Extracting Trend Inflation from Disaggregated Data

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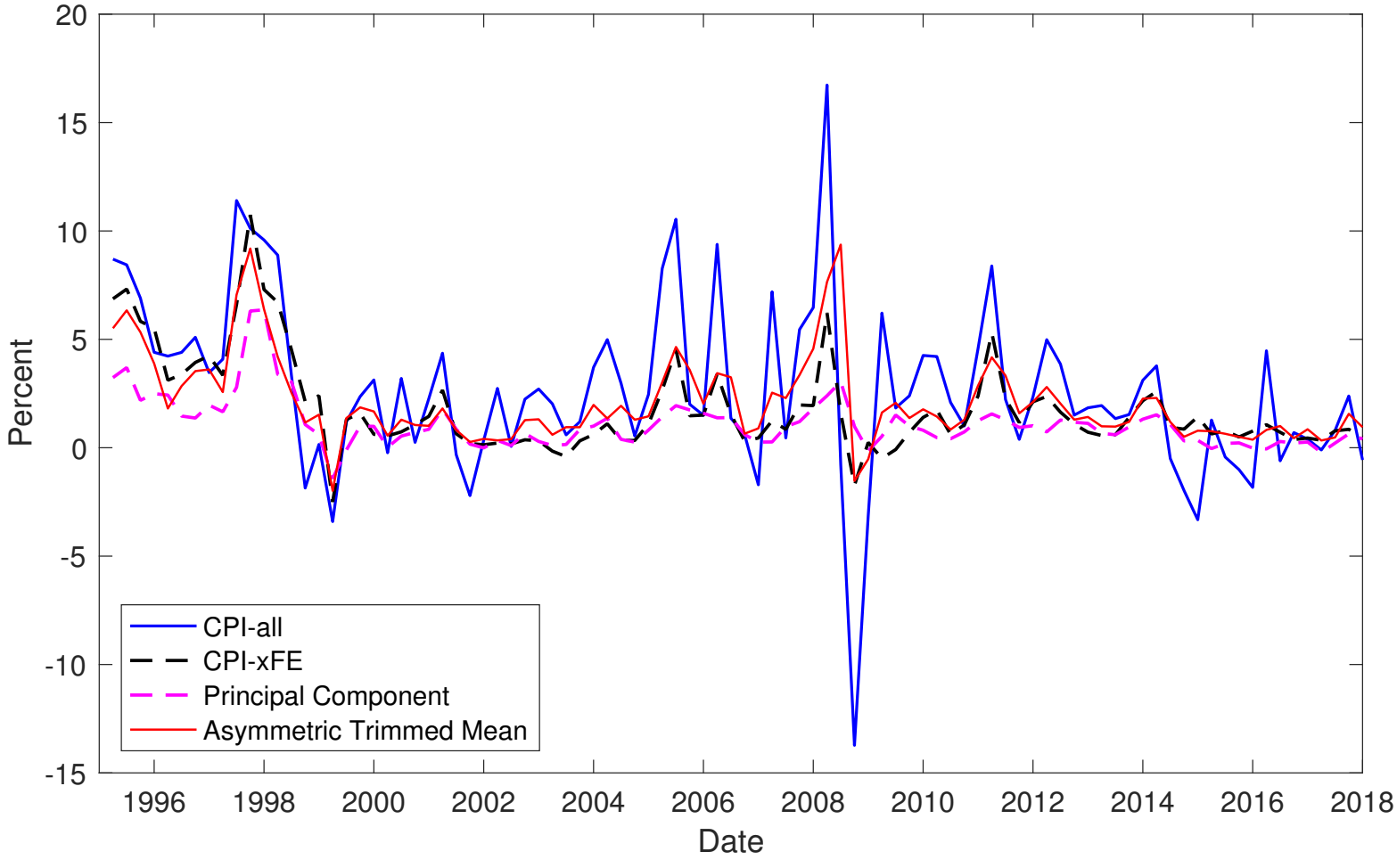
Trend Inflation

- Inflation that is within the control of monetary policy is "trend inflation" which is a *p*ersistent and *g*eneral process
- The challenge towards estimating trend inflation is
  - Extracting common price movements across goods
  - Disentangling persistent from temporary price movements and outliers

Measures of Trend Inflation



How to Estimate Trend Inflation?

Two main approaches:

(1) Exclusion Approach

- Core inflation measures eg. CPI excluding food and energy
- Asymmetric Trimmed Mean

