The Macroeconomic Effects of Inflation Expectations: The Distribution Matters

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Inflation: Drivers and Dynamics 2025 Conference

ECB, September 29-30, 2025

Research questions

What are the macroeconomic effects of shocks to the short-term inflation expectations distribution?

Does the whole cross-sectional heterogeneity matter for macroeconomic fluctuations?

What are the implications for Central Banks communication policies ?

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- Expectations are volatile and might be subject to exogenous shocks
- Seem to capture how policy makers think about expectations
- Such a shock can have macroeconomic consequence
- Large literature on "expectational shocks"

Inflation Expectation Shocks in Macro: Related Literature

Surprising small attention to macro effects of inflation expectation shocks

- We take a macroeconomic perspective by assessing the macroeconomic effects of an exogenous change of short-term inflation expectations

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  - **de-anchoring' shock** to long-term inflation expectations (e.g., Clark and Davig, 2011; Diegel and Nautz, 2021; Neri, 2021) or to the inflation target of the central bank (e.g., Ireland, 2007; Cogley et al., 2010; Haque, 2019)

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  - Ascari et al. (2023): A shock that increase short term inflation expectations **is stagflationary** ($\uparrow \pi, \downarrow y$). See also Adams and Barrett (2022).

IRFs Ascari et al. (2023)

Inflation Expectation Shocks in Macro: Related Literature

Looking at the whole distribution

- Surprising small attention to macro effects of inflation expectation shocks. $\Rightarrow$ In this paper we try a step forward by looking at the whole distribution.
- Pervasive cross-sectional heterogeneity in survey data (Weber et al., 2022).
  - Sensitivity to salient prices, gender and cognitive biases, low attention to MP...
  - Meeks and Monti (2023): statistical relevance of heterogeneous expectations for inflation dynamics.
  - Reis (2022): qualitative evidence about second and third moments of distribution beliefs help predict inflation $\rightarrow$ there is a lot of information from the whole distribution and especially from the tails: the distribution matters.

Contribution

We augment a parsimonious Monetary Policy BVAR with the distribution of the short-term inflation expectation to investigate the macroeconomic effects of exogenous variations of the short term inflation expectation distribution:

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- The cross-feedback effects between macroeconomic dynamics and expectations. **Who influences who**?

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- The importance of **accounting for the full heterogeneity in beliefs** in empirical analysis.
- The cross-feedback effects between macroeconomic dynamics and expectations. **Who influences who?**
- The macroeconomic consequences of various **shocks that modify both the location and the shape** of the distribution:
  $\Rightarrow$ Mean shocks, Dispersion (Variance, Tail, ...) shocks, Communication shocks

Results

Expectations affect macroeconomic variables ... but not (very little) vice versa

The distribution matters

Models based just on the consensus underestimate the macroeconomic effects of expectation shocks

$\Rightarrow$ Mean and Variance shocks are stagflationary

$\Rightarrow$ Tail (Skewness) shocks too....

$\Rightarrow$ The tails matter, especially the left one.

Communication should focus on the tails

Anchoring the expectation distribution is positive ... as long as the dispersion is limited $\Rightarrow$ **The reduction in dispersion** might be more effective than anchoring the mean of the distribution.

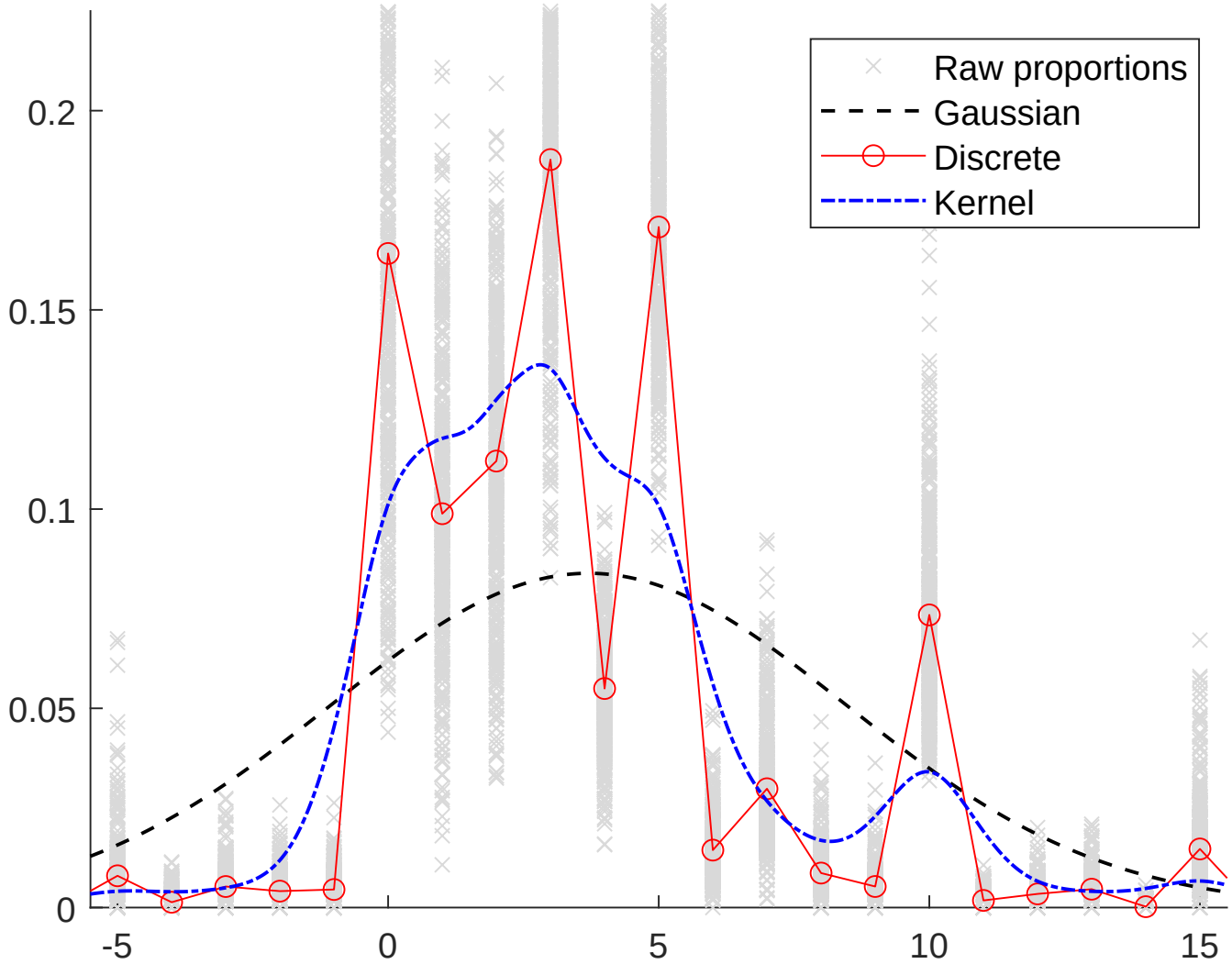
Methodology

Methodology

The Empirical Model

The empirical problem and our approach

- We face the problem of incorporating in the same model a time series of **distributions (functions)** and a time series of **indicators (scalars)**.
- We employ a simple multi-step approach suited for the original feature of the Michigan survey, where inflation expectations are reported as integer percentage values. We consider three options:
  - "raw data" $\rightarrow$ proportion of respondents reporting a specific inflation values
  - Rounding $\rightarrow$ approximating with a continuous Kernel that smooths individual expectations over the cross-sectional domain $\rightarrow$ intervals
  - parsimonious Gaussian distribution, $\sim \mathcal{N}(\mu_t, \sigma_t^2)$



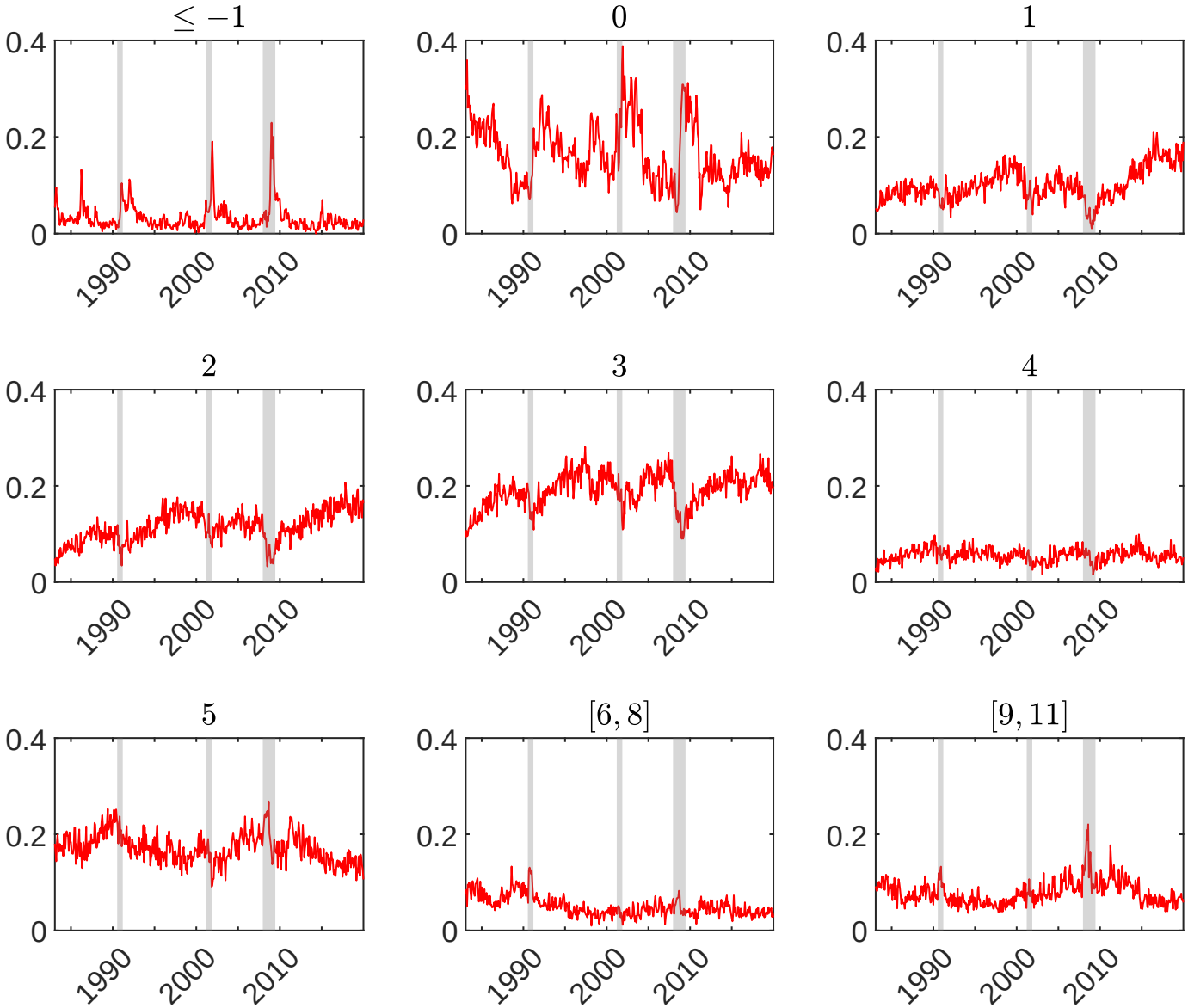
Inflation Expectations Dataset and the distributional approximations

How to put the functional approximation in the BVAR? Two Challenges

- **Aggregating probabilities**
  - High-dimensional object $\rightarrow$ summarize with a handful of parameters
  - Proportions/probabilities are positive and sum to 1, not on a vector space
  - Replace discrete and Kernel distributions with their respective cumulative probabilities/distribution functions over M intervals of interest

$$w^D_{m,t} = \sum_{i \in \{q_{m-1}, q_m\}} p_{i,t}, \quad w^K_{m,t} = \int_{q_{m-1}}^{q_m} f^K_t(x)dx \tag{1}$$

- **Interval selection.** Data-driven
  - they contain an average large amount of probability
  - the last interval $(q_M, 50)$ is wide enough to guarantee that the sum of the first M is lower than 1
  - the largest number of intervals such that each median is distinct



Time series of the 9 aggregated proportions, discrete approximation ($\mathbf{w}_t^D$)

Data and the model

- Expectation Block: $\mathbf{e}_t = [\mathbf{w}_t^a,\ s_t]'$, $a \in \{D, K, G\}$. Inflation expectations proportions ($\mathbf{w}_t^a$) and Consumer Sentiment s_t. [1]
- Macroeconomic block: $\mathbf{x}_t$. Consumer Price Index, Industrial Production, Federal Funds Rate, and three controls: Real Oil Price, and the measures of uncertainty: Financial and Macroeconomic Uncertainty (Jurado et al., 2015). [2]

- We model $\mathbf{y}_t = [\mathbf{e}_t^{'},\ \mathbf{x}_t^{'}]'$ as a BVAR in deviation from the steady state (Villani, 2009). Minnesota shrinkages estimated in a hierarchical fashion (Chan, 2021).
- Monthly data from January 1983 to December 2019, for a total of $T = 422$ observations.

