Trend Inflation Estimates for Thailand from Disaggregated Data

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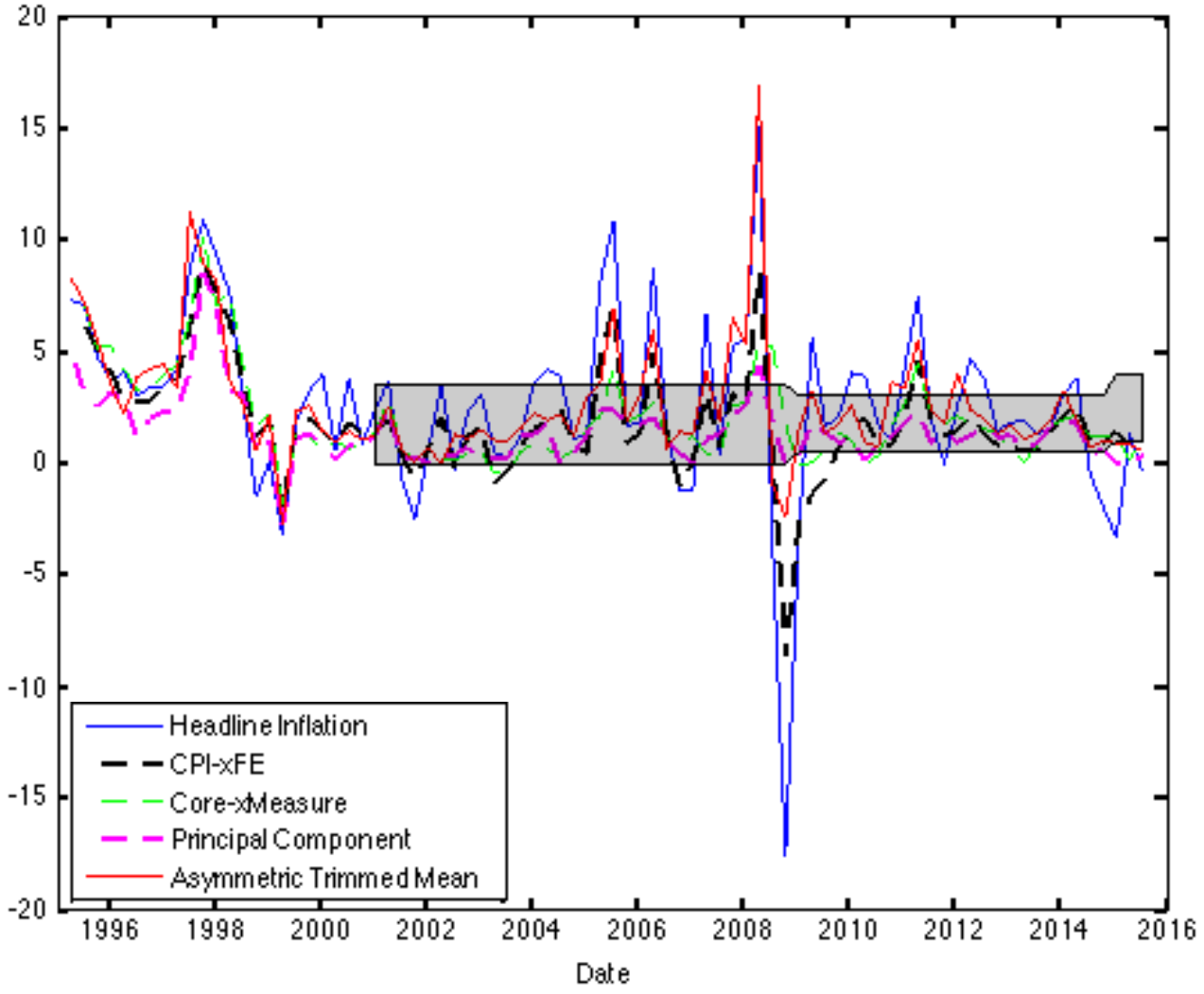
Inflation Dynamics in Thailand



How to Estimate Trend Inflation?

Two main statistical approaches:

(1) Univariate time series smoothing methods

- IMA(1,1) model (Nelson and Schwert, 1977)
- Four-quarter average of quarterly inflation (Atkeson and Ohanian, 2001)
- Unobserved components model with stochastic volatility (Stock and Watson, 2007)

$\rightarrow$ Can improved measures of trend inflation be obtained from information in disaggregated inflation data?