→ Ad hoc and rigid e.g. fixed weights

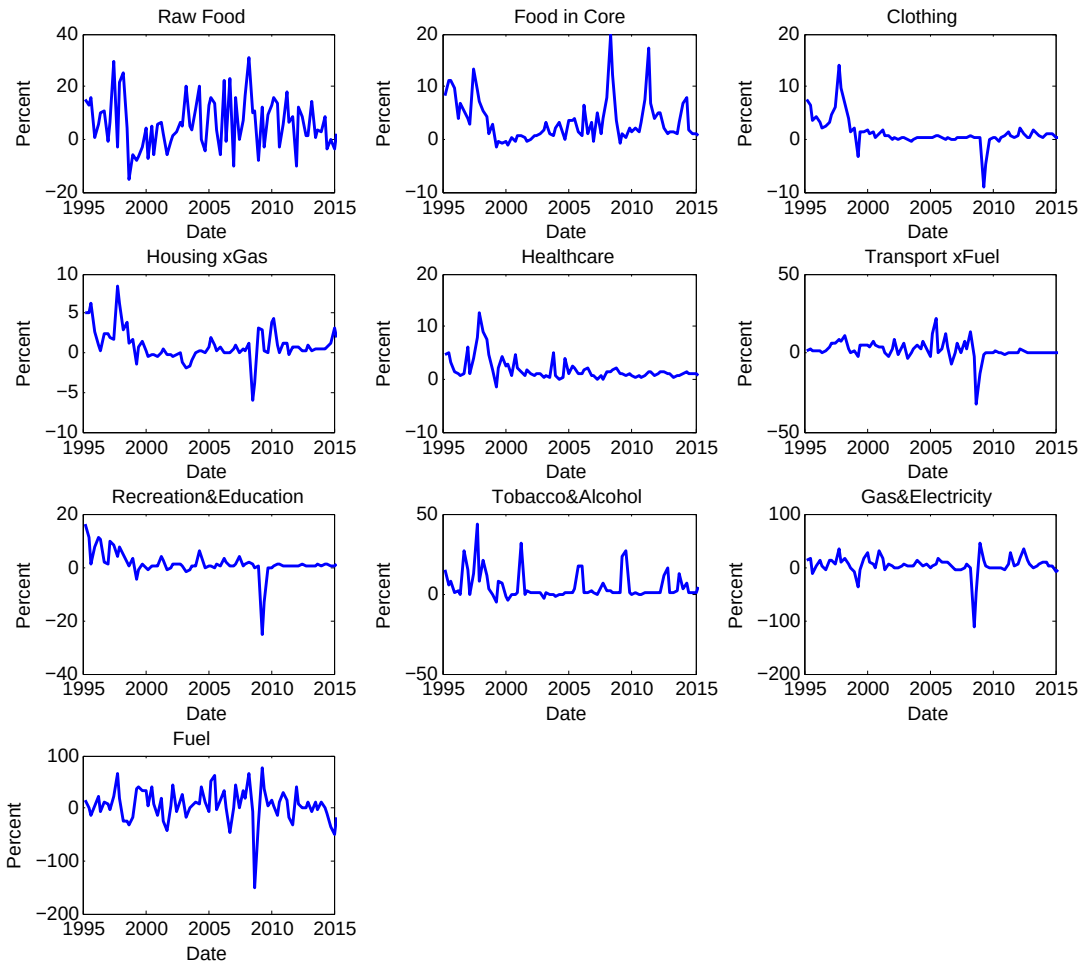
(2) Univariate Smoothing Approaches

- Moving average of past inflation (Atkeson and Ohanian, 2001)
- Unobserved components models (Stock and Watson, 2007)

→ Overlooks information in disaggregated data

This Paper

→ Extracts trend inflation based on the Multivariate Unobserved Components Stochastic Volatility Outlier-Adjusted (MUCSVO) model of Stock and Watson (2015)



Research Questions

- What is the role of permanent versus transitory shocks in driving inflation rate movements in Thailand? Has it changed over time?
- Can information in sectoral inflation series help measure trend inflation?
- Has the influence of each sector changed over time? How do the weights compare to expenditure share in the consumption basket?
- What is the 'best' trend inflation measure? Is it a good forecast of future headline inflation?

Roadmap

- Model specification
- Data and estimation methodology
- Empirical results
- Forecasting exercise
- Conclusion
- Ongoing work

Models: (1) UCSVO

Univariate Unobserved Components with Stochastic Volatility Outlier-Adjusted

$$\pi_t = \tau_t + \epsilon_t$$

$$\tau_t = \tau_{t-1} + \sigma_{\Delta\tau,t} \times \eta_{\tau,t}$$

$$\epsilon_t = \sigma_{\epsilon,t} \times s_t \times \eta_{\epsilon,t}$$

$$\Delta ln(\sigma^2_{\Delta\tau,t}) = \gamma_{\Delta\tau} v_{\Delta\tau,t}$$

$$\Delta ln(\sigma^2_{\epsilon,t}) = \gamma_{\epsilon} v_{\epsilon,t}$$

The UCSV model is an IMA(1,1) model i.e. filtered trend estimates follow exponential smoothing:

$$\tau_t = (1 - \theta_t) \sum_{i=0}^{\infty} \theta_t^i \pi_{t-i}$$

Models: (2) MUCSVO

Multivariate Unobserved Components with Stochastic Volatility Outlier-Adjusted

$$\pi_{i,t} = \alpha_{i,\tau,t}\tau_{c,t} + \alpha_{i,\epsilon,t}\epsilon_{c,t} + \tau_{i,t} + \epsilon_{i,t}$$

$$\tau_{c,t} = \tau_{c,t-1} + \sigma_{\Delta\tau,c,t} \times \eta_{\tau,c,t}$$

$$\epsilon_{c,t} = \sigma_{\epsilon,c,t} \times s_{c,t} \times \eta_{\epsilon,c,t}$$

$$\tau_{i,t} = \tau_{i,t-1} + \sigma_{\Delta\tau,i,t} \times \eta_{\tau,i,t}$$

$$\epsilon_{i,t} = \sigma_{\epsilon,i,t} \times s_{i,t} \times \eta_{\epsilon,i,t}$$

$$\alpha_{i,\tau,t} = \alpha_{i,\tau,t-1} + \lambda_{i,\tau}\zeta_{i,\tau,t}$$

$$\alpha_{i,\epsilon,t} = \alpha_{i,\epsilon,t-1} + \lambda_{i,\epsilon}\zeta_{i,\epsilon,t}$$

$$\Delta ln(\sigma^2_{\Delta\tau,c,t}) = \gamma_{\Delta\tau,c}v_{\Delta\tau,c,t}, \Delta ln(\sigma^2_{\epsilon,c,t}) = \gamma_{\epsilon,c}v_{\epsilon,c,t}$$

$$\Delta ln(\sigma^2_{\Delta\tau,i,t}) = \gamma_{\Delta\tau,i}v_{\Delta\tau,i,t}, \Delta ln(\sigma^2_{\epsilon,i,t}) = \gamma_{\epsilon,i}v_{\epsilon,i,t}$$