[1] IE microdata and the sentiment from the monthly **Michigan Survey of Consumers**
[2] Fred ID: DCOILWTICO, UMCSENT, CPIAUCSL, INDPRO, FEDFUNDS.

Identification

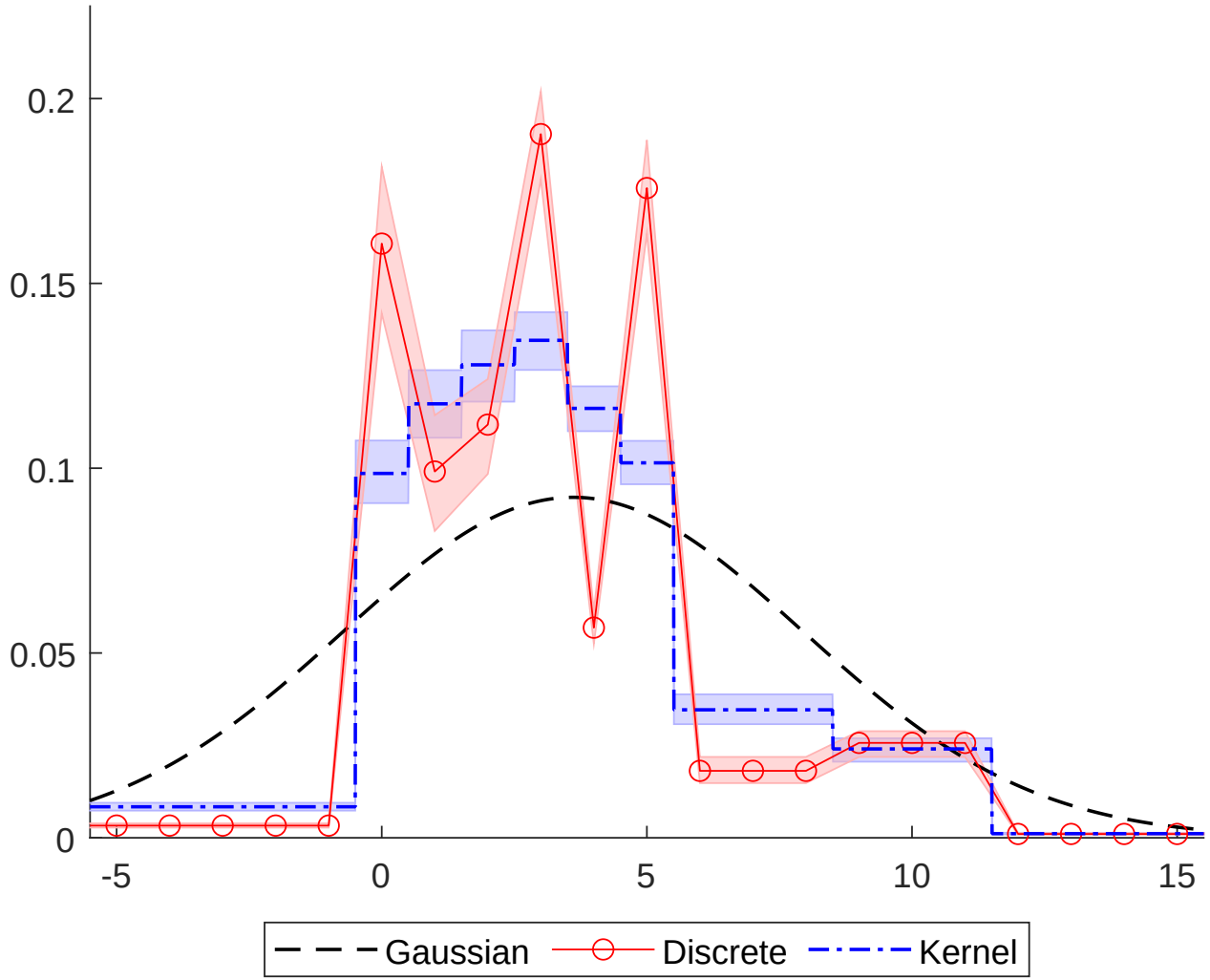
- Households fill the questionnaire on the third week of the month, so at that point, they do not know the data about the industrial production or the inflation rate of the month
- Main identification assumptions: on impact the macro variables does not affect expectations (only exception oil price and uncertainty)
- Block recursive structure: extensive robustness checks $\Rightarrow$ results robust to alternative ordering of the blocks

	OP + UNC	**Inflation expectations**	**Fundamental Macro**
OP + UNC	+	0	0
Expectation block		+	0
Other Macro			+

Results

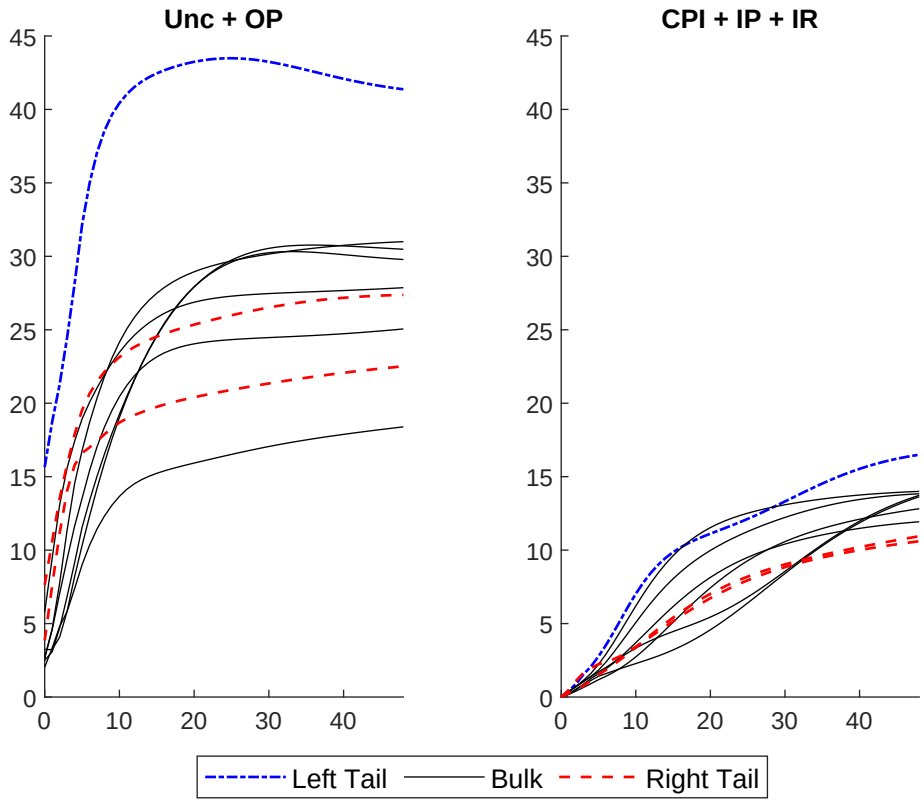
Results

SS-BVAR Steady States Distributions



FEVD by block of variables: Expectations block

Expectations are barely affected by macroeconomic shocks

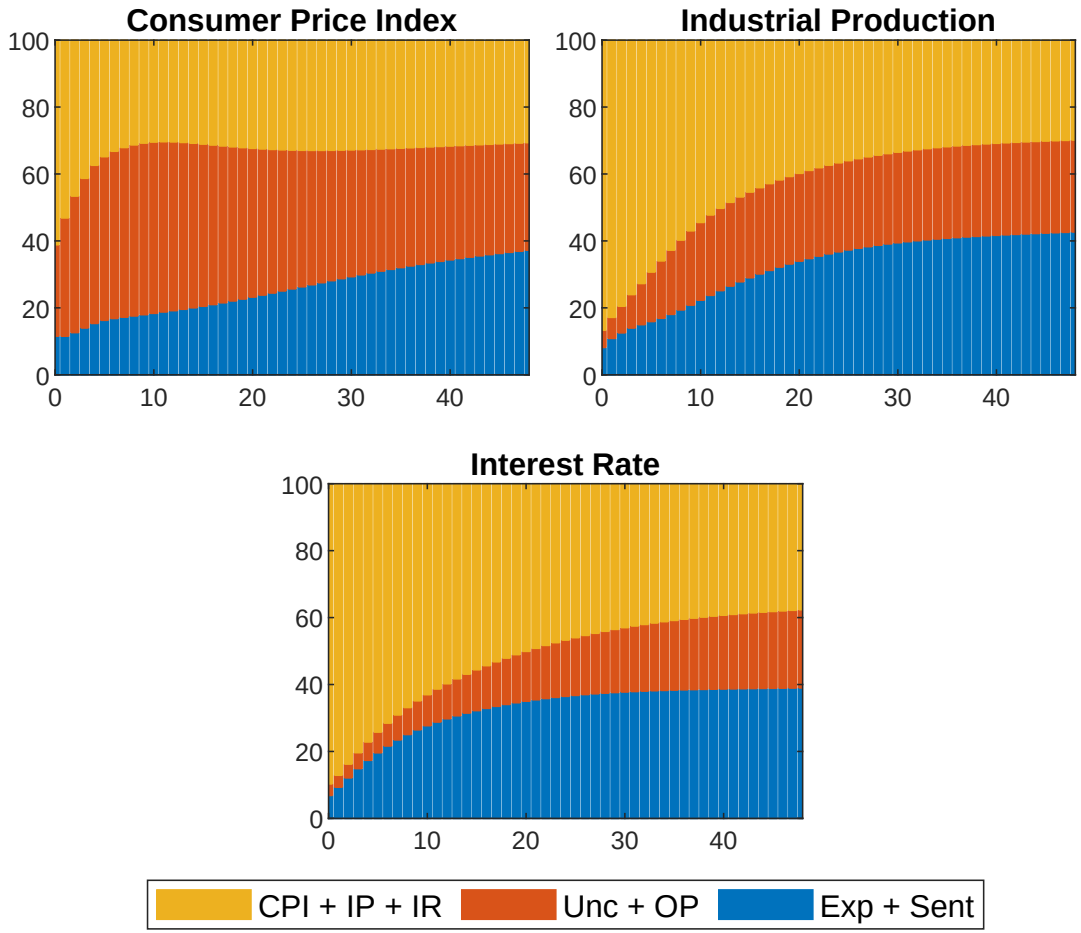


Forecast Error Variance Decompositions

Contribution of the two exogenous variables (first subplot) and the three macroeconomic variables (second subplot) to the FEVD of the nine expectations series at different horizons (x-axis). Different colors indicate the location in the domain of the proportions. Left tail (≤ 0, blue dashed-dotted line), bulk ($\in [1, 5]$, black lines), right tail (≥ 5, red dashed lines).