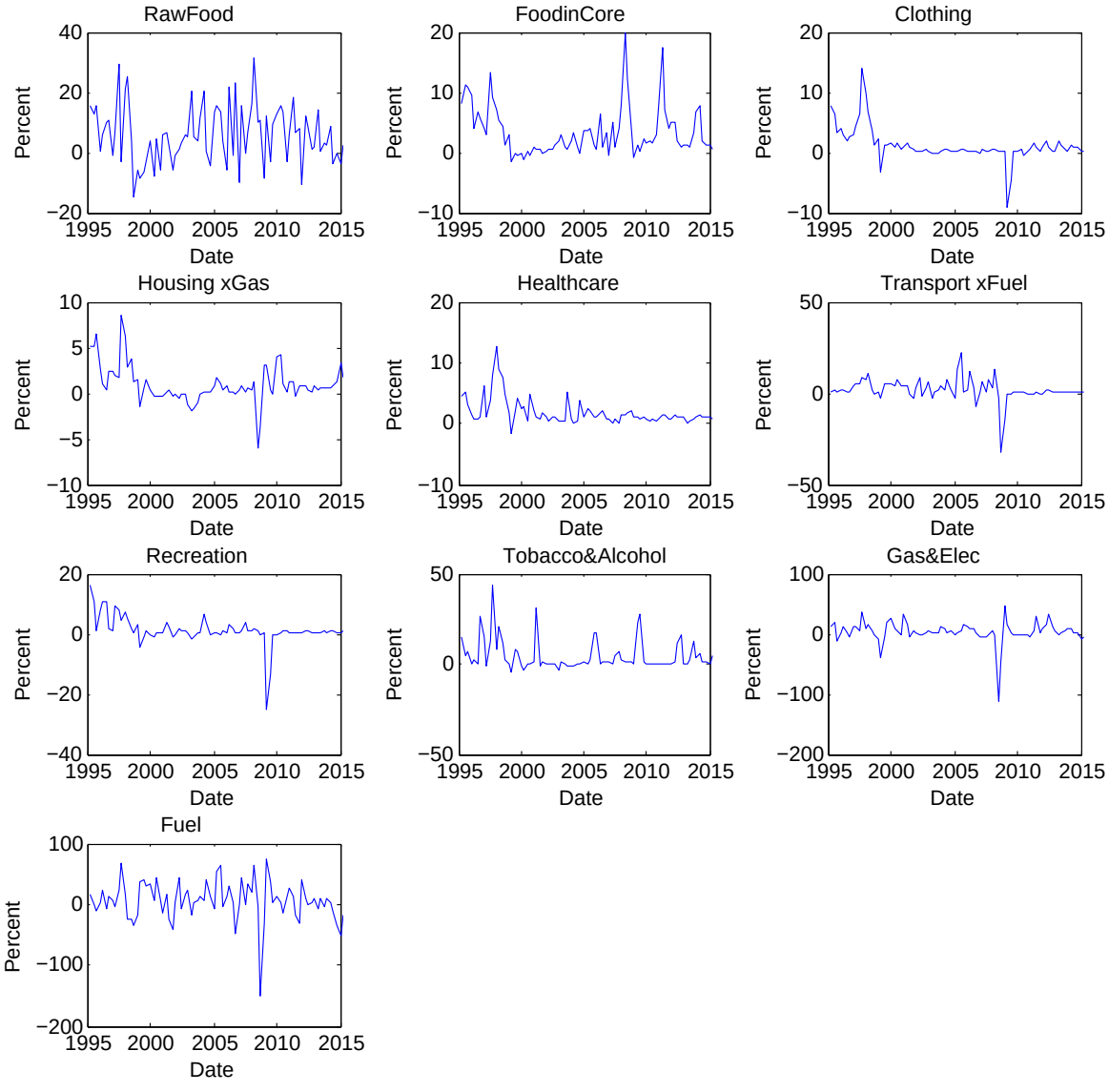
Sectoral Inflation in Thailand

(2) A weighting scheme that excludes sectoral inflation data with large non-persistent variation

- Core inflation measures eg. CPI excluding food and energy, CPI excluding administered price items
- Trimmed mean or median inflation (Bryan and Cechetti, 1994)

$\rightarrow$ Should sectoral weights evolve over time, or are they stable? How to decide on sectoral weights?

Sectoral Inflation in Thailand



Summary Statistics for Sectoral Inflation Data

Table 1: Standard deviation of annualized month-on-month inflation

	1995M1-1999M12	2000M1-2004M12	2005M1-2009M12	2010M1-2015M12
Raw Food	21.76	16.11	21.65	13.07
Food in Core	6.65	2.04	6.07	5.00
Clothing	5.56	0.89	5.61	1.14
Housing x Gas, Elect	2.98	1.24	5.42	1.99
Healthcare	4.95	2.68	1.11	0.85
Transport x Fuel	5.25	7.25	15.40	1.05
Recreation & Education	9.24	4.28	15.15	1.07
Tobacco and Alcohol	19.69	12.02	16.85	7.74
Gas and Electricity	33.26	25.85	71.43	20.21
Fuel	38.48	46.87	71.87	32.99

Table 2: Persistence as measured by the sum of AR(4) coefficients

	1995M1-1999M12	2000M1-2004M12	2005M1-2009M12	2010M1-2015M12
Raw Food	0.31	0.17	0.07	0.27
Food in Core	0.78	0.53	0.77	0.82
Clothing	0.82	0.71	-0.04	0.58
Housing x Gas, Elect	0.83	0.55	-0.21	0.46
Healthcare	0.83	0.42	0.81	0.89
Transport x Fuel	0.72	0.33	0.46	0.31
Recreation & Education	0.61	0.14	0.01	0.55
Tobacco & Alcohol	0.43	0.05	0.34	0.45
Gas & Electricity	0.22	-0.06	0.01	0.35
Fuel	0.43	0.05	0.41	0.30

What this paper does

(1) Addresses the following measurement questions for trend inflation:

- **Can univariate estimates of trend inflation be improved by using disaggregated inflation series?**

  $\rightarrow$ Produces a new multivariate trend measure based on the empirical model of Stock and Watson (2015)
  $\rightarrow$ Does the multivariate trend help reduce filtering uncertainty? Is it a good forecast of future inflation?

- **Should sectoral weights that enter trend estimates vary over time?**

  $\rightarrow$ Let the data decide how much weight to give each sectoral series
  $\rightarrow$ How do the implied sectoral weights compare to its expenditure share? Should food and energy prices be excluded from core inflation?

(2) Examines the changing time-series properties of Thai inflation:

- **What explains the changing inflation process in Thailand?**

  $\rightarrow$ Did the adoption of an inflation target in May 2000 or the global financial crisis alter the Thai inflation process?
  $\rightarrow$ How did trend versus transitory components of inflation change over time? What about stochastic volatility and outliers?

Multiple related literatures:

- Core inflation and disaggregated inflation
- Trend inflation
- Factor models for inflation
- Inflation forecasting
- Energy price pass through

Roadmap

- Empirical model specification
- Data and estimation methodology
- Univariate and multivariate model results
- Forecasting comparison
- Conclusion

Empirical Models

(1) Univariate unobserved components stochastic volatility outlier-adjusted model (UCSVO)

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

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

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

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

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

where $(\eta_\epsilon, \eta_\tau, v_\epsilon, v_{\Delta\tau})$ are iid. $N(0, I_4)$, and $s_t = 1$ with probability p.

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

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

(2) Multivariate unobserved components stochastic volatility outlier-adjusted model (MUCSVO)

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

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

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

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

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

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

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

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

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

where $(\epsilon_{c,t}, \epsilon_{i,t}, \eta_{c,t}, \eta_{i,t}, \zeta_{c,t}, \zeta_{i,t}, \nu_{\epsilon,c,t}, \nu_{\Delta\tau,i,t}, \nu_{\varepsilon,i,t})$ are i.i.d. $N(0, I_9)$, and $s_t = 1$ with probability p.

Multivariate Model Features

- Each sector can have idiosyncratic shocks and outliers that are large and highly transitory with no persistent link to aggregate inflation
- Sectoral indexes can have their own trend
- Common trend and transitory components are driven by aggregate-wide macro forces eg. monetary policy

  $\rightarrow$ Common components affect inflation through time-varying loading factors