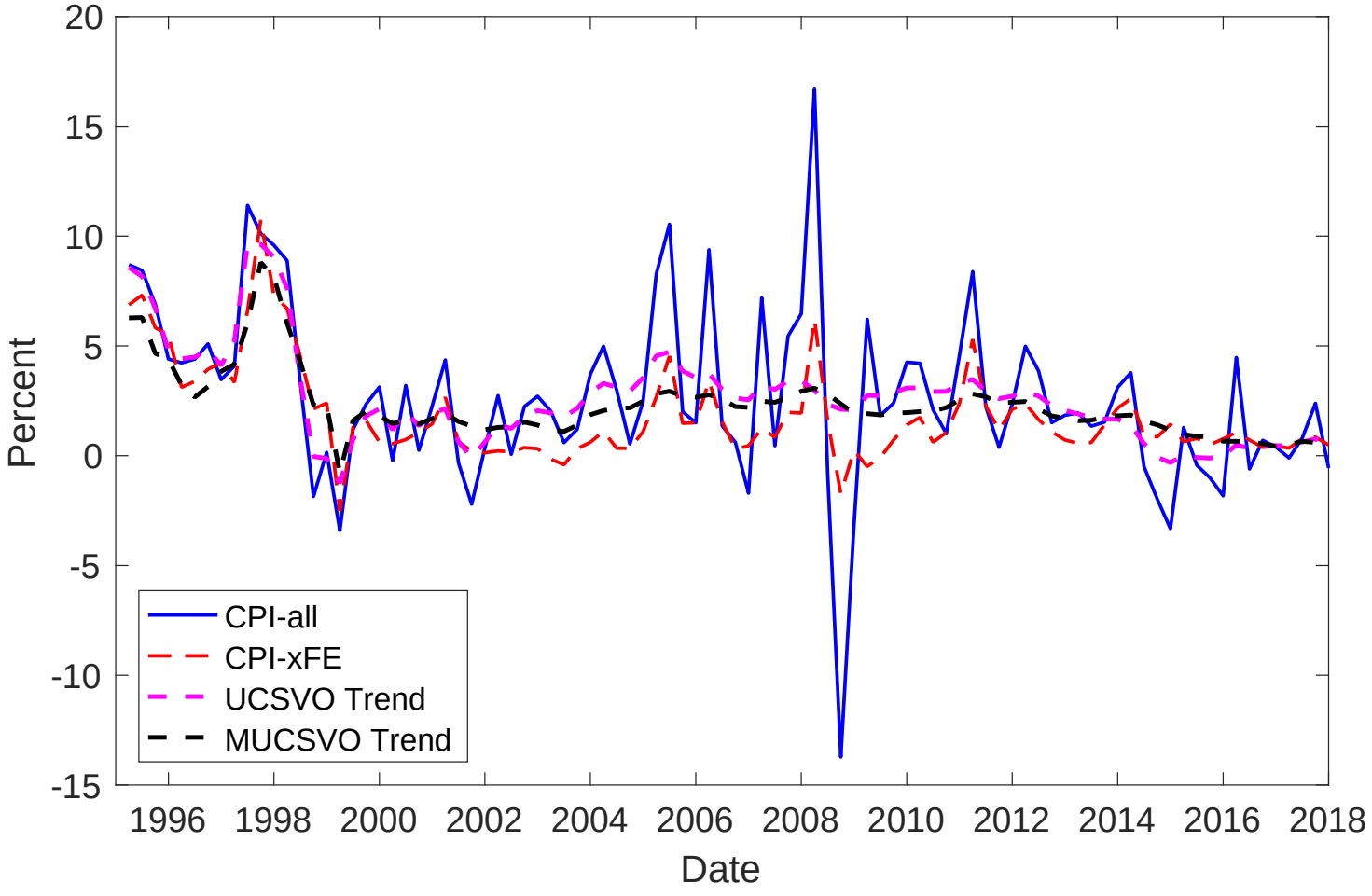
The overall trend is the sum of the common trend and the (share-weighted) individual trends ie. $\tau_t = \sum_{i=1}^{10} w_{it}(\alpha_{i,\tau,t}\tau_{c,t} + \tau_{i,t})$

Data and Estimation

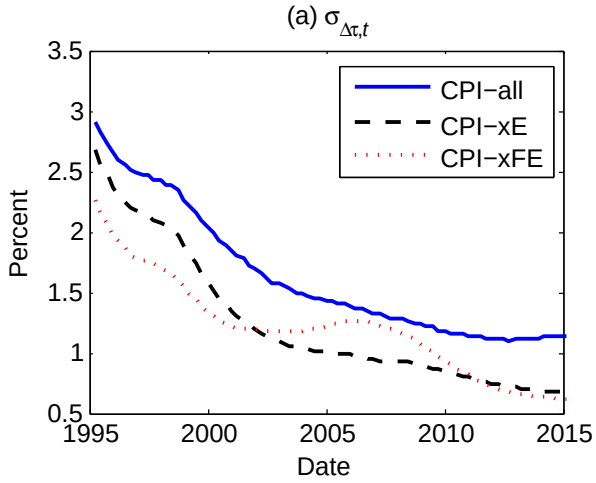
- CPI and sectoral inflation data over 1995Q2 - 2018Q1.
- Sectoral series include: (i) raw food (ii) food in core (iii) clothing (iv) housing excl. gas & electricity (v) healthcare (vi) transport excl. fuel (vii) recreation & education (viii) tobacco & alcohol (ix) gas & electricity (x) fuel
- Estimate the models via Bayesian methods using MCMC methods

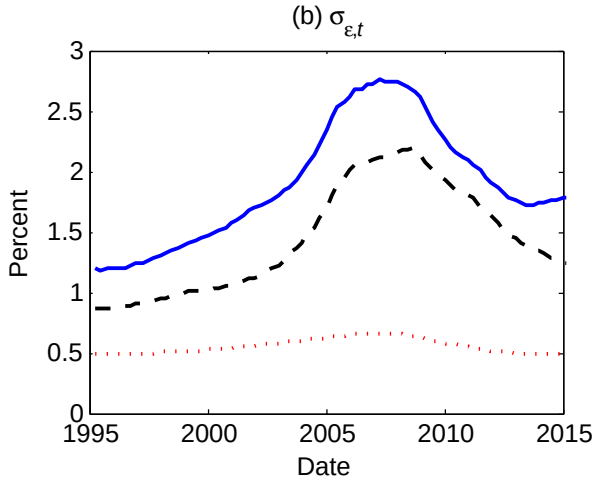
  $\rightarrow$ Smoothed estimates are the posterior mean using information from the full data set

