54.38*** | 69.69*** | 46.64*** | 47.52*** | 61.22*** | 63.92*** |
| | (5.117) | (7.050) | (2.665) | (2.698) | (4.765) | (5.781) |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |
| $R^2$ | 0.041 | 0.082 | 0.117 | 0.135 | 0.131 | 0.118 |
| *PANEL B: CONSUMER PRICES* | | | | | | |
| $CIR_T^{P_j}$ | -0.227 | -0.0248 | 0.192*** | 0.153*** | 0.394** | 0.332*** |
| | (0.272) | (0.208) | (0.0489) | (0.0335) | (0.157) | (0.125) |
| Constant | 87.22*** | 89.53*** | 91.55*** | 92.85*** | 102.0*** | 106.2*** |
| | (5.890) | (7.526) | (5.477) | (5.544) | (7.622) | (8.634) |
| Observations | 223 | 223 | 223 | 223 | 223 | 223 |
| $R^2$ | 0.004 | 0.000 | 0.014 | 0.023 | 0.019 | 0.024 |

Note: this table reports results of OLS regressions where the endogenous variable is the product-specific ratio $\frac{Kurt}{Freq}$ and the RHS variable is the $CIR_T^{P_j}$ (expressed in %). Each observation corresponds to a disaggregate CPI or PPI product. For CPI, the level of disaggregation is 5 digit-level of the ECOICOP classification (ie. '01.1.1.1') whereas for PPI, the product level is the 4-digit level of the NACE rev2 classification of sectors. PPI covers the manufacturing sectors whereas CPI covers about 60% of the whole French CPI (main products excluded are rents, cars, utilities like electricity). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table M: Regression Results: Role of sales - Consumer Prices

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Excluding food, clothing/footwear, furnishings - Constrained model* | | | | | | |
| Kurt/Freq | 0.0467** | 0.0692** | 0.159** | 0.257** | 0.0993*** | 0.129*** |
| | (0.0229) | (0.0290) | (0.0688) | (0.111) | (0.0342) | (0.0437) |
| Constant | -23.04*** | -39.33*** | -28.69** | -48.78** | -38.04*** | -57.39*** |
| | (4.330) | (5.454) | (12.67) | (20.35) | (6.312) | (8.042) |
| $R^2$ | 0.034 | 0.048 | 0.053 | 0.054 | 0.078 | 0.079 |
| *PANEL B: Excluding food, clothing/footwear, furnishings - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -8.726*** | -12.88*** | -41.62*** | -67.93*** | -19.92*** | -25.41*** |
| | (1.218) | (1.514) | (5.832) | (9.581) | (2.792) | (3.633) |
| $Kurt/\bar{K}$ | 5.318** | 6.718** | 7.192** | 9.855* | 6.500*** | 8.122*** |
| | (2.683) | (3.062) | (3.581) | (5.421) | (2.173) | (2.724) |
| Constant | -14.39*** | -25.38*** | 23.61*** | 38.21*** | -13.44*** | -25.64*** |
| | (3.494) | (3.996) | (6.327) | (10.11) | (3.537) | (4.559) |
| $R^2$ | 0.260 | 0.361 | 0.725 | 0.745 | 0.644 | 0.636 |
| Observations | 134 | 134 | 134 | 134 | 134 | 134 |
| *PANEL C: % of sales prices below the median - Constrained model* | | | | | | |
| Kurt/Freq | -0.000929 | 0.0316 | 0.157** | 0.297** | 0.133*** | 0.185*** |
| | (0.0276) | (0.0342) | (0.0783) | (0.124) | (0.0374) | (0.0473) |
| Constant | -12.32** | -30.73*** | -28.98* | -58.63** | -45.07*** | -69.35*** |
| | (5.440) | (6.705) | (14.92) | (23.51) | (7.003) | (8.771) |
| $R^2$ | 0.000 | 0.009 | 0.046 | 0.064 | 0.130 | 0.153 |