Aggregate trend:

$$\tau_t = \sum_{i=1}^{n} w_{it}(\alpha_{i,\tau,t}\tau_{c,t} + \tau_{i,t})$$

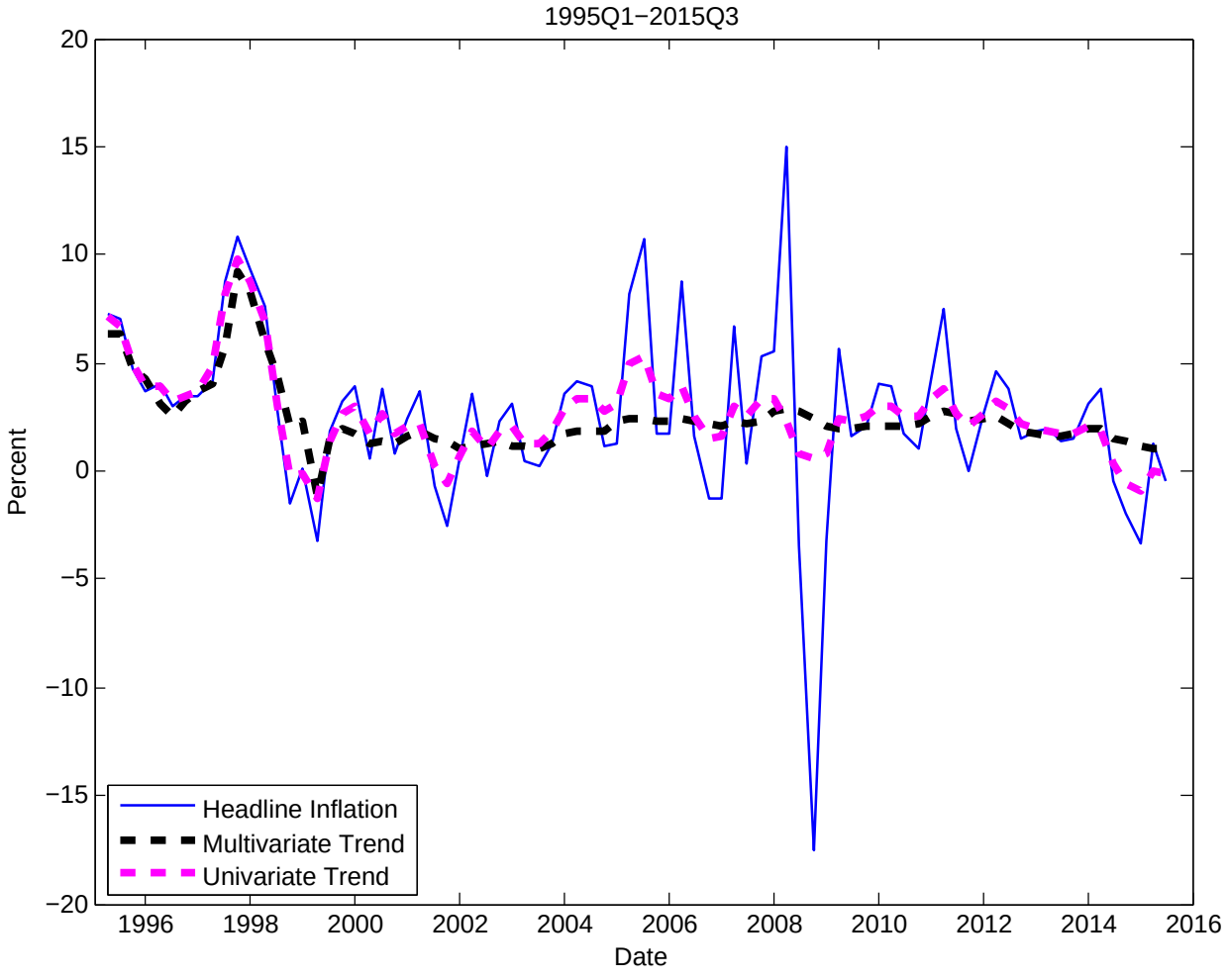
Data and Estimation Methodology

- CPI and sectoral inflation data over the sample 1995Q2 - 2015Q3
- We disaggregate CPI data into 10 sectors:

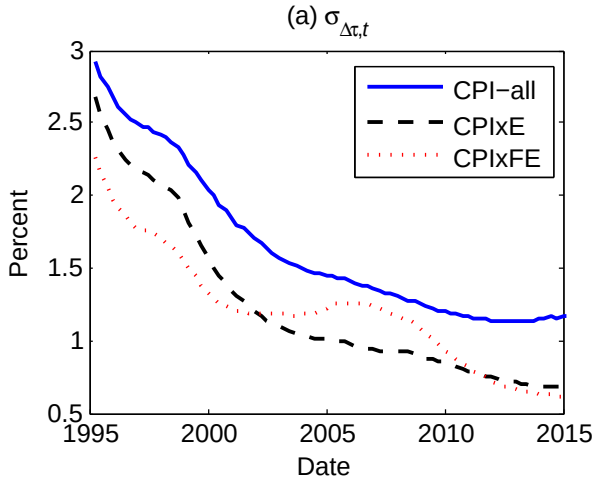
  (i) Raw food (ii) food in core (iii) clothing (iv) housing excl. gas & electricity (v) healthcare (vi) transport excl. fuel (vii) recreation & education (viii) tobacco & alcohol (ix) gas & electricity (x) fuel
- Estimate the models via Bayesian methods using MCMC methods

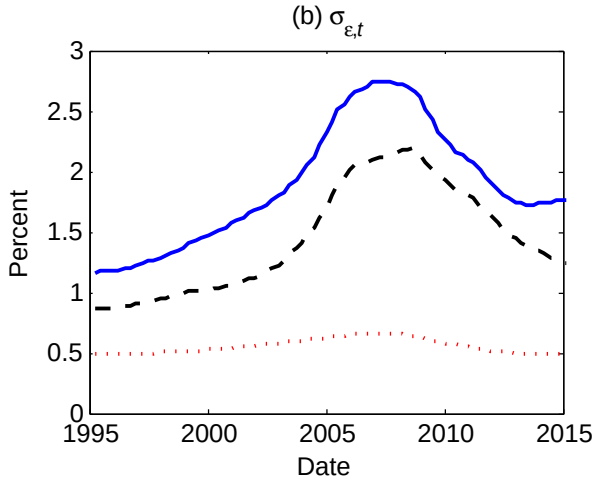
  $\rightarrow$ Smoothed estimates are the posterior mean using information from the full data set