FEVD by block of variables: Macroeconomic block

Exogenous variations in expectations affect macroeconomic variables

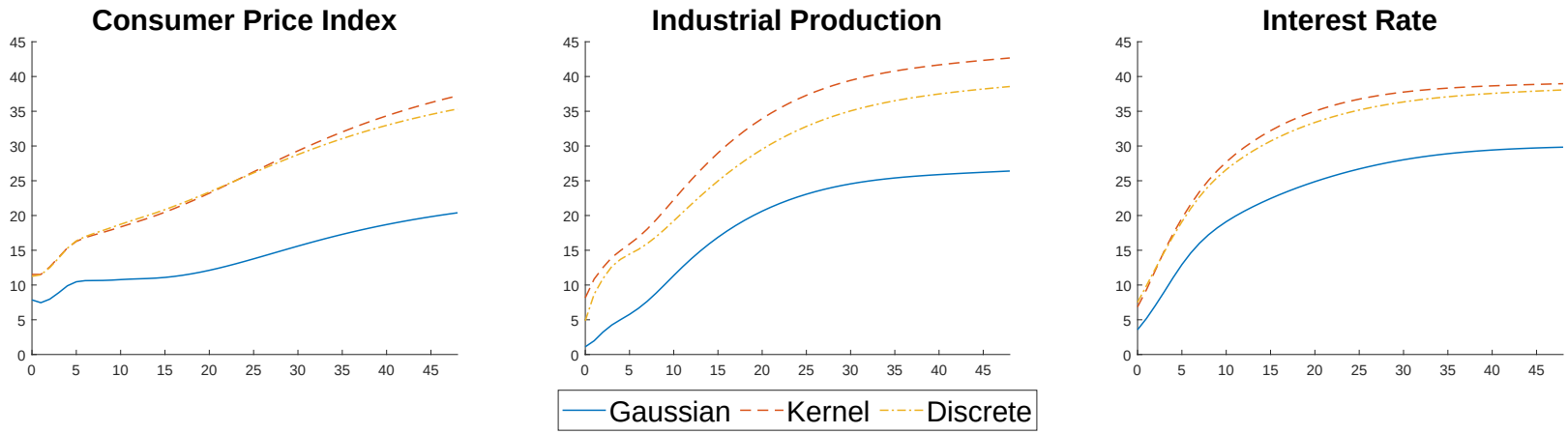


Forecast Error Variance Decompositions

Contributions of the three different identified blocks of indicators to the FEVDs of the macroeconomic variables at different horizons (x-axis).

Alternative/Opposite Identification

FEVD by block of variables: approximations comparison



Comparison among different approximations of the contribution of the expectation block to the FEVD of the macroeconomic variables

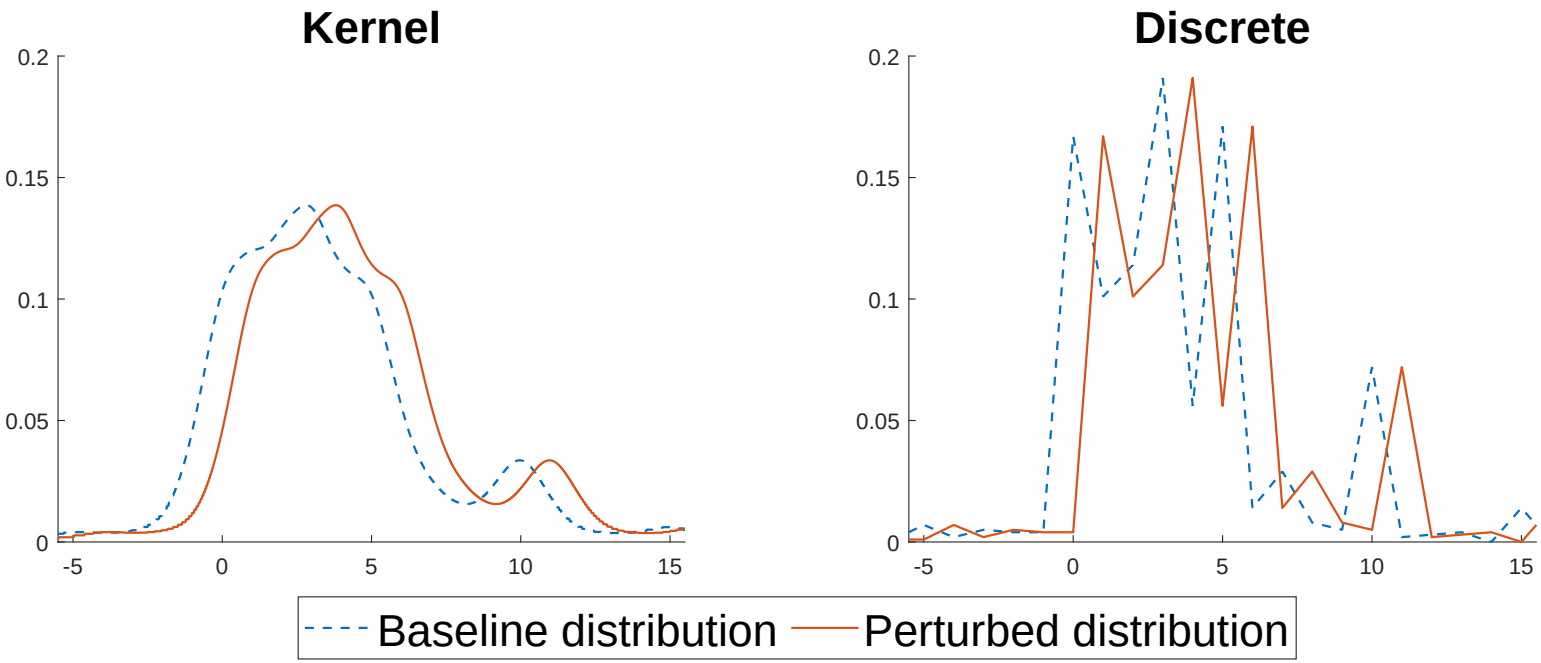
In order to isolate the contribution of the distribution the effect of the sentiment has been subtracted.

Density IRF Analysis

We now look at DENSITY IRFs to shocks to the short-term inflation expectations distribution

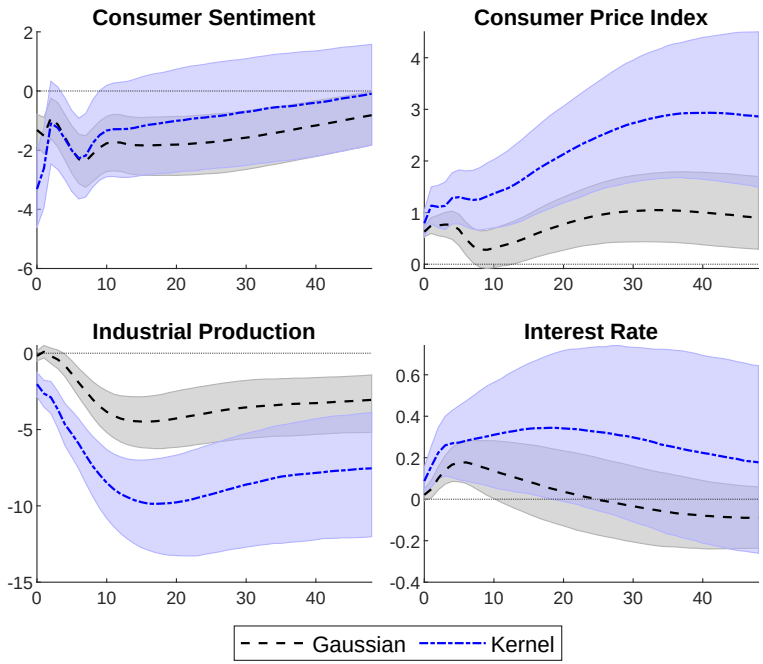
Mean and dispersion shocks

Mean shock

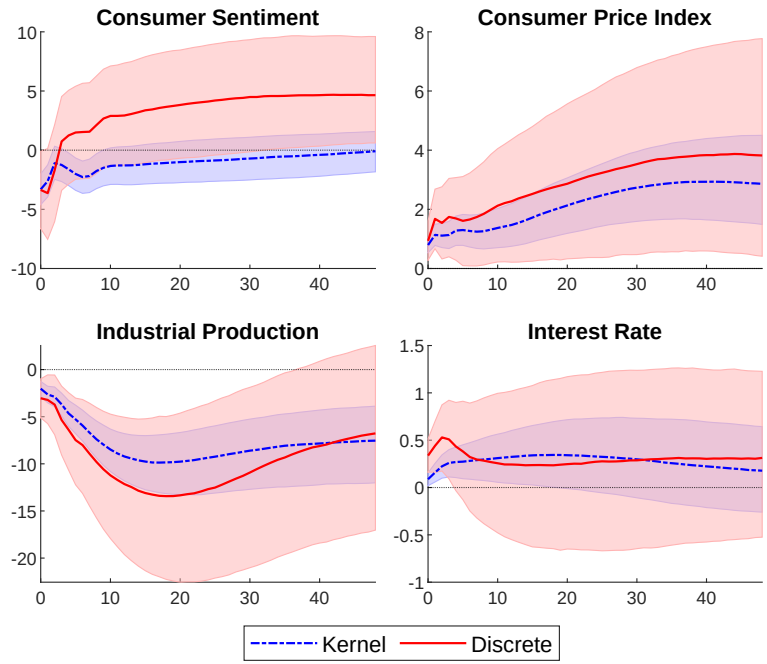


Positive mean shock. Baseline and perturbed distributions on impact for the discrete and Kernel approximations.