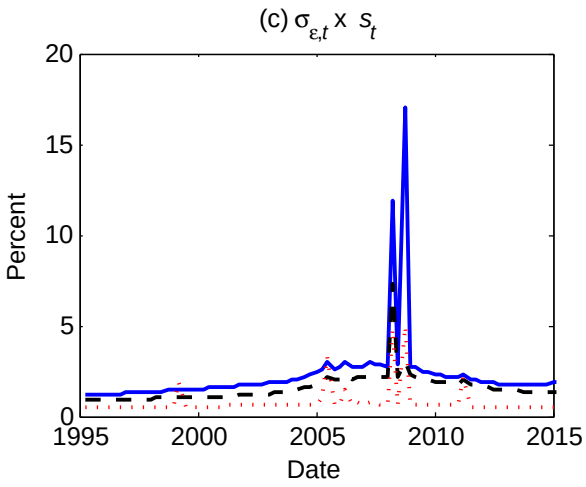
Trend Estimates



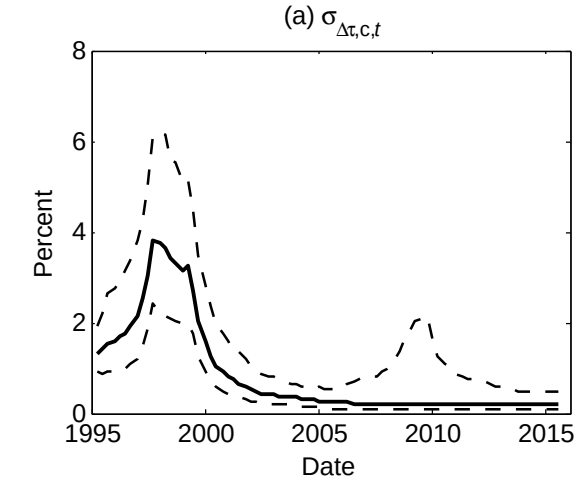
UCSVO Component Volatilities

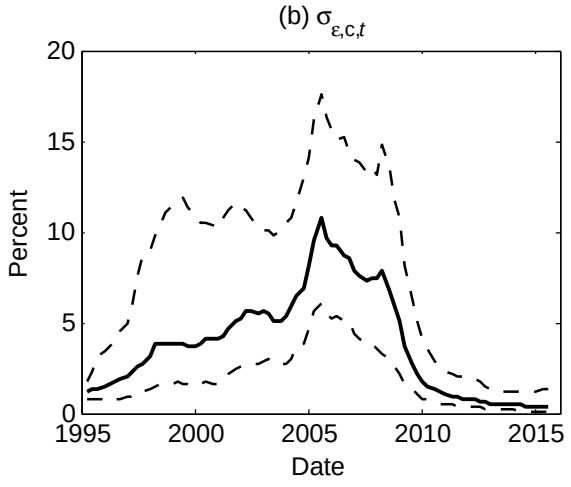


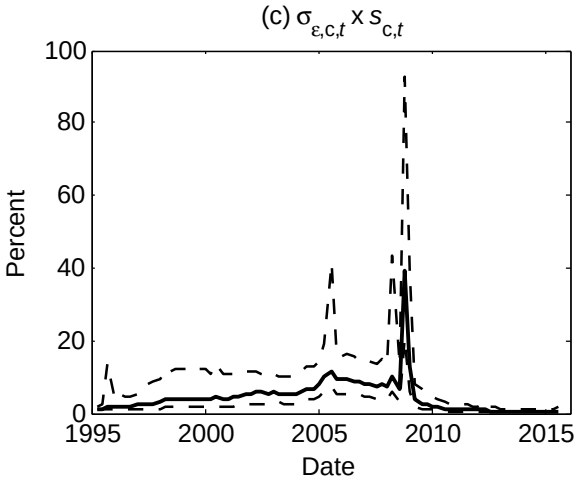




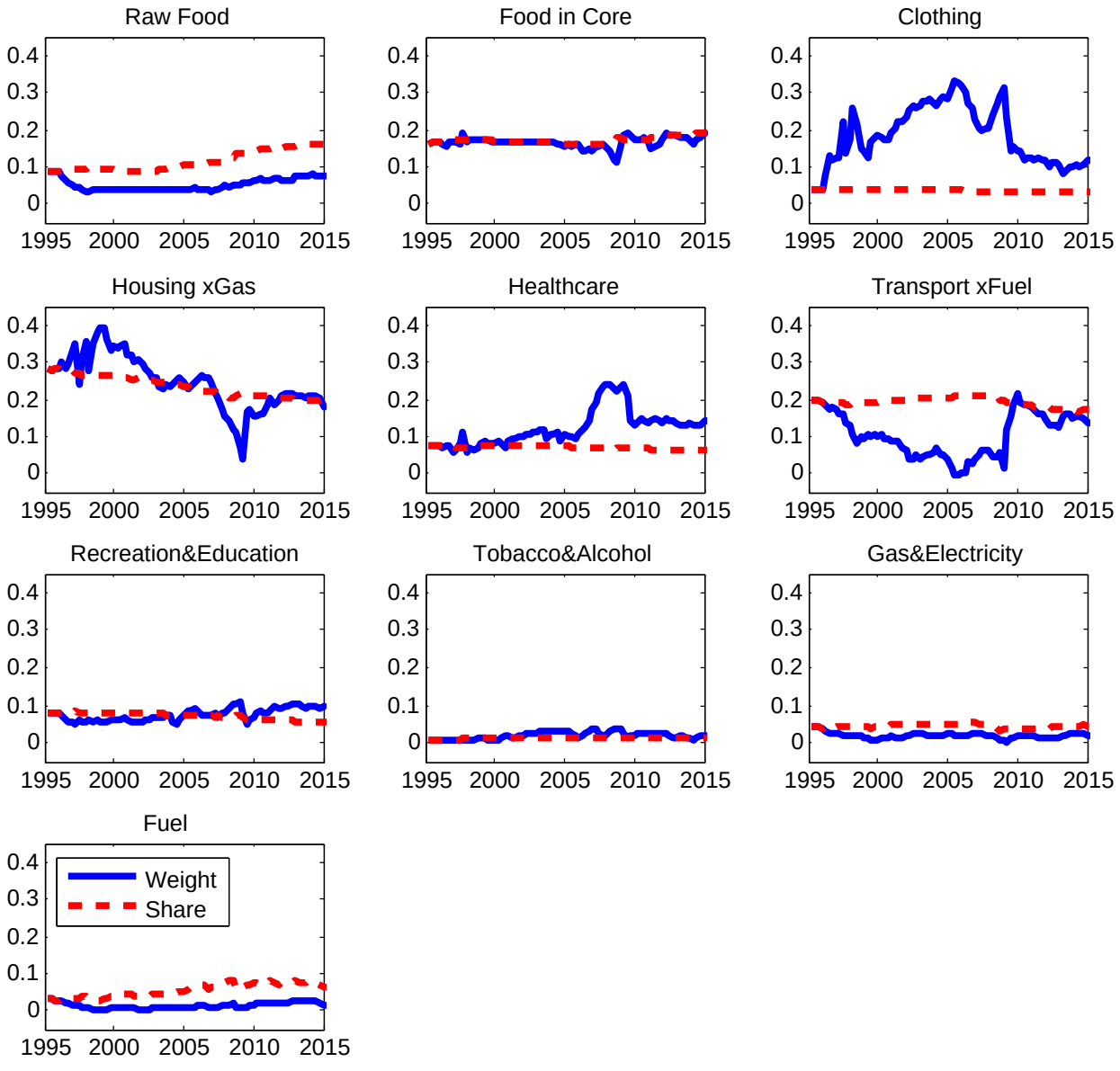
MUCSVO Common Component Volatilities



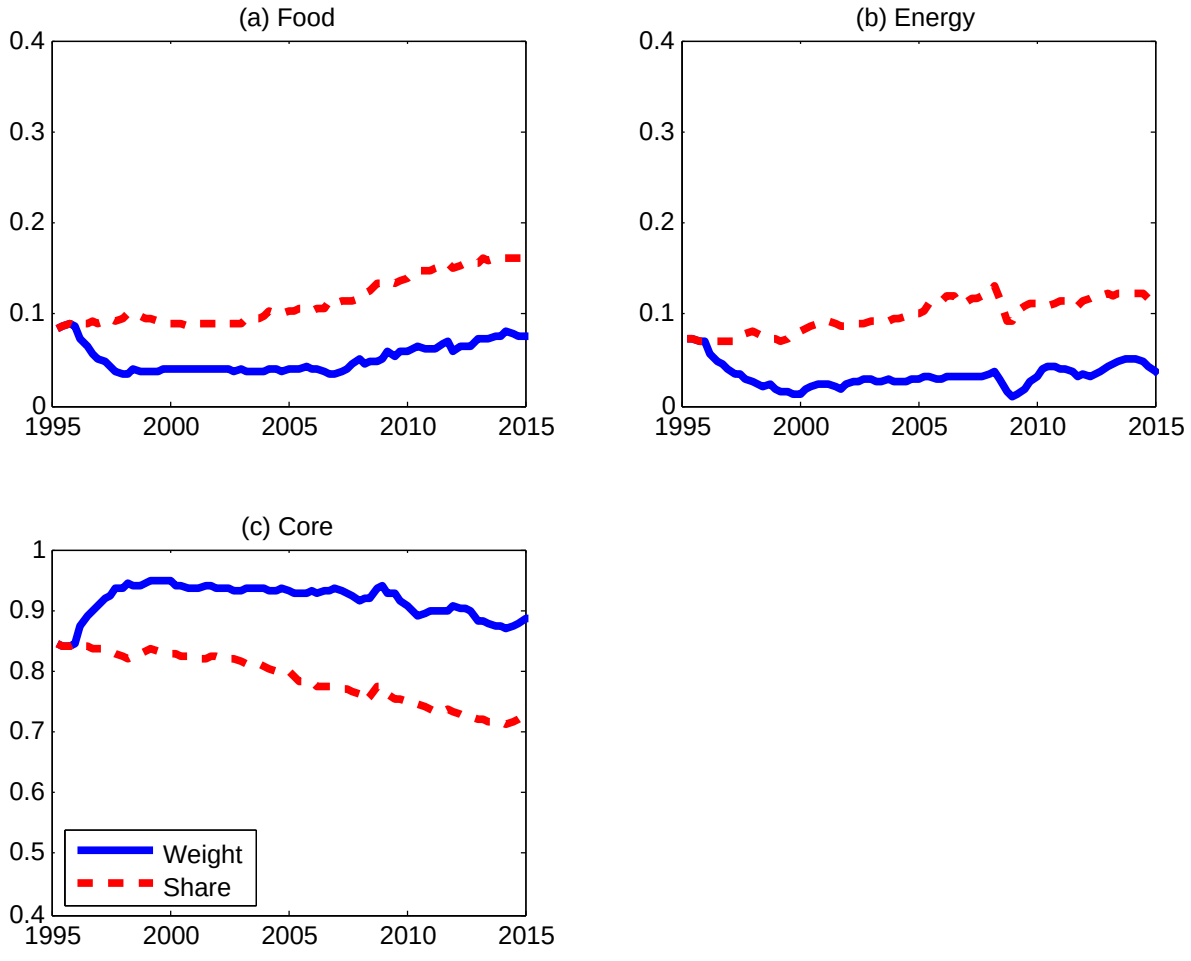




MUCSVO Implied Weights



Three Sector Weights



Accuracy of Trend Estimates

Table 3: Average width of 90 percent posterior intervals for trend inflation

Inflation Trend	1995Q2-1999Q4	2001Q1-2006Q4	2009Q1-2015Q2
UCSVO			
CPI-all	3.91	4.92	3.98
CPIxE	2.99	3.77	3.09
CPIxFE	2.01	2.50	1.63
MUCSVO (3 components)			
CPI-all	2.98	3.05	2.83
CPIxE	1.55	1.72	2.16
CPIxFE	1.07	1.29	1.60
MUCSVO (10 components)			
CPI-all	1.98	1.73	1.93
CPIxE	1.77	1.36	1.40
CPIxFE	1.39	1.03	0.77