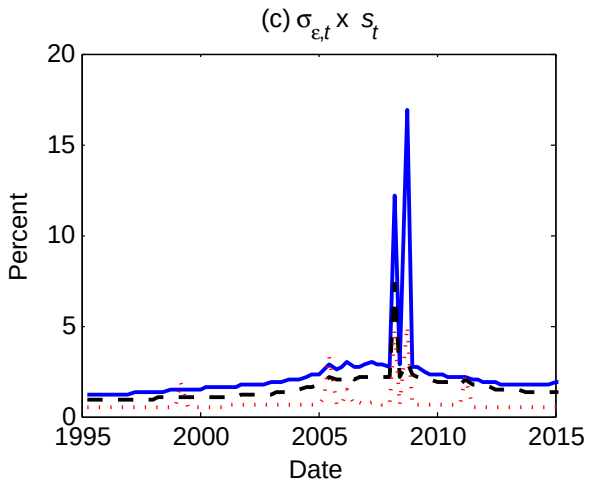
Trend Estimates



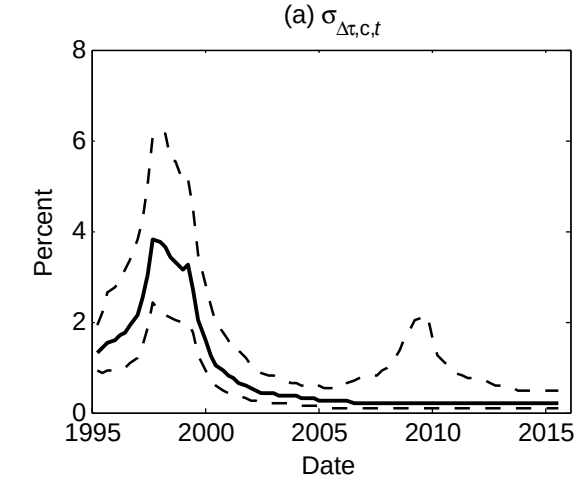
UCSVO Component Volatilities

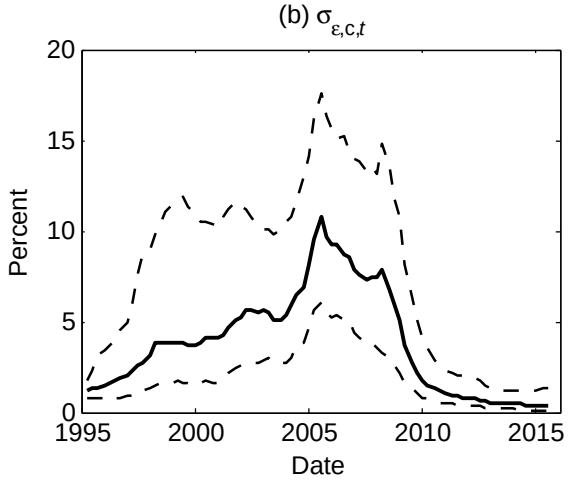


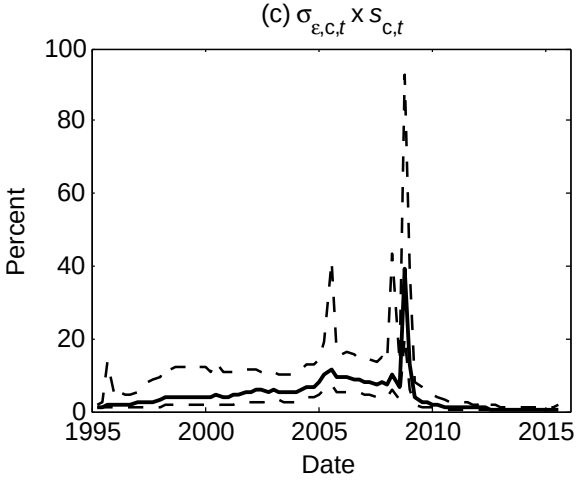