Mean shock



(a)



(b)

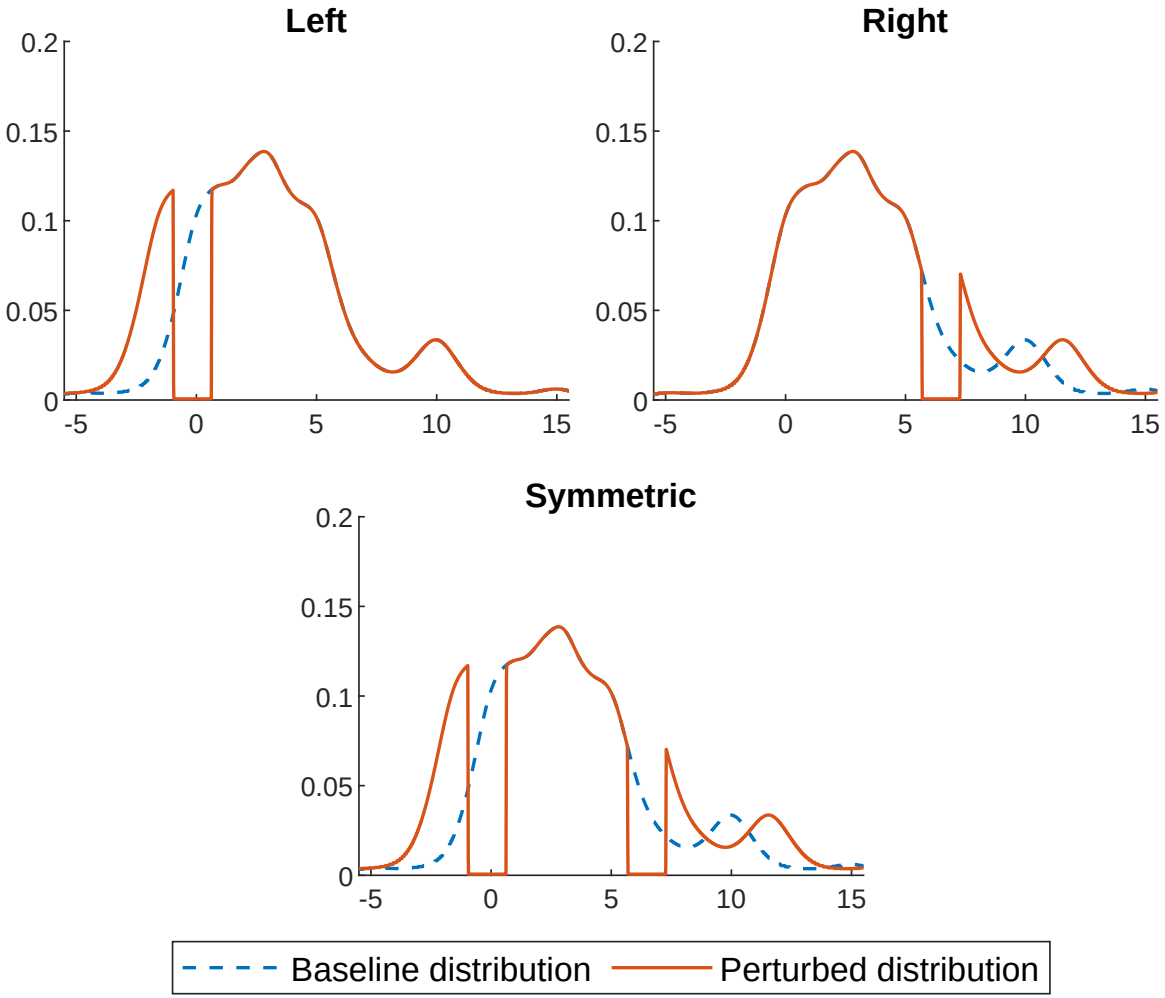
Positive mean shock

Panel (a): comparison between the Gaussian (black dashed lines), and the Kernel (blue dashed-dotted lines) approximations. Panel (b): comparison between the Kernel and the discrete (red continuous lines) approximation. 68% credible bands.

Dispersion shock

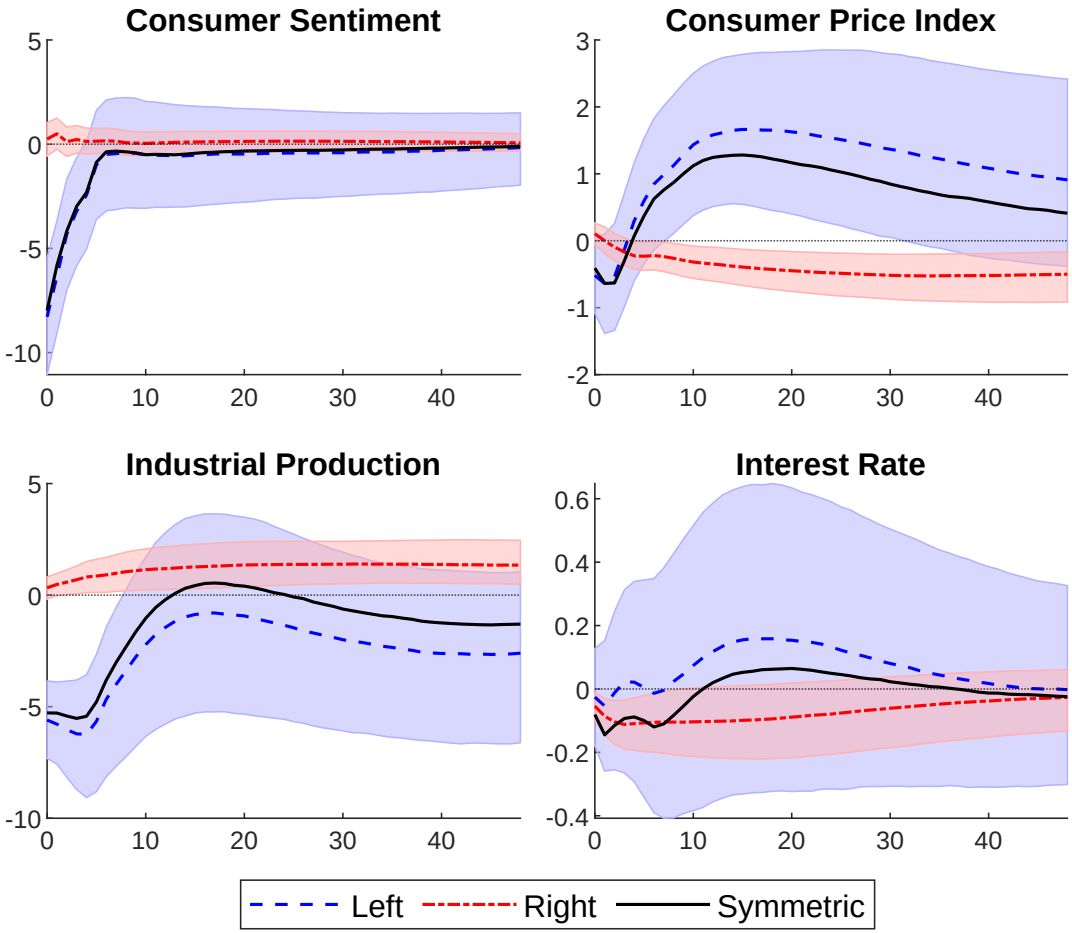
- We now analyze the macroeconomic effects of shocks **increasing the dispersion** of the expectations
- Unlike location, **dispersion is a general concept, and there are countless ways** to induce dispersion perturbation
- Among the infinite combinations, we focus on:
  - A **variance** shock (in a Gaussian sense) Variance Shock
  - A **kurtosis** shock (in a Student's t sense)
  - A **tail** shock Scaling, Kurtosis, and Tail Shock
  - **Asymmetric** shocks
- Location and Dispersion Shock when Macro variables are exogenous to expectations DIRFs: Alternative Identification

Asymmetric tail shock



Asymmetric Tail Shock. Contemporaneous effects of the left, right, and symmetric version of the tail shock.

Asymmetric tail shock



Asymmetric Tail Shock.

Median IRFs of the macroeconomic variables to the left, right, and symmetric version of the tail shock. 68% credible bands.

Policy Implications

Communication

Communication Shock

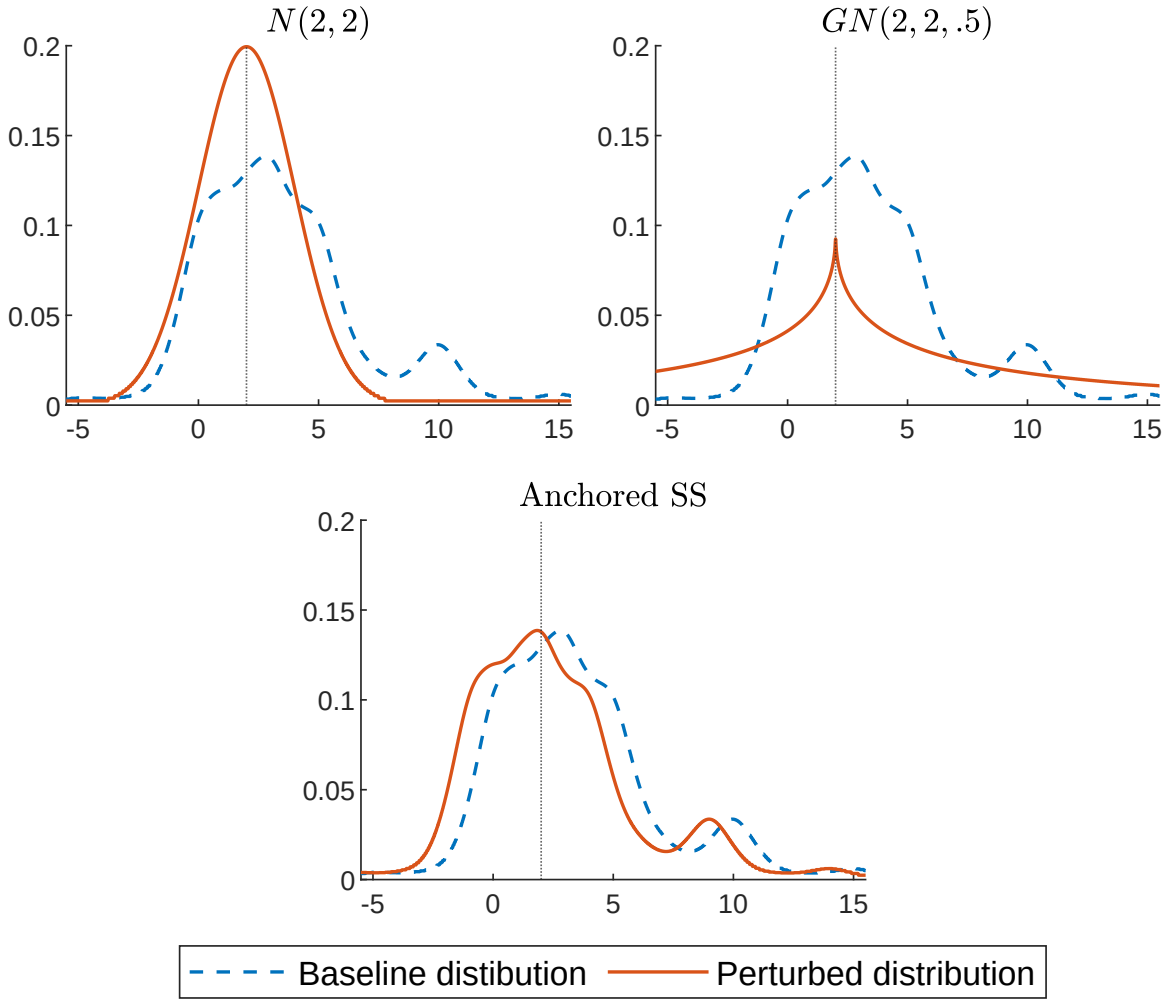
We devise a 'communication' shock $\rightarrow$ the central bank can influence expectations with communication, such that the mean of the expectation distribution shifts to 2%.

Three different scenarios:

- Ideal. Gaussian with signal to noise $= 1$: $\mathcal{N}(2, 2)$. [3]
- Consensus to the target + high dispersion. Generalized Normal with heavy tails: $\mathcal{GN}(2, 2, .5)$
- Consensus to the target preserving empirical shape. SS distribution centered at 2: "Anchored SS".