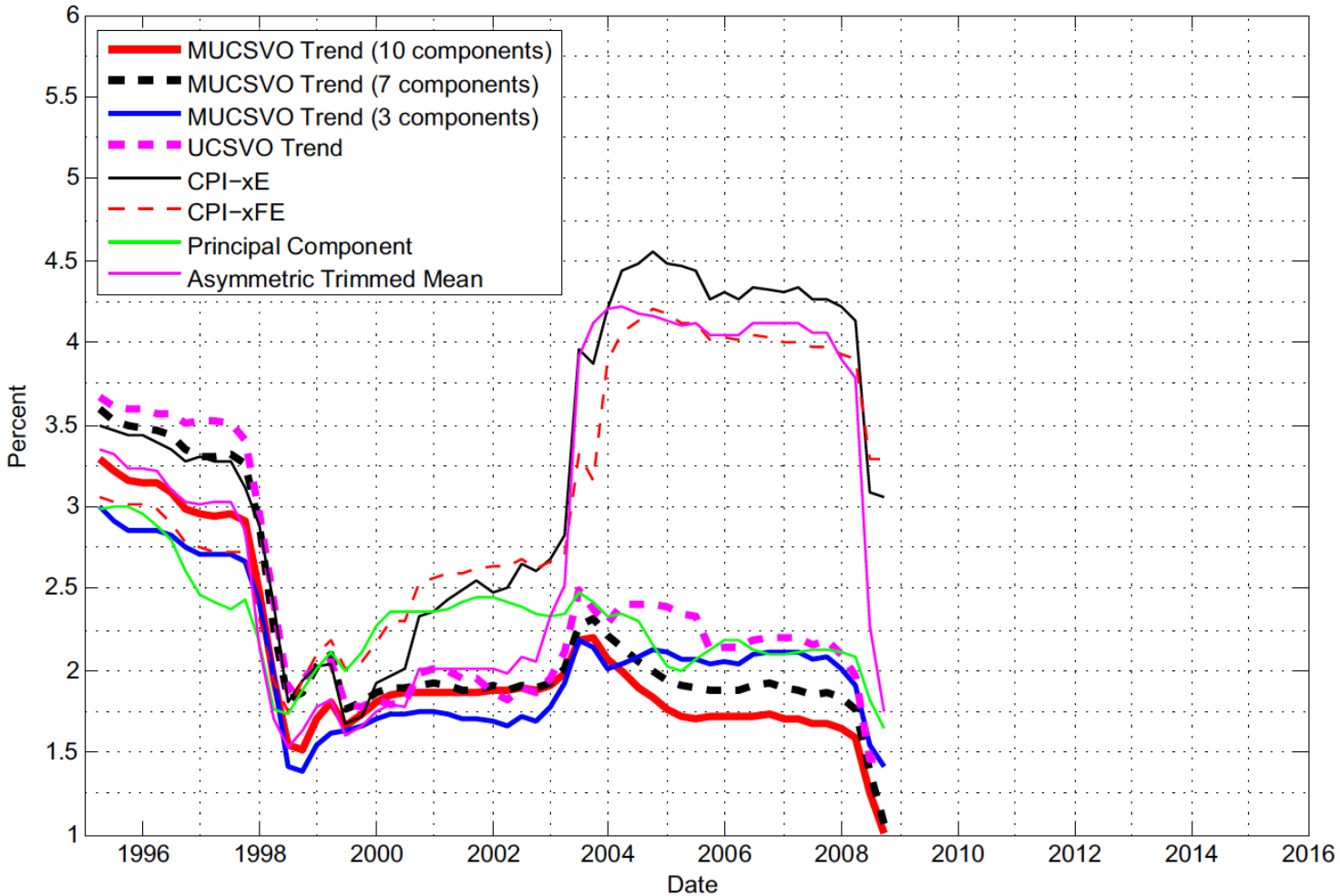
Forecasting Exercise

- One-sided posterior mean estimates of the trend $\tau_{t|t}$ are used to forecast the average value of inflation over the next h = 4, 8 and 12 quarters i.e. $h^{-1}\sum_{i=1}^{h}\pi_{t+i}$.
- Competing trend measures: UCSVO, MUCSVO with 3, 7, and 10 components, CPIxE, CPIxFE, principal components, asymmetric trimmed mean.
- Forecast evaluation is based on the average RMSEs over a five year horizon:

$$\sqrt{\frac{1}{20}\sum_{\tau=t}^{\tau+19} e^2_{\tau+h|\tau}},$$

$$e_{t+h|t} = \frac{1}{h}\sum_{t=1}^{h}\pi_{t+i} - \tau_{t|t}.$$

Forecasting Performance



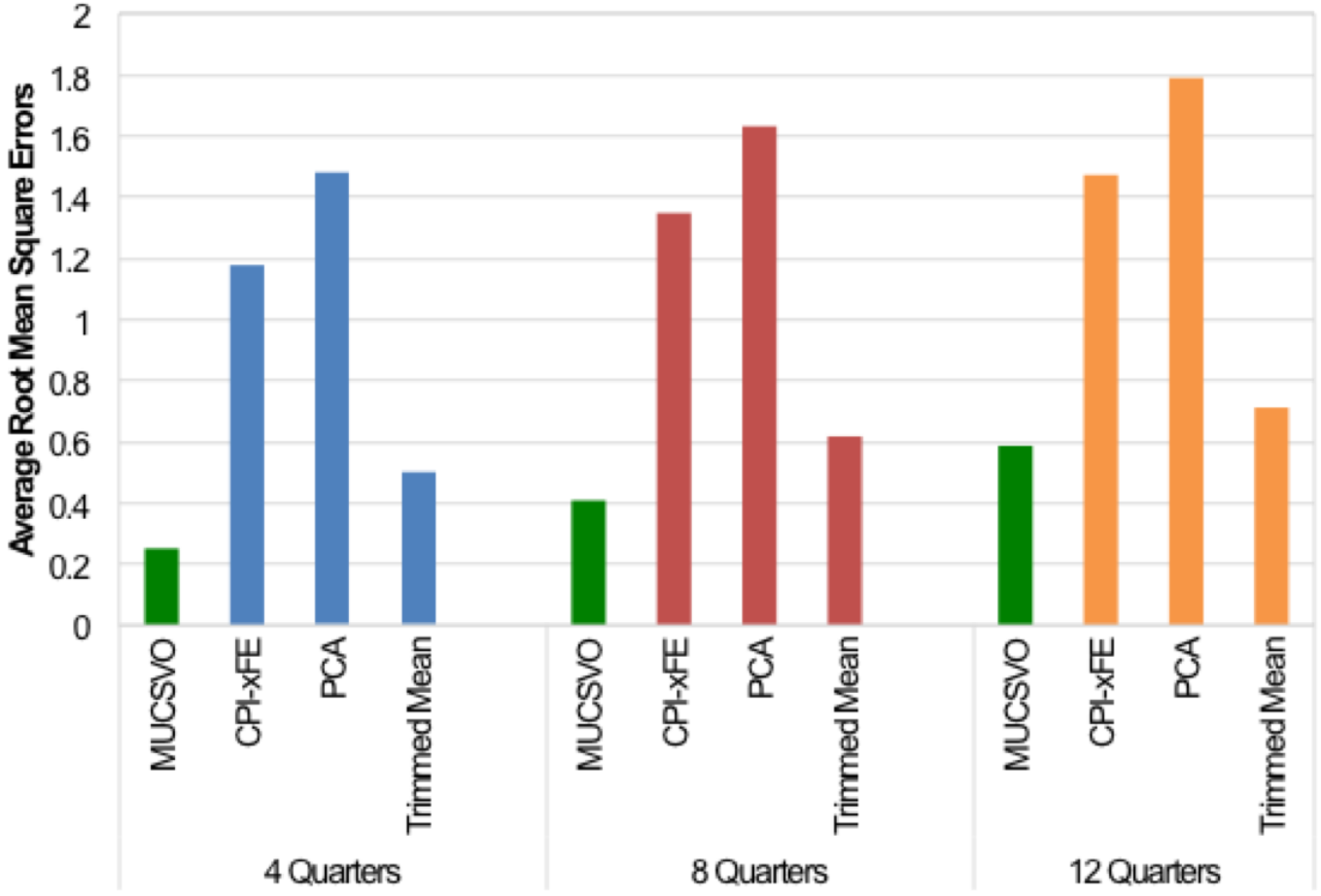
Note: Reported are rolling five-year average RMSFEs associated with 8-quarter ahead in-sample inflation forecasts from various trend inflation measures starting in 1995Q2.