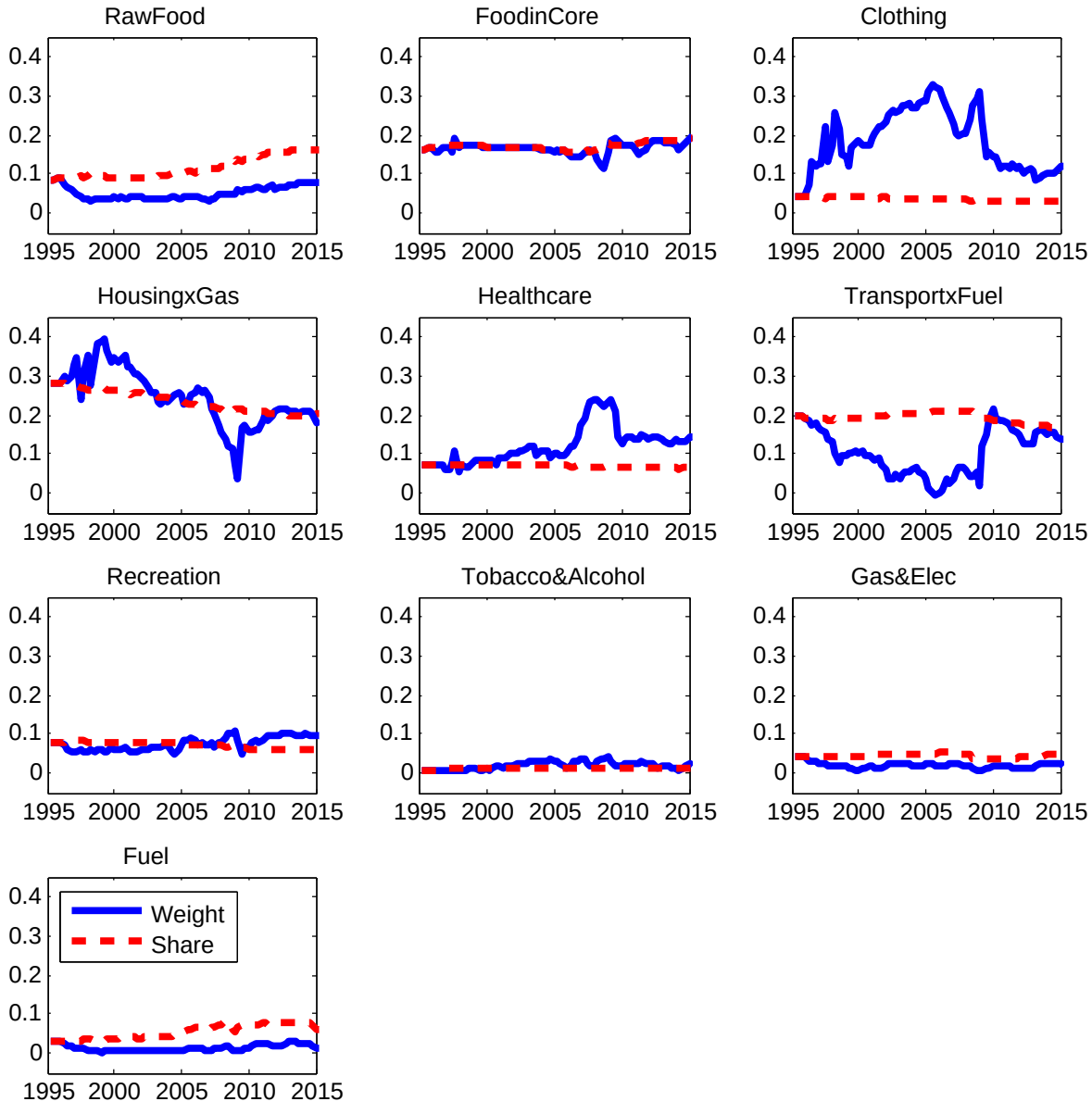
MUCSVO Common Component Volatilities







MUCSVO Implied Weights and Expenditure Shares

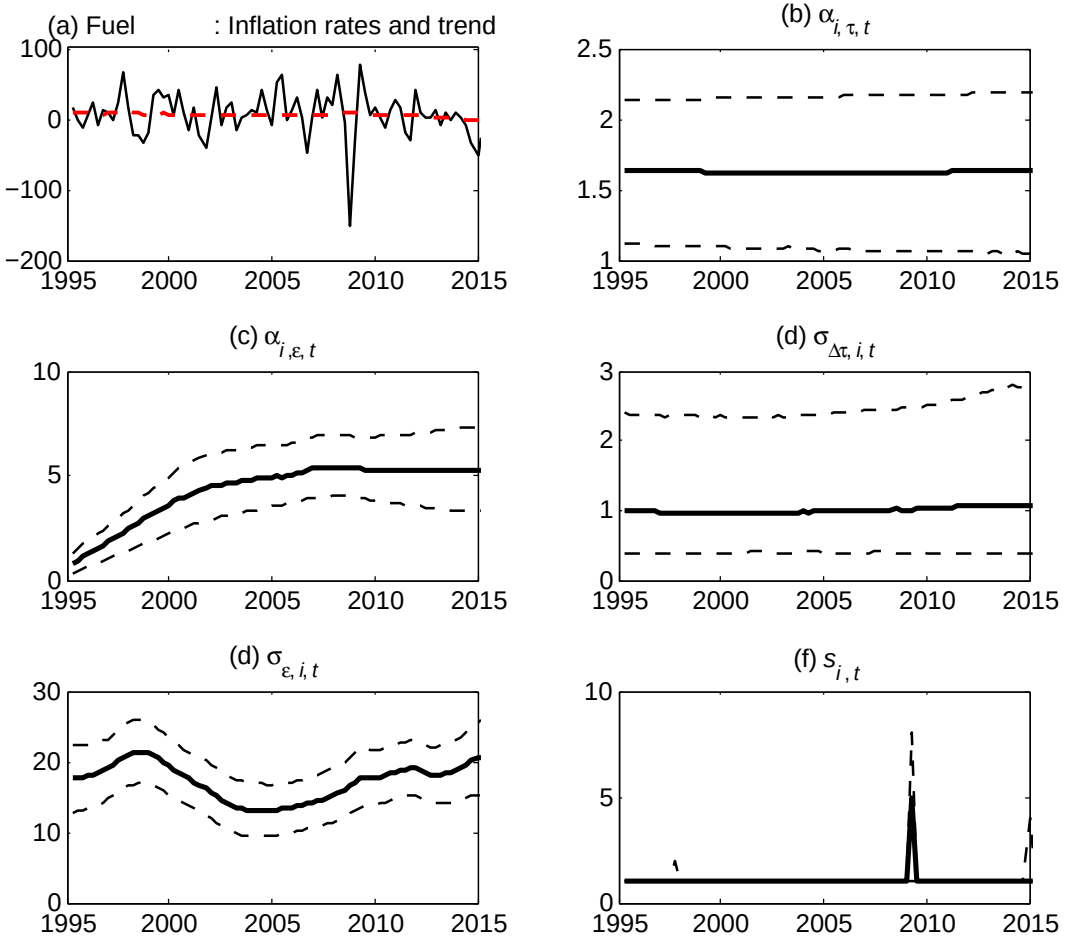


MUCSVO Results

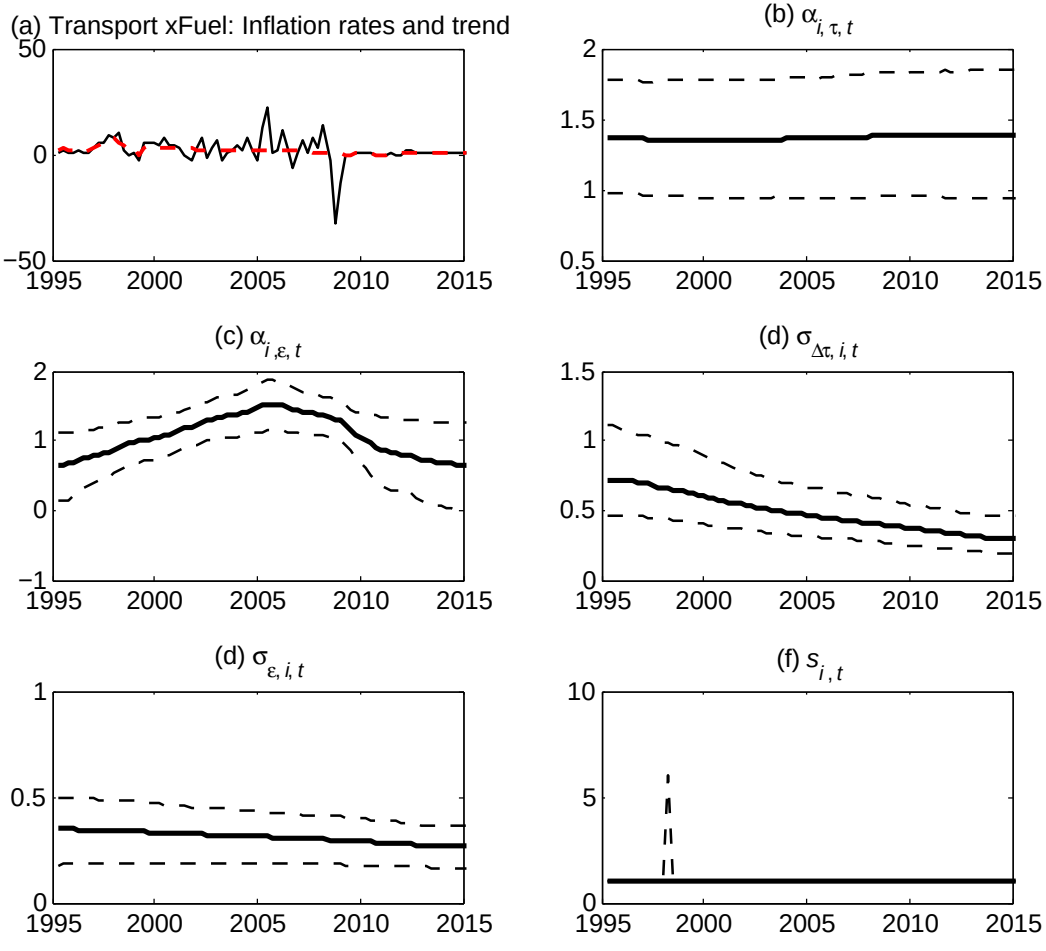
Overall observations:

- While all expenditure shares are stable, approximately half of the sectors have time-varying implied weights
- Sector-specific factor loadings and volatilities of the permanent components remain relatively stable
- Sector-specific factor loadings and volatilities of the transitory components exhibit considerable variation across time and across sectors
- Outliers are important and its nature is sector-specific

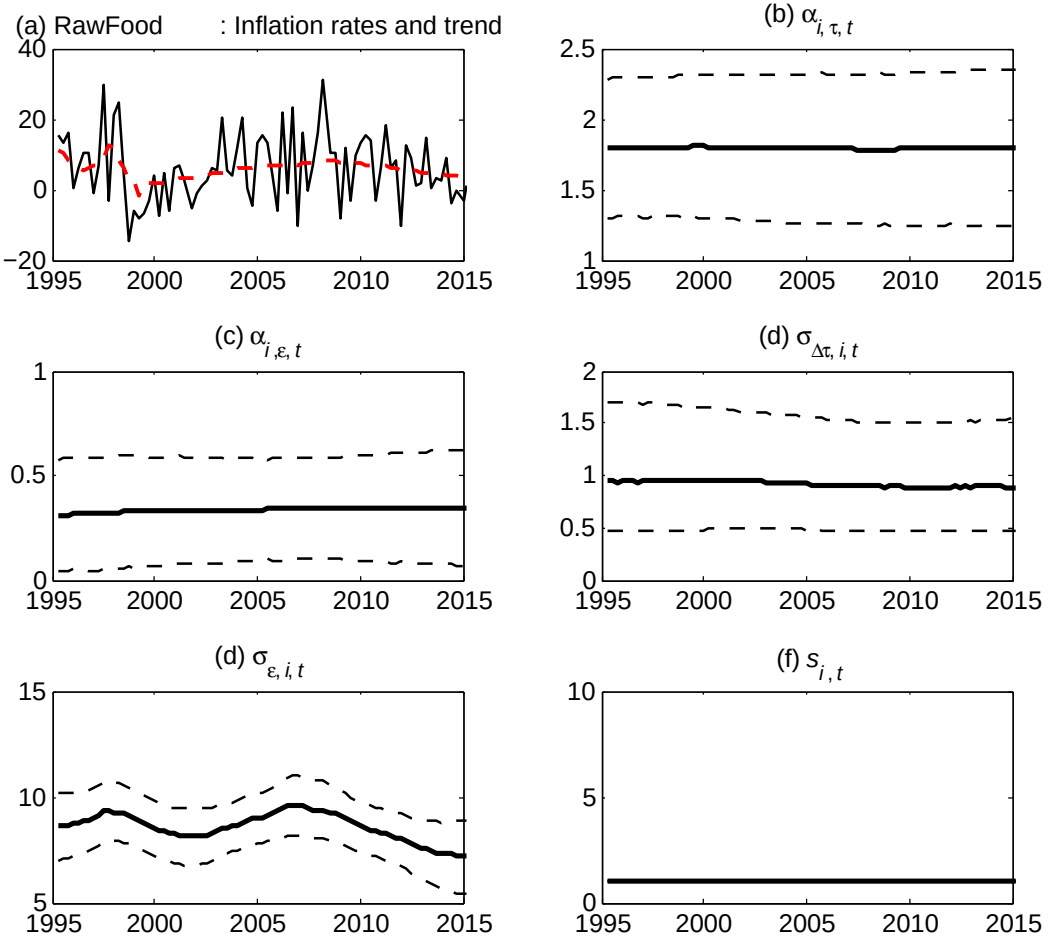
Fuel


(a) Fuel : Inflation rates and trend
100
0
−100
−200
1995
2000
2005
2010
2015
(b) $\alpha_{i,\tau,t}$
2.5
2
1.5
1
(c) $\alpha_{i,\varepsilon,t}$
10
5
0
(d) $\sigma_{\Delta\tau,i,t}$
3
2
1
(d) $\sigma_{\varepsilon,i,t}$
30
20
10
(f) $s_{i,t}$