| *PANEL D: % of sales prices below the median - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -8.872*** | -13.71*** | -46.39*** | -76.50*** | -23.27*** | -29.96*** |
| | (2.363) | (2.662) | (8.340) | (13.05) | (3.285) | (4.144) |
| $Kurt/\bar{K}$ | 0.410 | 2.409 | 1.933 | 4.958 | 7.194** | 10.26*** |
| | (2.749) | (3.355) | (5.007) | (7.617) | (2.802) | (3.579) |
| Constant | -3.958 | -15.85*** | 33.29*** | 46.49*** | -13.92*** | -28.66*** |
| | (4.625) | (5.405) | (9.066) | (13.62) | (4.492) | (5.665) |
| $R^2$ | 0.166 | 0.273 | 0.645 | 0.693 | 0.676 | 0.690 |
| Observations | 111 | 111 | 111 | 111 | 111 | 111 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) for CPI products relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. In Panels A and B, we have removed goods of three broad sectors where sales concentrate (COICOP01.1 Food, COICOP03 Clothing/Footwear, and COICOP05 Furnishing goods). In Panels C and D, we have removed products for which the share of sales and promotions represent more than 11% of all price changes (this threshold corresponds to the median of this ratio over all CPI products). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table N: Regression Results: Alternative Specifications - Sector Fixed Effects

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Producer prices - Constrained model* | | | | | | |
| Kurt/Freq | 0.0366 | 0.0565* | 0.187** | 0.308*** | 0.119** | 0.153** |
| | (0.0301) | (0.0321) | (0.0746) | (0.113) | (0.0483) | (0.0662) |
| Constant | -14.93*** | -27.83*** | -10.95 | -21.18** | -27.53*** | -44.18*** |
| | (2.701) | (3.153) | (6.680) | (9.927) | (3.258) | (3.918) |
| $R^2$ | 0.371 | 0.440 | 0.521 | 0.549 | 0.527 | 0.476 |
| *PANEL B: Producer prices- Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -1.705 | -1.951 | -5.645 | -8.545 | -2.621 | -2.957 |
| | (1.310) | (1.274) | (3.587) | (5.466) | (2.336) | (3.375) |
| $Kurt/\bar{K}$ | 2.562 | 2.722 | 10.22** | 15.54** | 3.630 | 3.823 |
| | (1.964) | (1.984) | (4.954) | (7.317) | (2.902) | (3.963) |
| Constant | -14.62*** | -26.72*** | -8.912 | -17.16* | -24.30*** | -39.57*** |
| | (2.986) | (3.177) | (6.631) | (9.341) | (2.908) | (3.588) |
| $R^2$ | 0.396 | 0.462 | 0.544 | 0.567 | 0.525 | 0.467 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |
| *PANEL C: Consumer prices - Constrained model* | | | | | | |
| Kurt/Freq | 0.0246 | 0.0422* | 0.0869* | 0.147* | 0.0821*** | 0.110*** |
| | (0.0187) | (0.0224) | (0.0505) | (0.0814) | (0.0259) | (0.0337) |
| Constant | 1.697 | -14.68*** | -0.568 | -18.47*** | -34.83*** | -58.09*** |
| | (2.922) | (2.760) | (3.821) | (5.835) | (2.039) | (3.063) |
| $R^2$ | 0.530 | 0.544 | 0.334 | 0.338 | 0.486 | 0.491 |
| *PANEL D: Consumer prices - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -11.03*** | -14.88*** | -44.40*** | -70.72*** | -19.96*** | -24.87*** |
| | (1.623) | (1.883) | (6.174) | (9.915) | (2.697) | (3.495) |
| $Kurt/\bar{K}$ | 3.499 | 4.357* | -2.829 | -6.232 | 4.020** | 5.231* |
| | (2.458) | (2.456) | (3.174) | (5.412) | (1.988) | (2.688) |
| Constant | 16.46*** | 5.828 | 73.59*** | 101.4*** | -4.886 | -20.75*** |