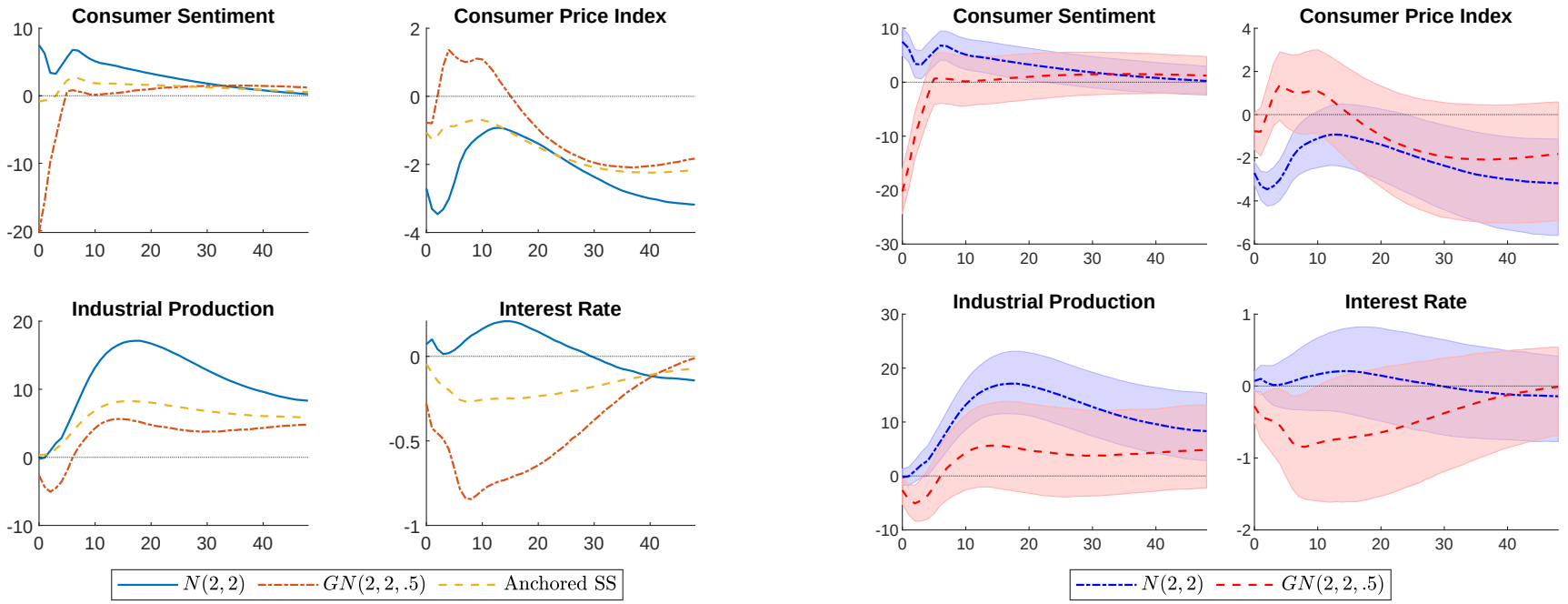
[3] The standard Normal is recovered by setting $\mathcal{GN}(2, 2, 2)$.

Communication Shock



Communication Shock. Contemporaneous effects on the inflation expectations distribution for the three communication shocks considered

Communication Shock



Communication Shock.

Panel (a): Median IRFs of the macroeconomic variables after the three shocks. Panel (b): Median IRFs and 68% credible bands of the macroeconomic variables after two selected shocks: the Normal (dotted blue) and the Generalized Normal (fat tails, dashed red).

Conclusions

- We have proposed a simple yet effective way of jointly modeling a time series of vectors and a time series of distributions to analyze the macroeconomic impact of changes in the distribution of short-term household inflation expectations
- Households inflation expectations affect macro variables (seemingly more than vice versa).
- A positive mean shock is stagflationary.
- Anchoring the expectation distribution is positive, conditionally on a limited variance
  $\Rightarrow$ Communication needs to target also the dispersion.

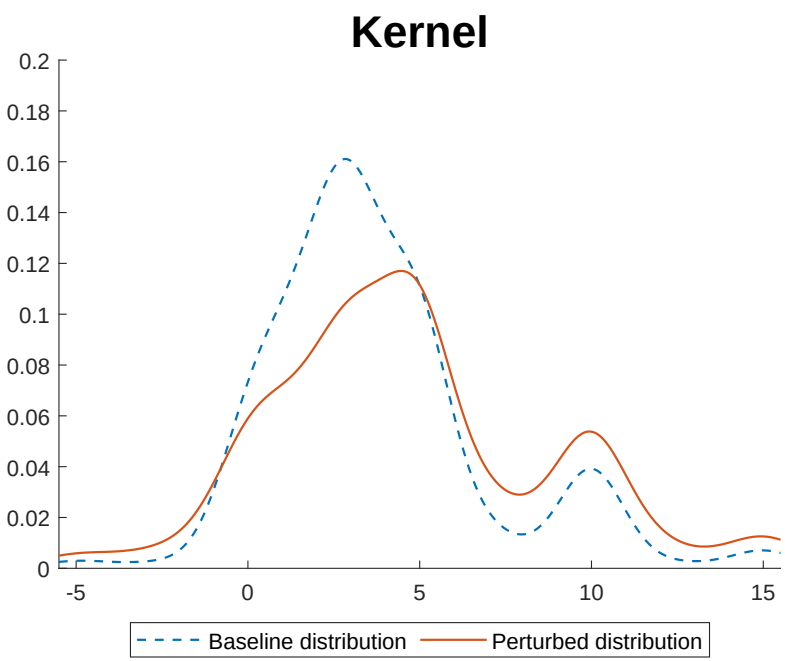
Additional Slides

Event Studies

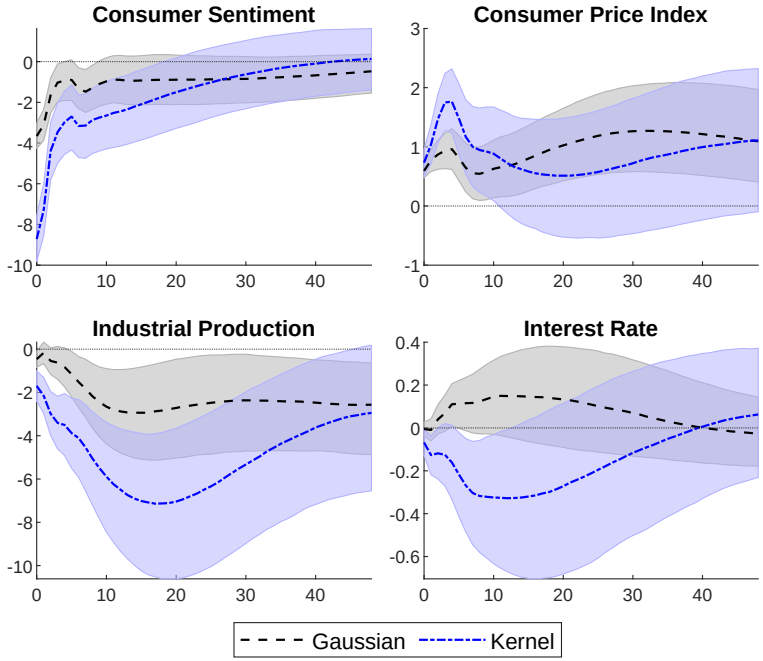
Event studies

GFC and Covid-19

GFC



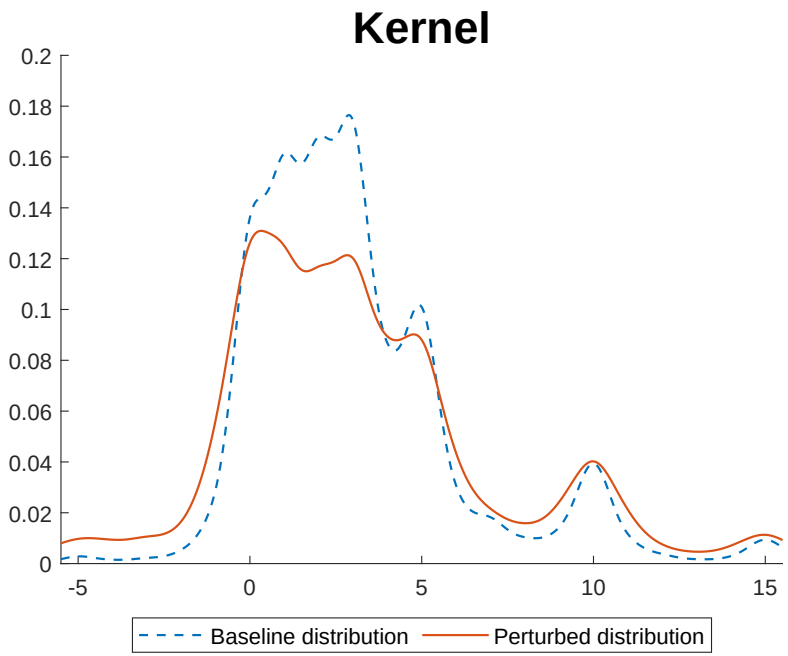
(a) GFC Impact DIRFs



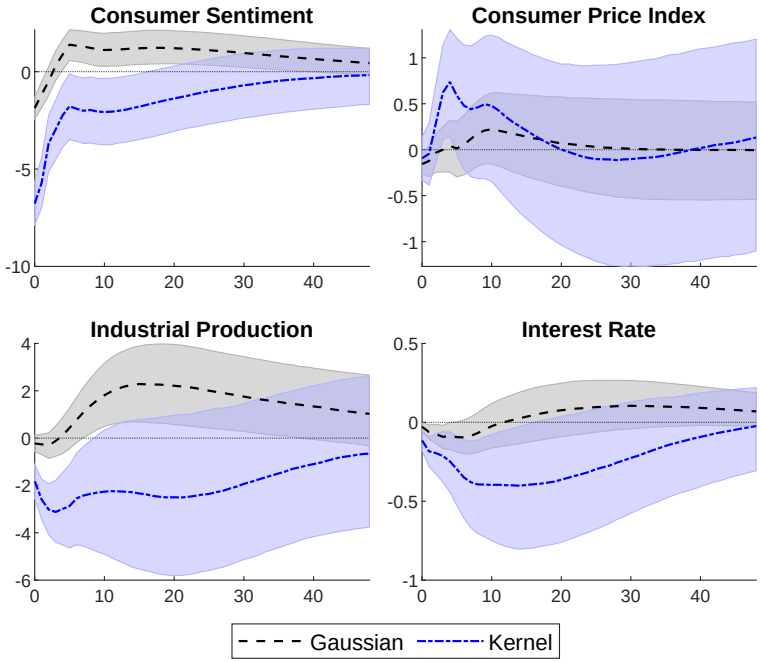
(b) GFC Macro IRFs

Figure: Panel (a): Baseline and perturbed distributions on impact for the Kernel approximation. Panel (b): comparison between the Gaussian (black dashed lines), and the Kernel (blue dashed-dotted lines) approximations.