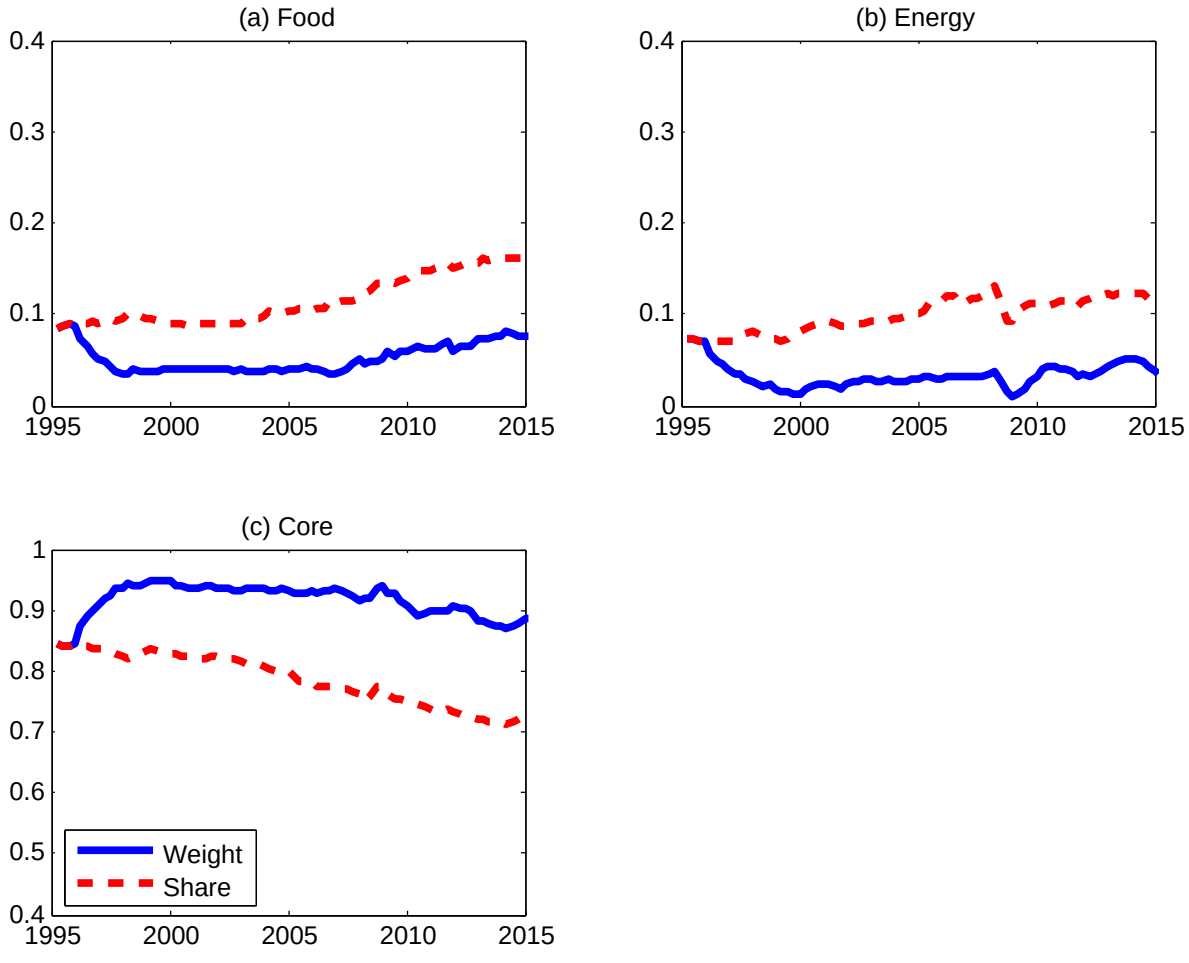
Transport excluding Fuel



Raw Food


(a) RawFood : Inflation rates and trend
(b) $\alpha_{i,\tau,t}$
(c) $\alpha_{i,\varepsilon,t}$
(d) $\sigma_{\Delta\tau,i,t}$
(d) $\sigma_{\varepsilon,i,t}$
(f) $s_{i,t}$

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
Univariate			
CPI-all	3.91	4.92	3.98
CPIxE	2.99	3.77	3.09
CPIxFE	2.01	2.50	1.63
Multivariate (3 components)			
CPI-all	2.98	3.05	2.83
CPIxE	1.55	1.72	2.16
CPIxFE	1.07	1.29	1.60
Multivariate (10 components)			
CPI-all	1.98	1.73	1.93
CPIxE	1.77	1.36	1.40
CPIxFE	1.39	1.03	0.77

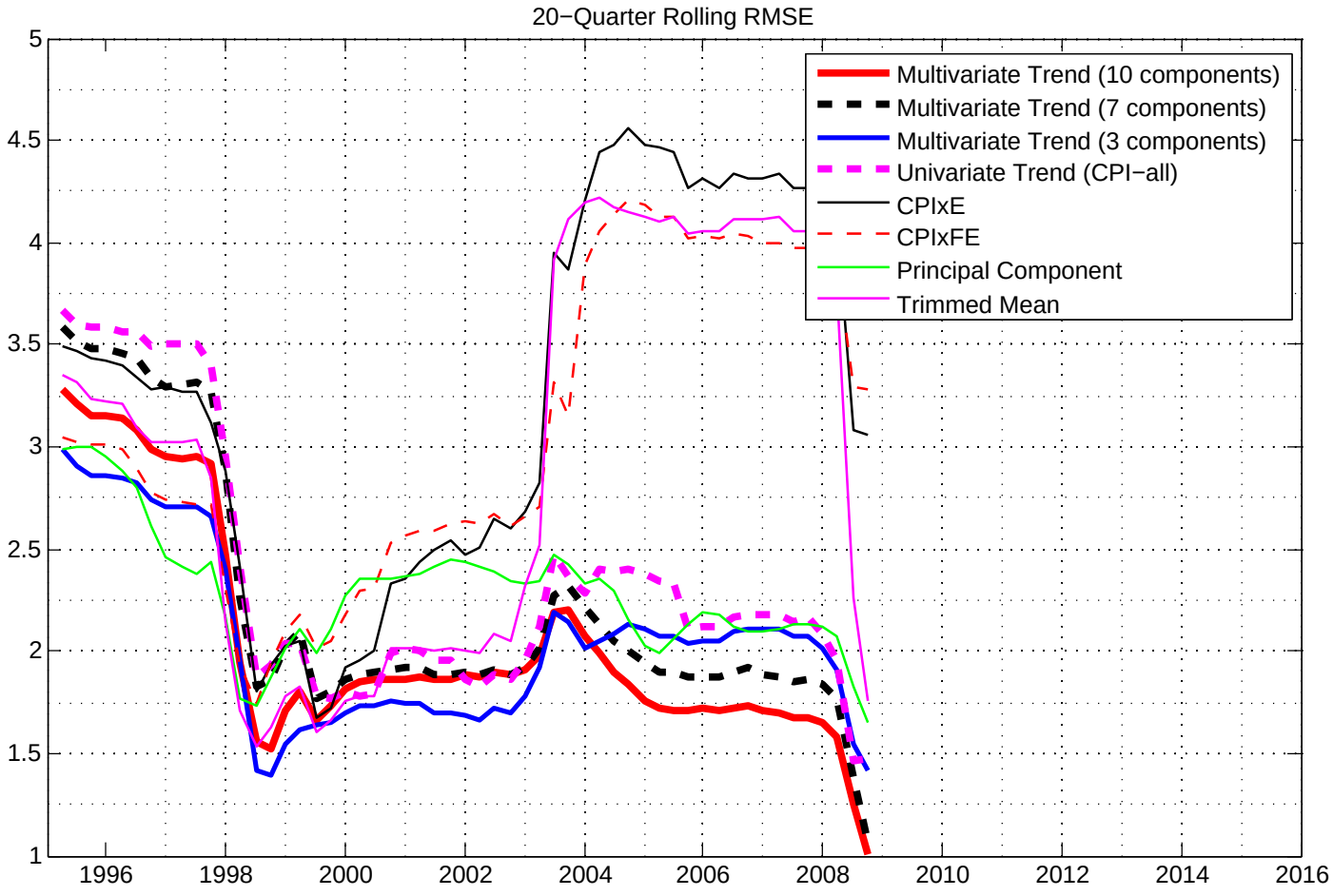
Forecasting Exercise

- One-sided posterior mean estimates of the trend $\tau_{t|t}$ are used to forecast the average value of inflation over the next 8 quarters i.e. $h^{-1}\sum_{i=1}^{h}\pi_{t+i}$ where $h = 8$.
- 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:

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

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

Forecasting Performance



Are the gains from using disaggregated data significant?

Table 4: Tests of equal predictive accuracy

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 test statistic and corresponding p-values in parenthesis for the null of equal predictive accuracy between various trend inflation measures compared against the UCSVO trend.