| | (4.419) | (4.571) | (10.25) | (16.40) | (4.972) | (6.628) |
| $R^2$ | 0.678 | 0.743 | 0.765 | 0.766 | 0.747 | 0.723 |
| Observations | 223 | 223 | 223 | 223 | 223 | 223 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. Regressions include sectoral fixed effects at the 2-digit level for both CPI and PPI products (38 sectors for CPI and 24 sectors for PPI). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table O: Regression Results: 2-year German Bond - High-Frequency IV

| Identification | High-Frequency IV | | High-Frequency IV | |
|---|---|---|---|---|
| Long-run Restriction | Yes | | No | |
| | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Producer Prices - Constrained model* | | | | |
| Kurt/Freq | 0.186*** | 0.244*** | 0.293*** | 0.463*** |
| | (0.0669) | (0.0775) | (0.0959) | (0.154) |
| Constant | -20.34*** | -34.78*** | -25.38*** | -45.14*** |
| | (4.393) | (4.993) | (5.932) | (9.271) |
| $R^2$ | 0.069 | 0.091 | 0.092 | 0.095 |
| *PANEL B: Producer Prices - Unconstrained model* | | | | |
| $Freq/\bar{F}$ | -5.148* | -6.623** | -9.108** | -14.76** |
| | (2.627) | (2.973) | (3.684) | (5.895) |
| $Kurt/\bar{K}$ | 8.553** | 10.98** | 7.716 | 9.263 |
| | (3.931) | (4.451) | (4.982) | (7.542) |
| Constant | -15.64*** | -28.50*** | -11.24* | -19.45** |
| | (5.071) | (5.651) | (6.250) | (8.931) |
| $R^2$ | 0.104 | 0.131 | 0.144 | 0.149 |
| Observations | 118 | 118 | 118 | 118 |
| *PANEL C: Consumer Prices - Constrained model* | | | | |
| Kurt/Freq | -0.0265 | -0.00828 | 0.0422* | 0.133*** |
| | (0.0171) | (0.0158) | (0.0222) | (0.0442) |
| Constant | -3.369 | -16.95*** | -9.440*** | -29.42*** |
| | (2.802) | (2.516) | (3.347) | (6.229) |
| $R^2$ | 0.010 | 0.001 | 0.016 | 0.041 |
| *PANEL D: Consumer Prices - Unconstrained model* | | | | |
| $Freq/\bar{F}$ | -3.898 | -5.798* | -15.37*** | -29.36*** |
| | (2.999) | (3.015) | (2.927) | (4.435) |
| $Kurt/\bar{K}$ | -1.131 | 1.167 | -6.664*** | -10.20** |
| | (1.960) | (1.774) | (2.377) | (4.764) |
| Constant | -0.732 | -13.06*** | 16.40*** | 22.13*** |
| | (3.180) | (3.008) | (4.000) | (7.265) |
| $R^2$ | 0.032 | 0.091 | 0.324 | 0.304 |
| Observations | 223 | 223 | 223 | 223 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. CIR are here calculated using the 2-year German bond rate as a policy rate and the model is identified using a high frequency instrument method. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table P: Regression Results: FAVAR PPI only - Euribor vs German 2-year Bond

| Identification | Euribor | | | | High-Frequency IV | | | |
|---|---|---|---|---|---|---|---|---|
| Long-run Restriction | No | | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Constrained model* | | | | | | | | |
| Kurt/Freq | 0.348*** | 0.527*** | 0.0734** | 0.0858*** | 0.432*** | 0.571*** | 0.240*** | 0.251*** |
| | (0.117) | (0.173) | (0.0300) | (0.0279) | (0.137) | (0.185) | (0.0766) | (0.0752) |
| Constant | -29.50*** | -47.13*** | -21.41*** | -34.12*** | -38.37*** | -56.29*** | -30.89*** | -43.82*** |
| | (7.065) | (10.30) | (1.976) | (1.761) | (8.034) | (10.60) | (4.777) | (4.614) |