Covid-19



(a) Covid-19 Impact DIRFs



(b) Covid-19 Macro IRFs

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The empirical problem

- We face the problem of incorporating in the same model a time series of **distributions (functions)** and a time series of **indicators (scalars)**.
- Functional analysis approaches approximate the distribution with **spline-basis functions** (Chang et al., 2024; Meeks and Monti, 2023):

$$y_i = \int_{\Omega} X_i(\omega)\beta(\omega)d\omega = \sum_{k}^{\infty} x_{i,k}\beta_k \approx \sum_{k}^{K} x_{i,k}\beta_k$$

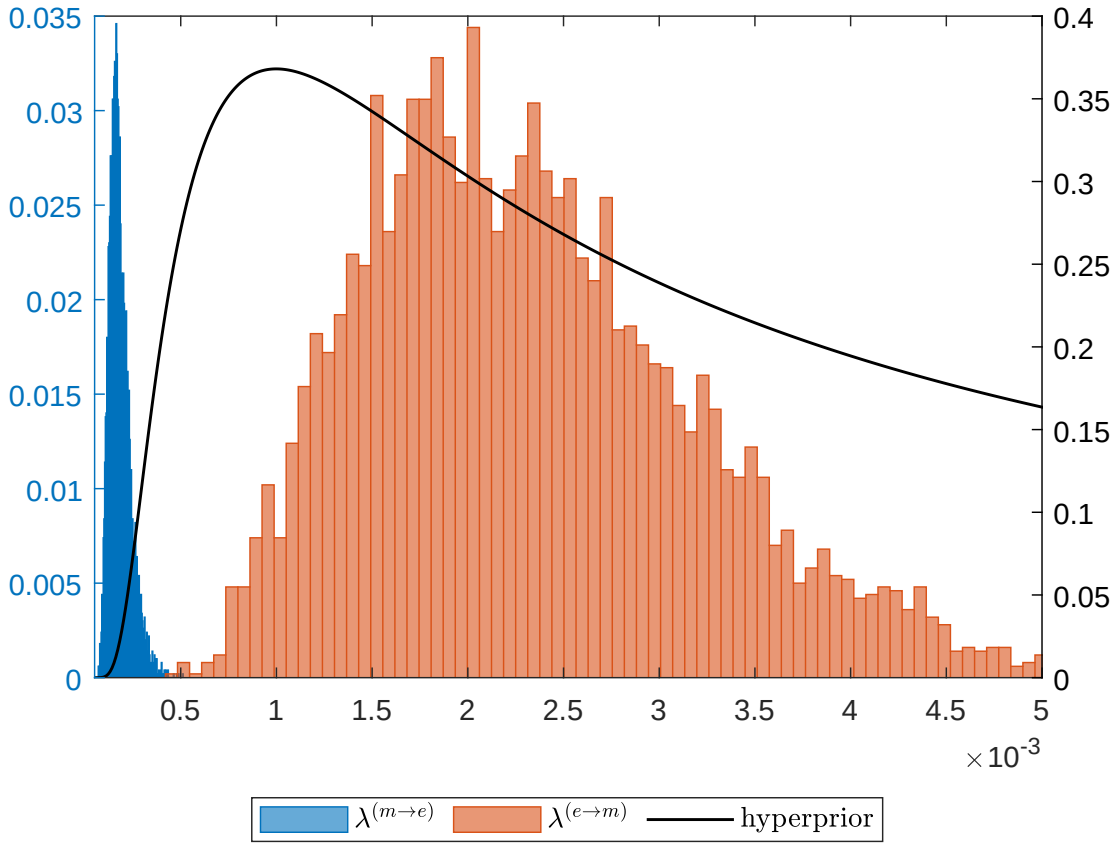
with K finite.

Pros: **Good approximation** performance. **Cons**: **Troublesome interpretation**: hard to endow the basis functions with economic meaning.

Why Proportions?

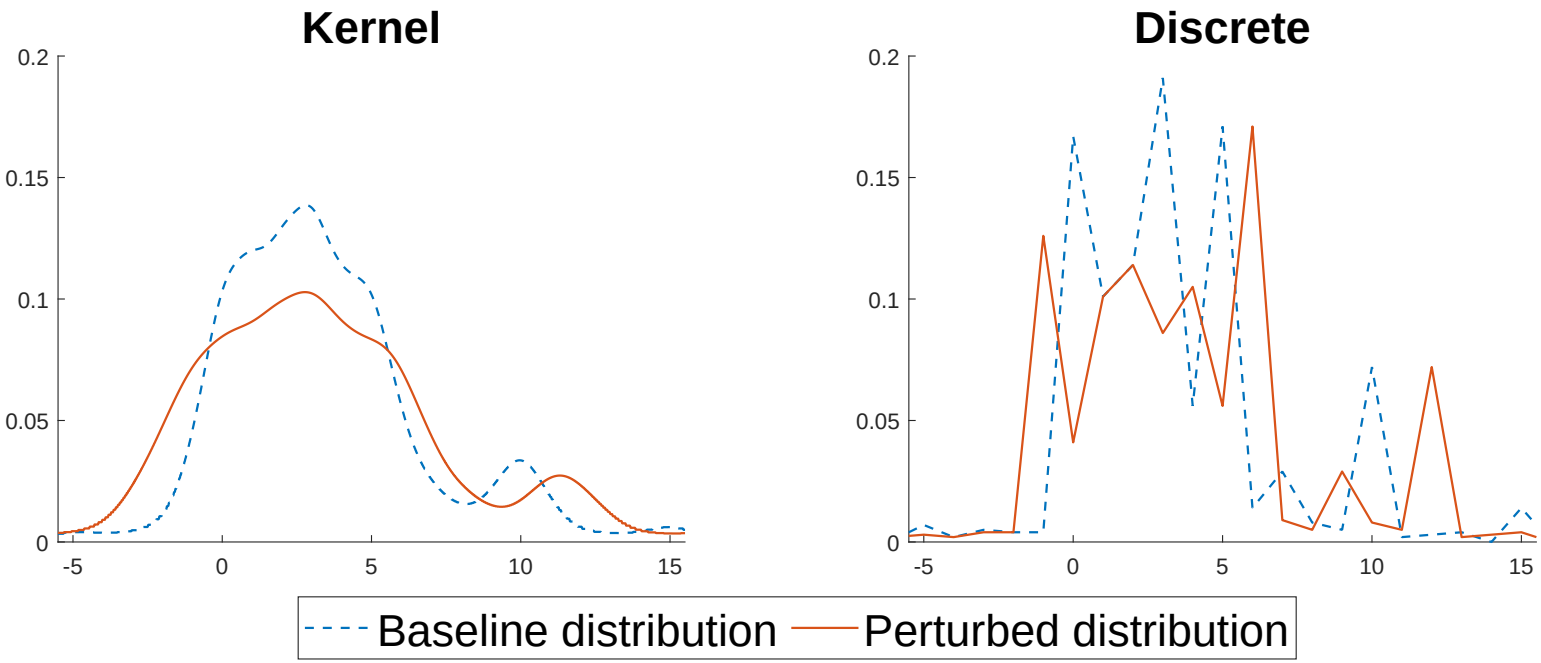
- Interpretability $\Rightarrow$ $w_{j,t}^{D}$ simply equals the proportion of respondents who report a specific inflation value in a given interval $\{q_{j-1}, q_j\}$ in a given period t $\Rightarrow$ Each series is endowed with a **direct economic interpretation** (anchored, fear of deflation, ...)
- The more general functional framework lacks parameters interpretability
- Having the proportions under control in the BVAR, we can perform DIRF by shocking these **sub-classes of agents**, where the perturbation of the distribution can be directly interpreted

Cross-influence between blocks of variables



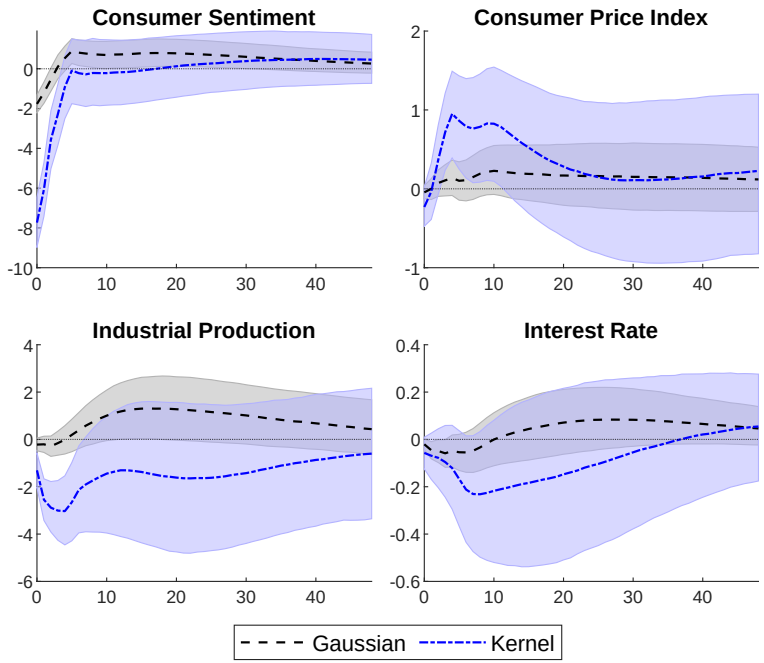
Hyperprior (black line, right axis scale) and posterior distribution of the two shrinkage parameters: $\lambda^{(m \to e)}$ (blue bins, left axis scale), and $\lambda^{(e \to m)}$ (orange bins, left axis scale).

Positive standard deviation shock

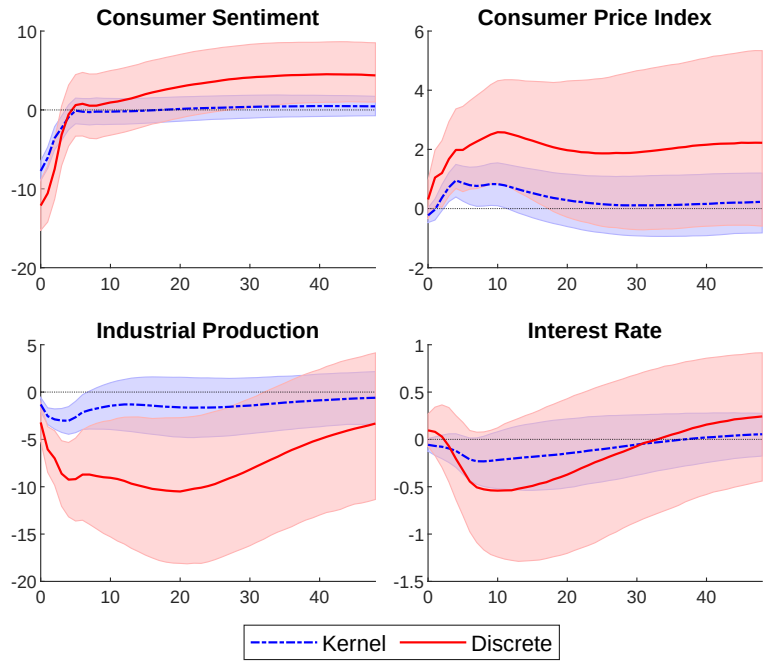


Positive standard deviation shock. Baseline and perturbed distributions on impact for the discrete and Kernel approximations. back

Positive standard deviation shock



(a)



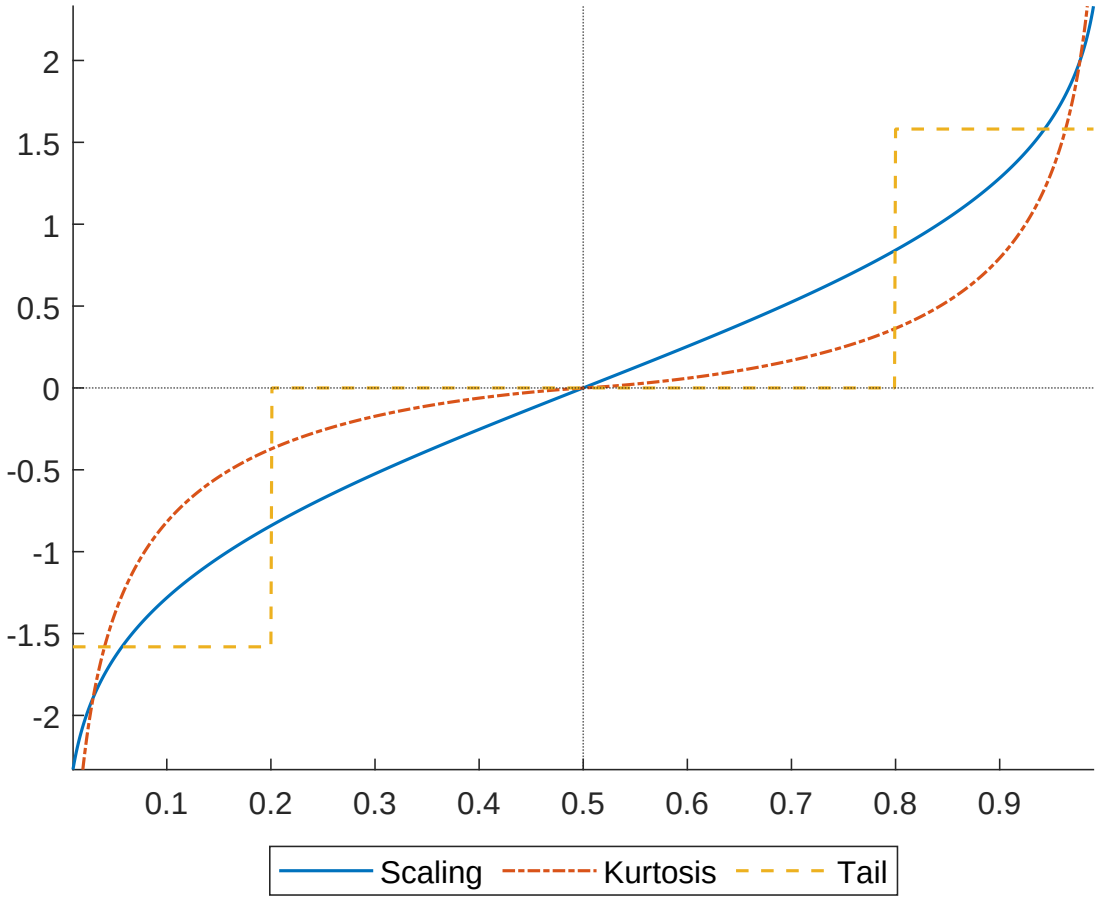
(b)

Positive standard deviation shock.