Forecasting Evaluation

Inflation Trend	1995Q2-2015Q2	2000Q1-2015Q2	2005Q1-2015Q2
MUCSVO (10 components)	**-2.162 (0.017)**	**-1.401 (0.083)**	**-3.542 (0.001)**
MCUSVO (7 components)	**-1.450 (0.075)**	-1.074 (0.144)	**-2.541 (0.079)**
MUCSVO (3 components)	**-2.428 (0.009)**	**-1.365 (0.089)**	**-2.701 (0.005)**
Principal Components	-0.178 (0.429)	0.748 (0.229)	-0.200 (0.421)
Trimmed Mean	0.552 (0.291)	**1.248 (0.109)**	**1.419 (0.082)**
CPIxE	**2.357 (0.011)**	**3.061 (0.002)**	**2.632 (0.001)**
CPIxFE	1.094 (0.139)	**2.227 (0.015)**	**1.906 (0.033)**

Note: Reported are the modified Diebold Mariano tests statistic and corresponding p-values in parenthesis for the null of equal predictive accuracy between various trend inflation measures compared against the UCSVO trend.

Forecasting Performance



Note: The results are average RMSFEs for various in-sample inflation forecasts generated over the post inflation targeting regime.

Takeaways

- **Trend inflation has become well anchored since 2000**
  - Clear communication about the inflation target is important
- **Core is an imperfect measure of trend inflation**
  - Throws away useful information embodied in food and energy prices
  - Fixed weights are restrictive
- **Disaggregated prices help us better understand inflation dynamics**

$\rightarrow$ Disaggregate further!

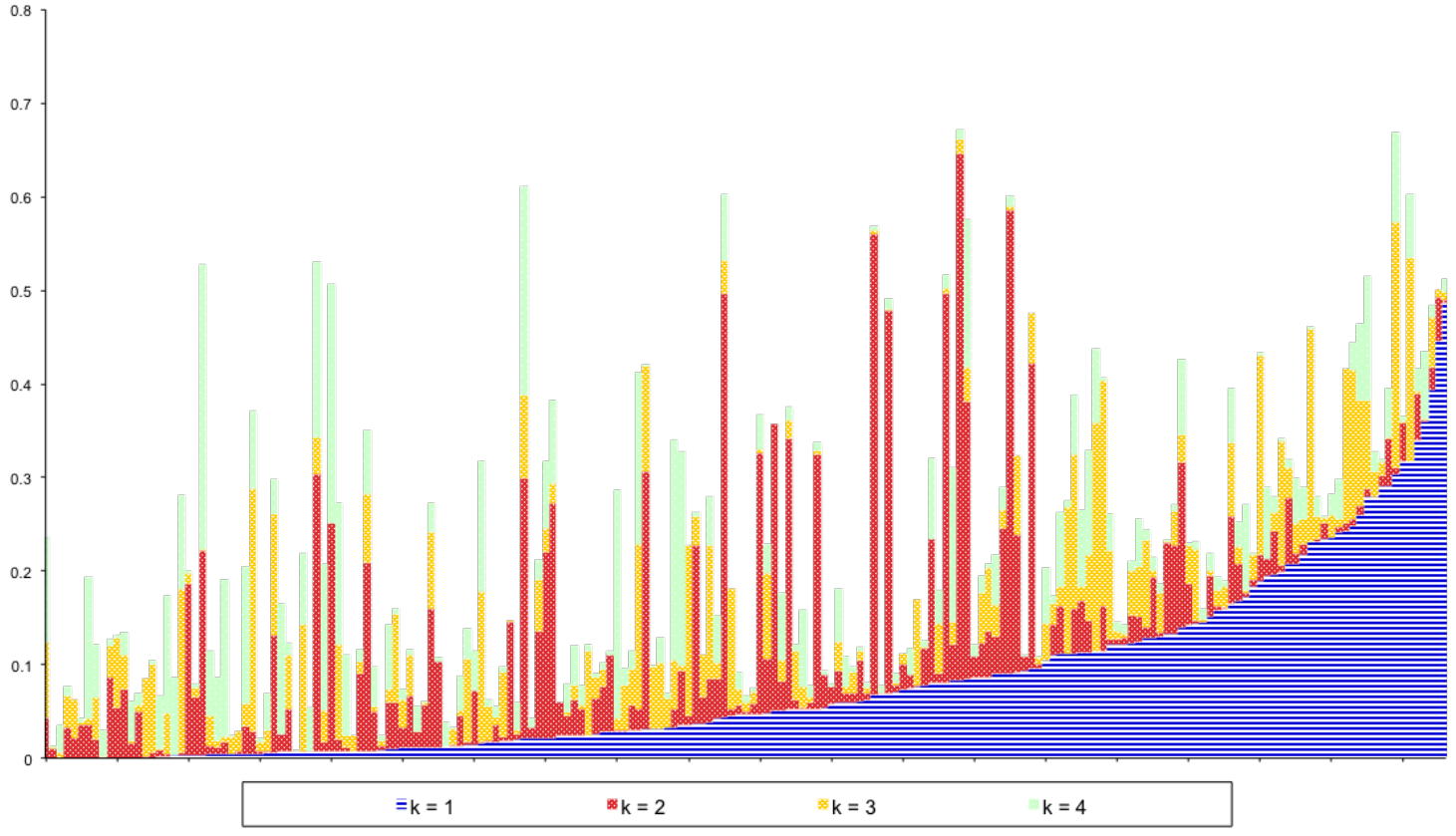
Ongoing Research - Disaggregating further ...