| $R^2$ | 0.104 | 0.112 | 0.052 | 0.087 | 0.115 | 0.112 | 0.102 | 0.118 |
| *PANEL B: Unconstrained model* | | | | | | | | |
| $Freq/\bar{F}$ | -12.30*** | -18.31*** | -2.349** | -2.306** | -13.41*** | -17.43*** | -7.233** | -7.120** |
| | (4.472) | (6.561) | (1.132) | (0.962) | (4.803) | (6.153) | (3.016) | (2.873) |
| $Kurt/\bar{K}$ | 12.89** | 19.36** | 2.986* | 3.428** | 12.16* | 14.04 | 10.17** | 10.72** |
| | (6.110) | (8.872) | (1.794) | (1.588) | (6.747) | (8.807) | (4.267) | (4.112) |
| Constant | -14.94** | -25.21** | -18.85*** | -31.51*** | -18.28** | -28.01*** | -23.36*** | -36.48*** |
| | (6.872) | (9.685) | (2.379) | (2.065) | (7.808) | (9.966) | (5.117) | (4.866) |
| $R^2$ | 0.218 | 0.227 | 0.095 | 0.117 | 0.181 | 0.167 | 0.169 | 0.178 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 | 118 | 118 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. CIR are here calculated from a FAVAR model estimated using only PPI product-level series (non-seasonnaly adjusted) using both the Euribor (with no instrument) and the 2-year German bond rate as a policy rate, in this latter model, the model is identified using a high frequency instrument method. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table Q: Regression Results: FAVAR PPI only (including seasonal adjustment) - Euribor vs German 2-year Bond

| Identification | Euribor | | | | High-Frequency IV | | | |
|---|---|---|---|---|---|---|---|---|
| Long-run Restriction | No | | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Constrained model* | | | | | | | | |
| Kurt/Freq | 0.334*** | 0.526*** | -0.00175 | 0.00144 | 0.402*** | 0.595*** | -0.0379** | -0.0356*** |
| | (0.101) | (0.155) | (0.0118) | (0.00911) | (0.122) | (0.176) | (0.0150) | (0.0129) |
| Constant | -24.45*** | -39.20*** | -19.19*** | -30.97*** | -29.46*** | -43.98*** | -20.93*** | -31.77*** |
| | (6.149) | (9.375) | (0.837) | (0.646) | (7.485) | (10.74) | (0.931) | (0.793) |
| $R^2$ | 0.131 | 0.141 | 0.000 | 0.000 | 0.120 | 0.127 | 0.063 | 0.076 |
| *PANEL B: Unconstrained model* | | | | | | | | |
| $Freq/\bar{F}$ | -10.96*** | -17.01*** | -0.119 | -0.0517 | -12.80*** | -18.61*** | 0.621 | 0.597 |
| | (4.125) | (6.339) | (0.564) | (0.417) | (4.757) | (6.788) | (0.626) | (0.530) |
| $Kurt/\bar{K}$ | 14.43*** | 22.74*** | -0.152 | -0.0568 | 15.29** | 22.49** | -1.493* | -1.532** |
| | (5.376) | (8.157) | (0.765) | (0.591) | (6.355) | (9.050) | (0.881) | (0.741) |
| Constant | -13.36** | -21.98** | -18.99*** | -30.80*** | -14.42* | -21.96** | -21.70*** | -32.39*** |
| | (5.859) | (8.704) | (1.055) | (0.816) | (7.432) | (10.47) | (1.058) | (0.887) |
| $R^2$ | 0.252 | 0.264 | 0.001 | 0.000 | 0.210 | 0.216 | 0.042 | 0.055 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 | 118 | 118 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. CIR are here calculated from a FAVAR model estimated using only PPI product-level series (seasonnaly adjusted) using both the Euribor (with no instrument) and the 2-year German bond rate as a policy rate, in this latter model, the model is identified using a high frequency instrument method. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table R: Regression Results: No drift - Sectoral Average Inflation< 5%