Panel (a): comparison between the Gaussian (black dashed lines), and the Kernel (blue dashed-dotted lines) approximations. Panel (b): comparison between the Kernel and the discrete (red continuous lines) approximation. 68% credible bands.

back

Dispersion shock

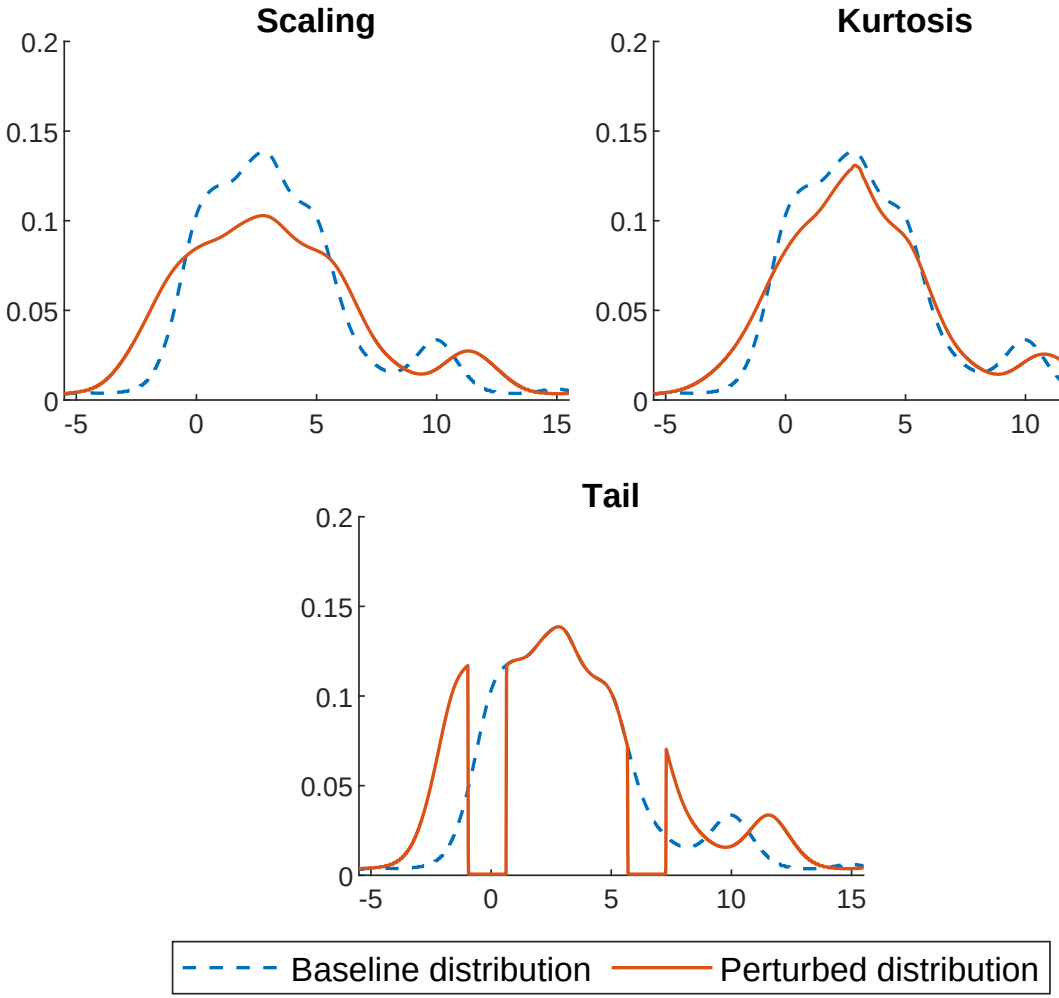


Scaling (Variance), Kurtosis, and Tail shock

Three quantile functions used to induce an increase in dispersion.

back

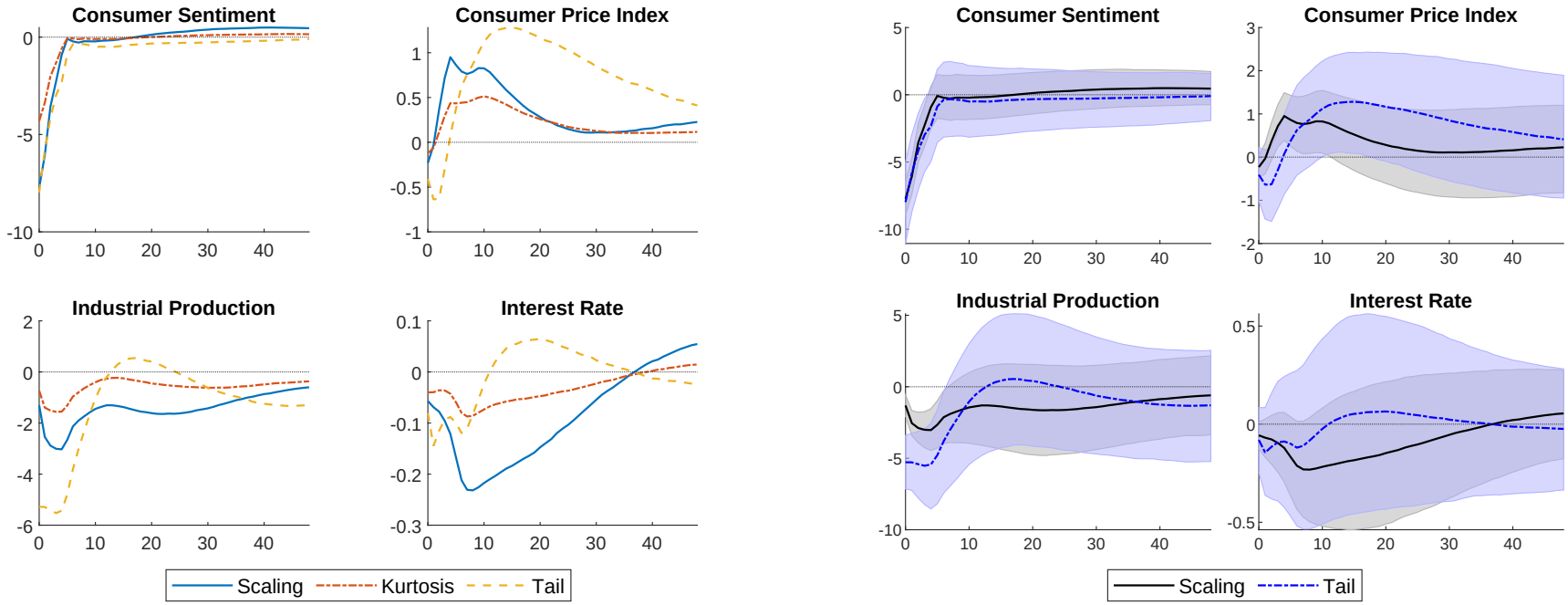
Dispersion shock



Scaling (Variance), Kurtosis, and Tail Shock Contemporaneous effects of the three different perturbations on the inflation expectations distribution.

back

Dispersion shock



(a) (b)

Scaling, Kurtosis, and Tail Shock. back

Panel (a): Median IRFs of the macroeconomic variables after the three shocks. Panel (b): Median IRFs and 68% credible bands of the macroeconomic variables after two selected shocks: the Scaling (blue dashed-dotted lines), and the Tail (black lines).

Who is populating the left tail? Panel regression

	$A=[-50,2]$	$A=[0,2]$	$A=[1,2]$
Hold diploma	-1.085	-1.090	1.403^{**}
	(0.007)	(0.007)	(0.006)
Hold degree	1.066^{***}	1.052^{***}	1.823^{***}
	(0.003)	(0.003)	(0.003)
Income	1.296^{***}	1.237^{***}	0.727^{***}
(quintiles)	(0.001)	(0.001)	(0.001)
If invest	1.751^{***}	2.055^{***}	3.937^{***}
	(0.004)	(0.003)	(0.003)
Sentiment	8.198^{***}	7.893^{***}	3.718^{***}
	(0.001)	(0.001)	(0.001)
R^2	0.0323	0.0437	0.061
Observations	114847	114847	114847
Effects	Time	Time	Time
Controls	Yes	Yes	Yes
VCV Robust	Yes	Yes	Yes

$$\mathrm{P}\left[\mathrm{E}_{i,t}(\pi_{t+12}) \in A\right] = \mu_t + \mathbf{x}_{i,t}^{'}\boldsymbol{\beta} + \epsilon_{i,t}$$

- Pooled OLS regression on inflation expectations
- Dependent variables take value of 1 if individual i has an inflation expectation that falls within the set A, 0 otherwise
- For interpretability, all the coefficients has been multiplied for 100.

Inflation Expectation Shocks in Macro: Related Literature

Surprising small attention to macro effects of inflation expectation shocks

A shock that increase short term inflation expectations **have a negative macroeconomic impact** ($\downarrow y, \uparrow \pi$) (Ascari et al., 2023).