- Using 197 (cleaned) consumption goods and service price series over 2002Q1-2017Q3, we decompose prices at the broad product level into pure, relative and idiosyncratic components:

$$\Pi_t = \mathbf{1}v_t + \Theta\rho_t + u_t$$

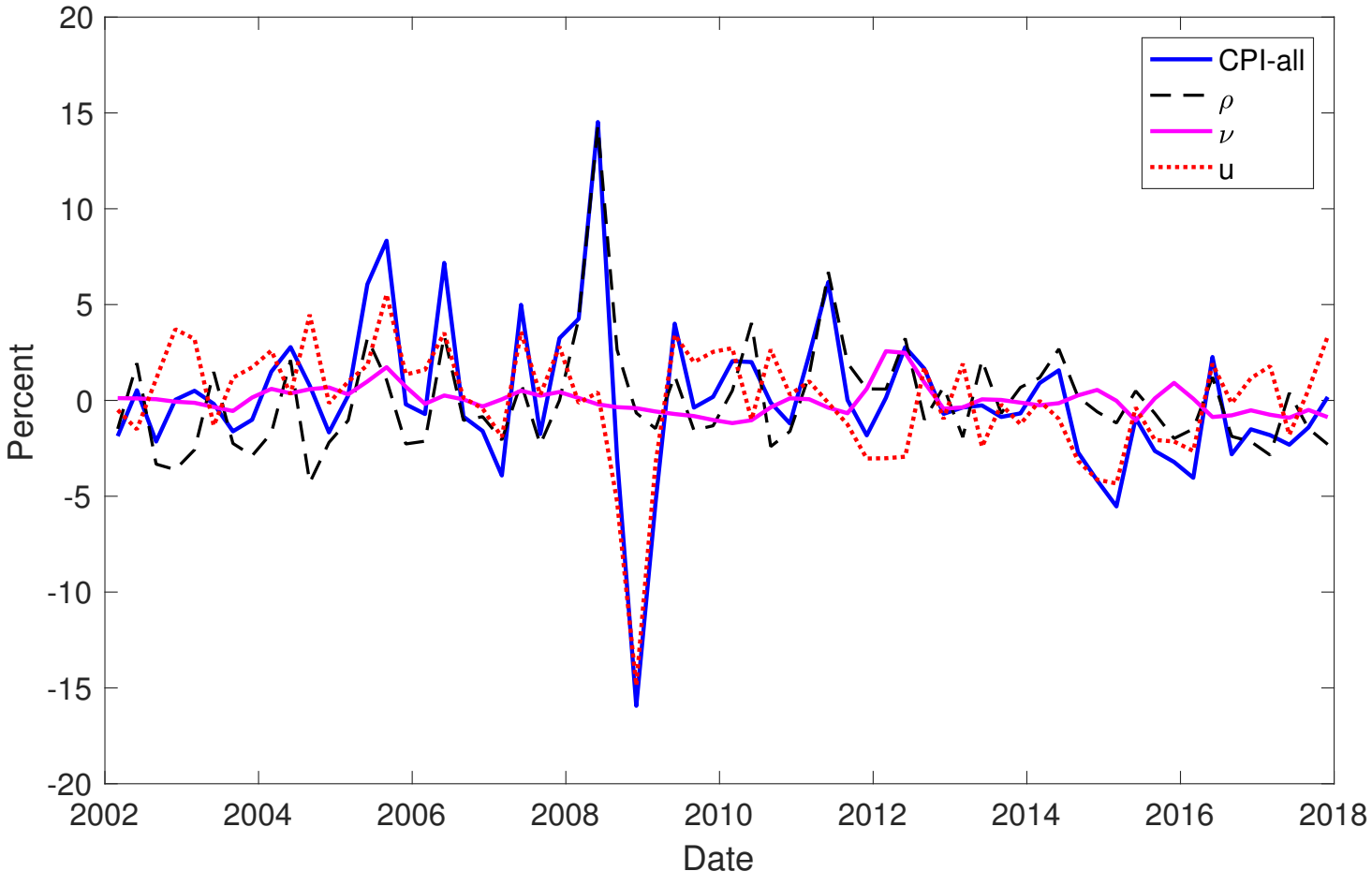
- This helps us better understand the role of:
  - Aggregate versus sectoral shocks
  - Anticipated versus unanticipated shocks
  - The (dead) Phillips curve relation
- Following Reis and Watson (2010) the model is estimated as a dynamic factor model using an EM algorithm to maximize the likelihood function.

Number of Factors



Note: Plotted is the fraction of sample variance of inflation explained by k factors. The horizontal axis orders the series by the fraction of variance explained by the first factor.

Inflation Decomposition



Fraction of Variability Explained

Inflation Measure	All frequencies ρ_t	All frequencies v_t	Business cycle ρ_t	Business cycle v_t
Aggregate Inflation Rates				
Headline CPI	0.78	0.18	0.87	0.08
197 Sectoral Inflation Rates				
25th Percentile	0.28	0.08	0.26	0.02
50th Percentile	0.34	0.11	0.36	0.06
75th Percentile	0.39	0.15	0.48	0.10

Note: Reported are the average squared canonical coherence over frequencies where business cycle frequencies are defined over $\pi/32 \leq \omega \leq \pi/6$.

Correlations with Macro Observables

	All frequencies	Business Cycle
Relative-price index ρ_t		
Food	0.20	0.12
Energy	0.72	0.82
Export prices	0.33	0.46
Import prices	0.58	0.64
NEER	0.67	0.70
Tradables	0.37	0.77
Pure inflation v_t		
Broad money	0.33	0.16
Policy rate	0.24	0.25
Term spread (10Y-3m)	0.27	0.15
NEER	0.24	0.54

Note: Reported are the average squared canonical coherence over over frequencies where business cycle frequencies are defined over $\pi/32 \leq \omega \leq \pi/6$.