| Identification | Cholesky | | Cholesky | | High-Frequency IV | |
|---|---|---|---|---|---|---|
| Long-run Restriction | Yes | | No | | Yes | |
| | 24 months | 36 months | 24 months | 36 months | 24 months | 36 months |
| *PANEL A: Producer Prices - Constrained model* | | | | | | |
| Kurt/Freq | 0.0597* | 0.0917** | 0.309*** | 0.509*** | 0.190*** | 0.242*** |
| | (0.0318) | (0.0350) | (0.103) | (0.161) | (0.0616) | (0.0805) |
| Constant | -19.95*** | -34.68*** | -21.03*** | -36.50*** | -34.05*** | -52.25*** |
| | (2.037) | (2.150) | (6.203) | (9.569) | (3.671) | (4.851) |
| $R^2$ | 0.042 | 0.085 | 0.127 | 0.142 | 0.129 | 0.118 |
| *PANEL B: Producer Prices - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -2.615** | -3.243** | -11.65*** | -18.37*** | -6.092** | -7.294* |
| | (1.290) | (1.324) | (4.279) | (6.712) | (2.798) | (3.787) |
| $Kurt/\bar{K}$ | 2.817* | 4.008** | 11.29** | 18.19** | 6.322** | 7.900* |
| | (1.604) | (1.808) | (4.838) | (7.521) | (3.095) | (4.056) |
| Constant | -17.54*** | -31.44*** | -7.149 | -14.05** | -26.00*** | -42.29*** |
| | (1.637) | (1.790) | (4.549) | (7.011) | (2.985) | (4.029) |
| $R^2$ | 0.133 | 0.184 | 0.295 | 0.303 | 0.220 | 0.179 |
| Observations | 116 | 116 | 116 | 116 | 116 | 116 |
| *PANEL C: Consumer Prices - Constrained model* | | | | | | |
| Kurt/Freq | -0.0261 | -0.00991 | 0.0730 | 0.156** | 0.0542** | 0.0805** |
| | (0.0171) | (0.0207) | (0.0443) | (0.0706) | (0.0249) | (0.0322) |
| Constant | -9.926*** | -25.94*** | -13.56* | -32.02*** | -35.30*** | -56.26*** |
| | (2.909) | (3.448) | (7.372) | (11.66) | (3.613) | (4.624) |
| $R^2$ | 0.009 | 0.001 | 0.014 | 0.025 | 0.023 | 0.030 |
| *PANEL D: Consumer Prices - Unconstrained model* | | | | | | |
| $Freq/\bar{F}$ | -4.783 | -8.439** | -34.78*** | -58.65*** | -16.45*** | -21.44*** |
| | (2.896) | (3.398) | (8.877) | (13.67) | (3.852) | (4.740) |
| $Kurt/\bar{K}$ | 3.505 | 5.047** | 4.216 | 6.237 | 7.892*** | 10.43*** |
| | (2.169) | (2.524) | (3.022) | (4.729) | (2.418) | (3.105) |
| Constant | -11.07*** | -23.47*** | 23.76*** | 34.83*** | -21.73*** | -37.79*** |
| | (3.655) | (4.291) | (8.425) | (12.97) | (4.977) | (6.361) |
| $R^2$ | 0.059 | 0.128 | 0.478 | 0.533 | 0.360 | 0.357 |
| Observations | 214 | 214 | 214 | 214 | 214 | 214 |

Note: This table reports results of OLS results of the constrained model ( equation (10)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio $Kurt/freq$ and OLS results of the unconstrained model ( equation (11)) relating product-specific $CIR_T^{P_j}$ (expressed in %) to the ratio of the product-level frequency over its average $Freq/\bar{F}$ and the ratio of the product-level kurtosis over its average $Kurt/\bar{K}$. We remove products for which the average annual inflation is above 5% (in absolute values) over the sample period. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1