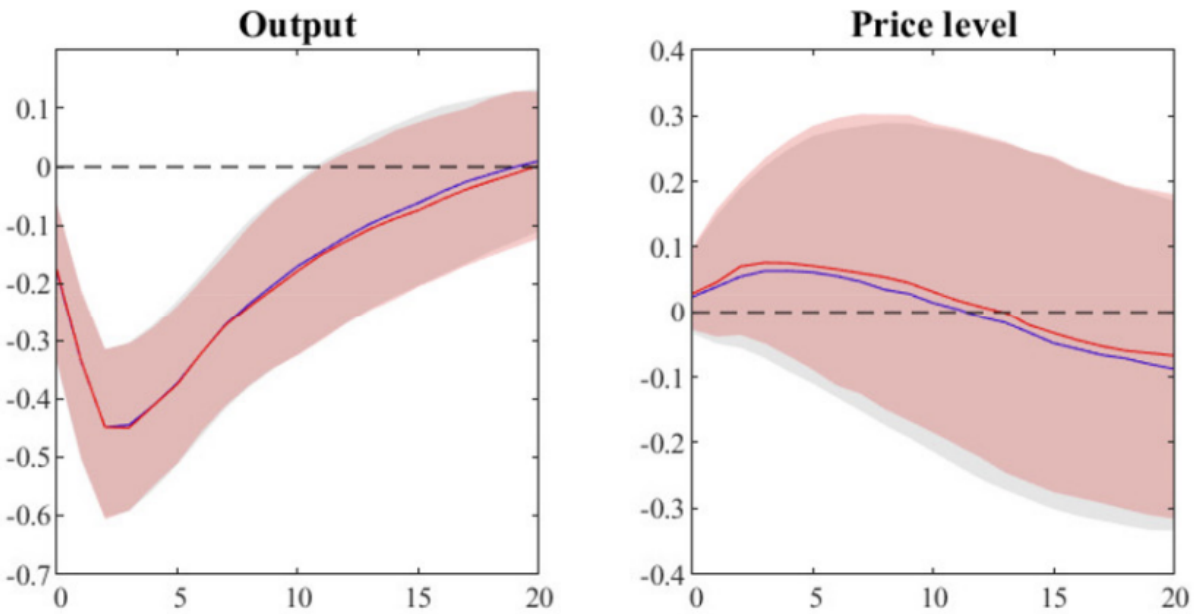
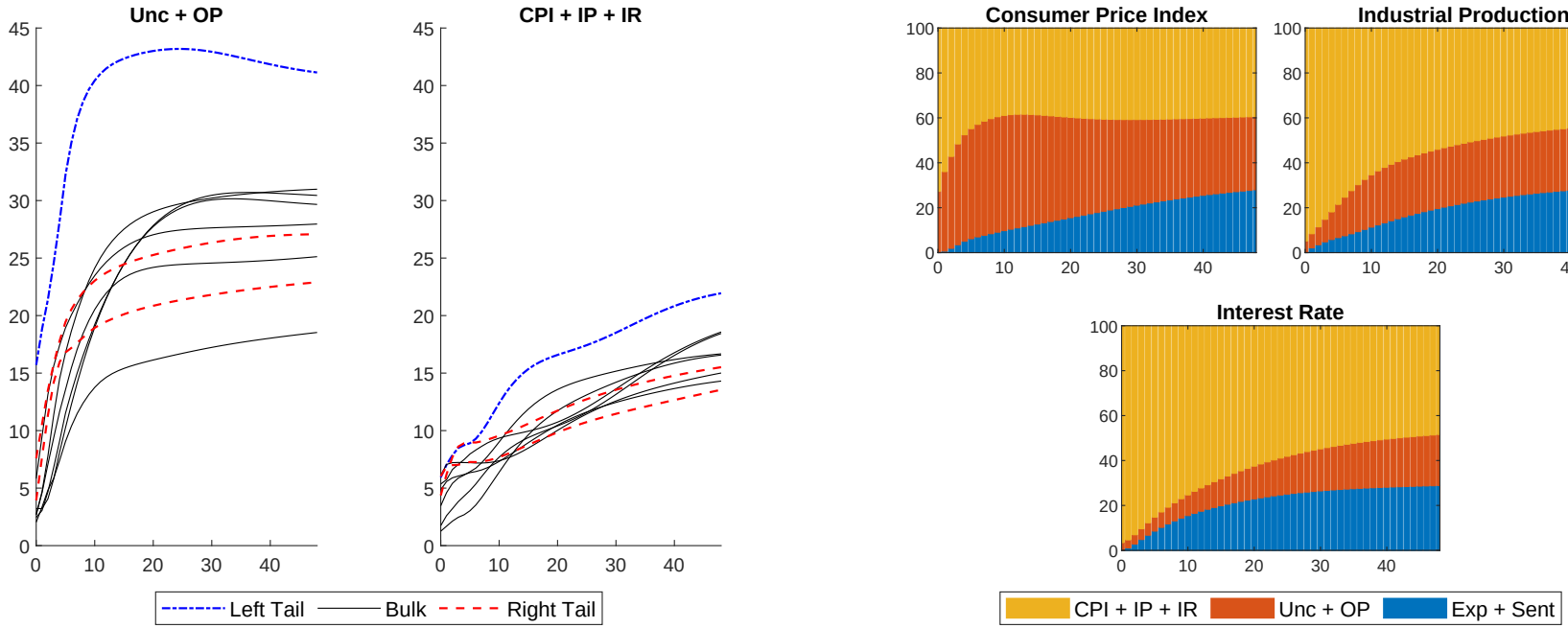


Figure: VAR Irfs to an inflation expectation shock, from Ascari et al. (2023).

back

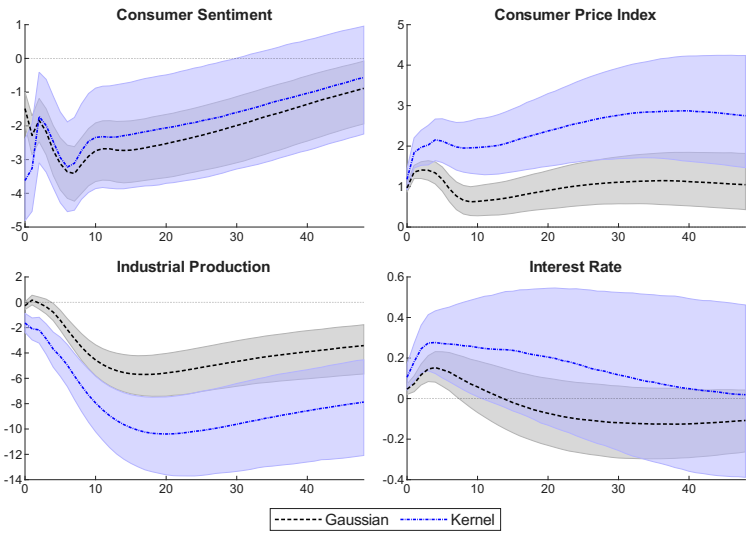
FEDV: Macro vbls exogenous to expectations



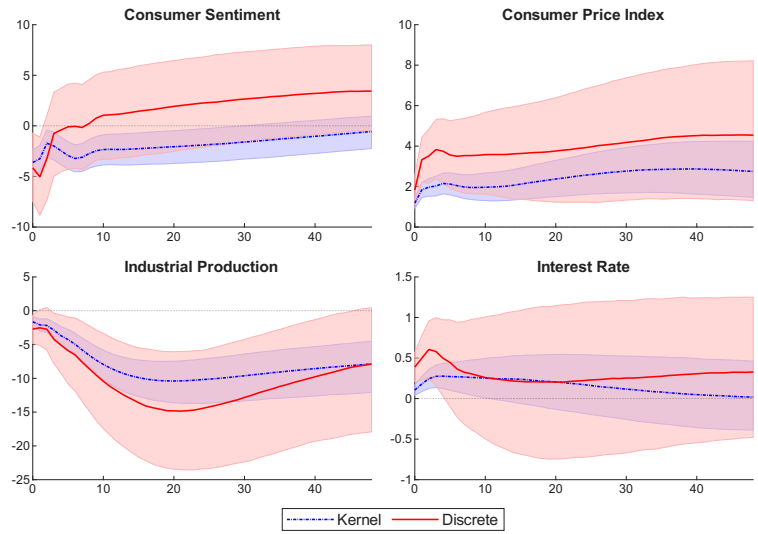
Forecast Error Variance Decompositions.
All the macroeconomic variables exogenous to Expectations, but endogenous to Uncertainty indicators and the oil price.

Contributions of the different identified blocks of indicators to the FEVDs of the expectations (left panel) and of macroeconomic variables (right panel) at different horizons (x-axis). back to FEDV

Location Shock: Macro vbls exogenous to expectations



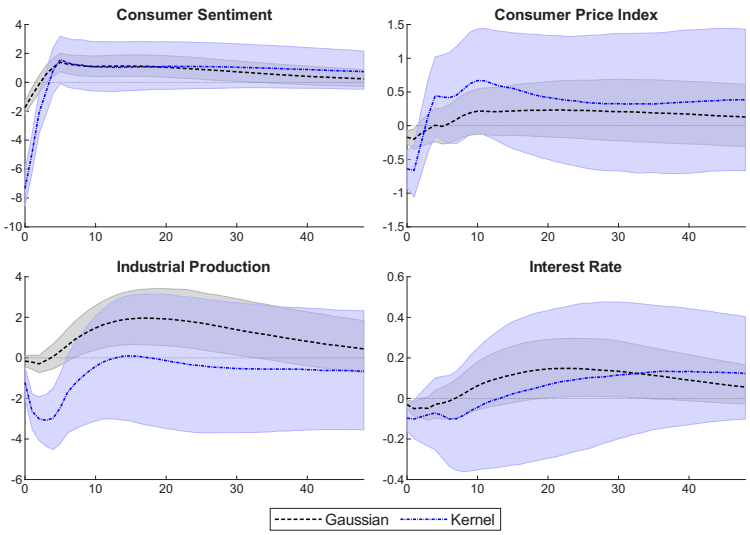
(a)



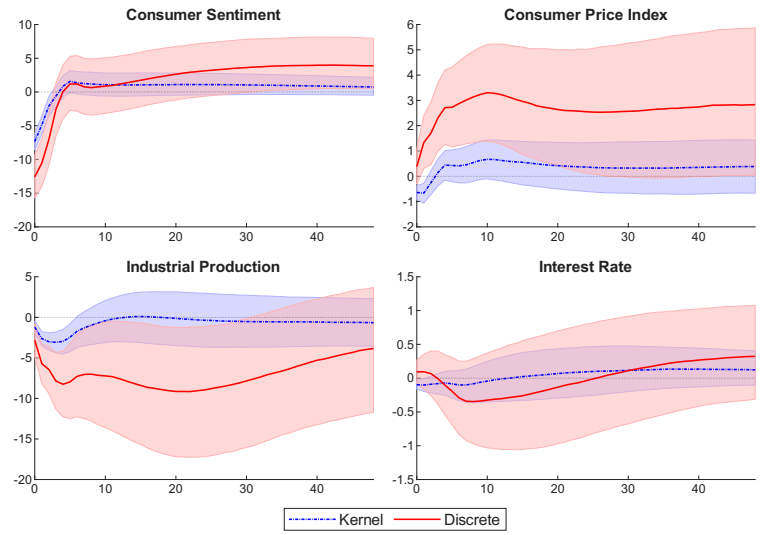
(b)

Positive location shock with no contemporaneous identification between the fundamental macro and expectations blocks. The figure shows the effects of a shock that increases the location of the inflation-expectations distribution of 1% on impact. No zero restrictions are imposed between the macro block and the expectations blocks. back

Variance shock: Macro vbls exogenous to expectations



(a)



(b)

Positive standard deviation shock with no contemporaneous identification between the fundamental macro and expectations blocks. The figure shows the effects of a positive standard deviation shock. No zero restrictions are imposed between the macro block and the expectations blocks. back

References I

Ascari, G., S. Fasani, J. Grazzini, and L. Rossi (2023). Endogenous uncertainty and the macroeconomic impact of shocks to inflation expectations. *Journal of Monetary Economics*.

Chan, J. C. (2021). Minnesota-type adaptive hierarchical priors for large bayesian vars. *International Journal of Forecasting 37*(3), 1212–1226.

Chang, M., X. Chen, and F. Schorfheide (2024). Heterogeneity and aggregate fluctuations. *Journal of Political Economy 132*(12), 000–000.

Jurado, K., S. C. Ludvigson, and S. Ng (2015, March). Measuring uncertainty. *American Economic Review 105*(3), 1177–1216.

Meeks, R. and F. Monti (2023). Heterogeneous beliefs and the phillips curve. *Journal of Monetary Economics*.

Reis, R. (2022). Losing the inflation anchor. *Brookings Papers on Economic Activity 2021*(2), 307–379.

Villani, M. (2009). Steady-state priors for vector autoregressions. *Journal of Applied Econometrics 24*(4), 630–650.

Weber, M., F. D'Acunto, Y. Gorodnichenko, and O. Coibion (2022, August). The subjective inflation expectations of households and firms: Measurement, determinants, and implications. *Journal of Economic Perspectives 36*(3), 157–84.