Conclusion

(1) **Can univariate estimates of trend inflation be improved by using disaggregate inflation series?**

- The model-based filtering uncertainty about trend inflation is substantially reduced by using disaggregated series in the MUCSVO model
- The MUCSVO model forecasts 8 quarter-ahead average inflation more accurately when compared to other benchmark trend measures, especially after the year 2000

(2) **Should sectoral weights that enter trend estimates vary over time?**

- Approximately half of the estimated sectoral weights are time-varying in contrast to their relatively stable expenditure shares
- While raw food and energy components are noisy, persistence in these sectoral series help explain approximately 10 percent of multivariate trend movements

(3) **What explains the changing inflation process in Thailand?**

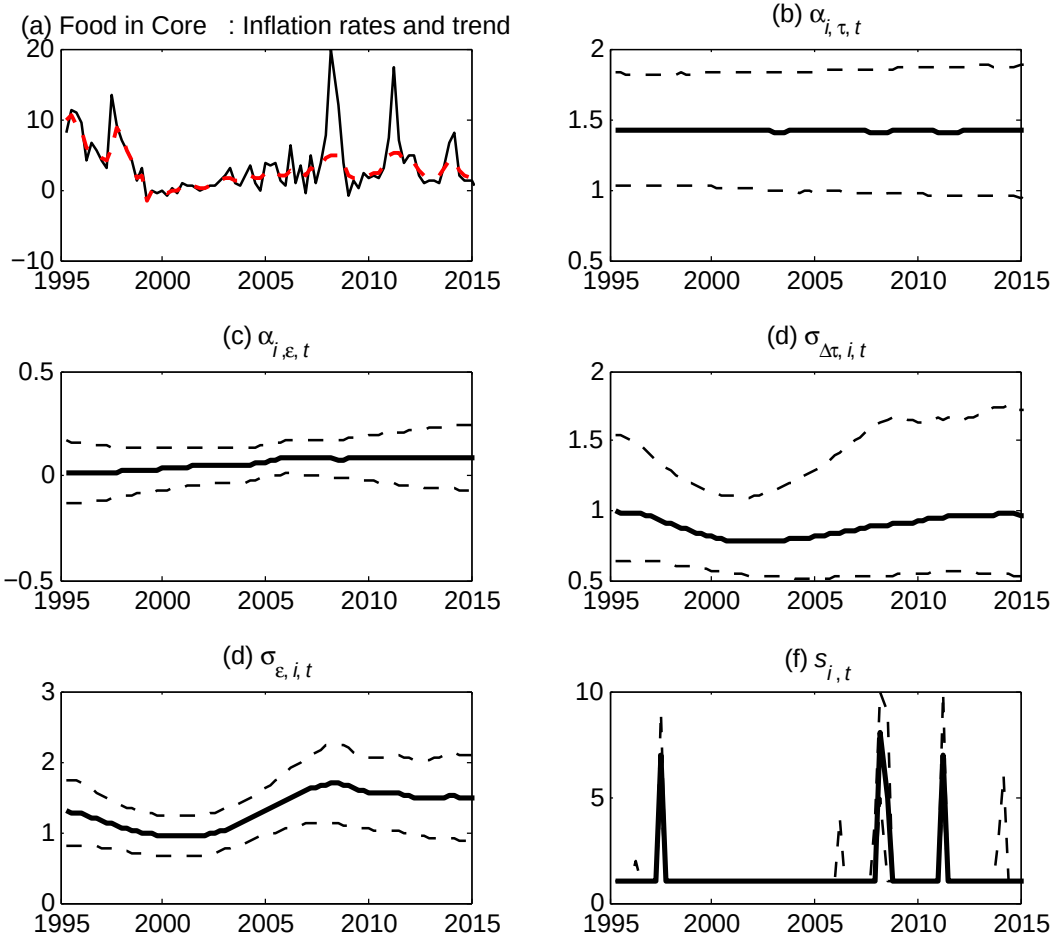
- The common trend component dominates Thai inflation rate movements up until the adoption of an inflation targeting framework in the year 2000, but since then the common transitory component plays a more prominent role.
- Since 2000, the common transitory component is largely driven by volatility in fuel prices
- The global financial crisis is marked by enhanced short-term volatility but there is no evidence of a structural change in inflation dynamics

Extensions:

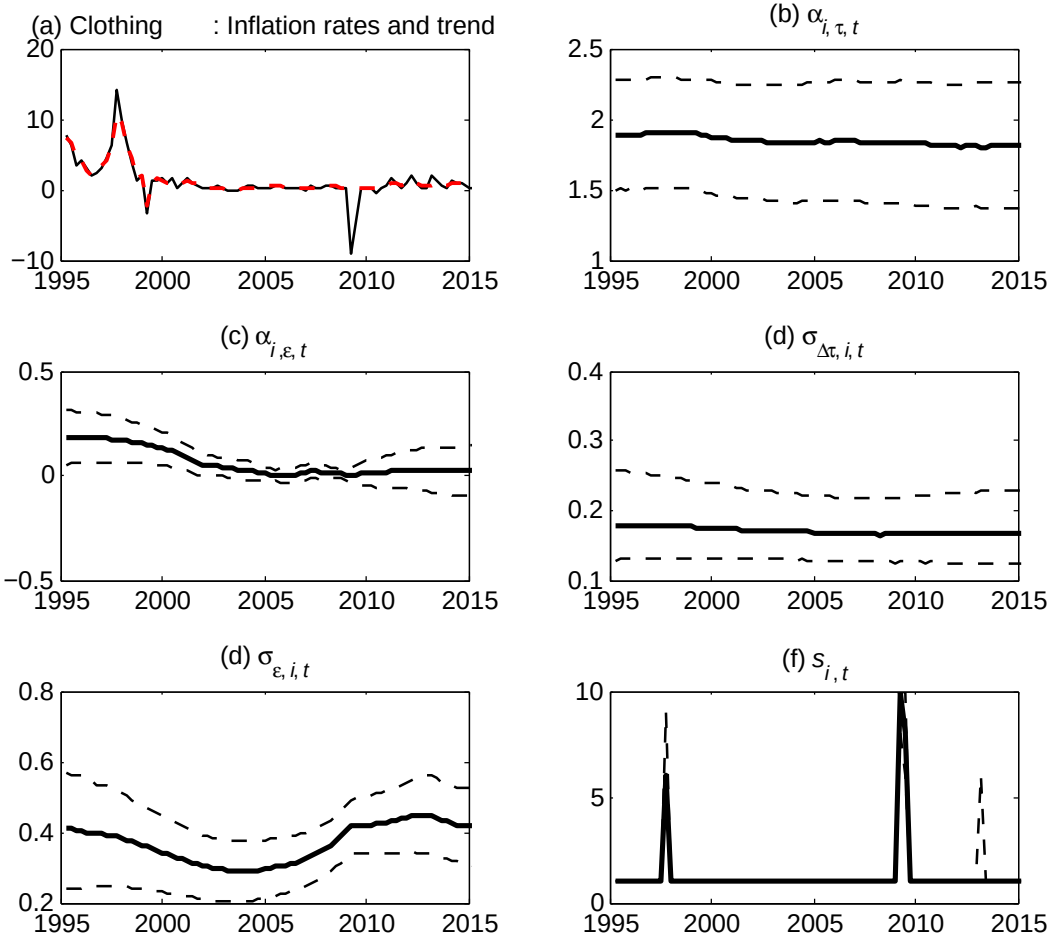
- Finer sectoral dissagregation
- Allowing for different dynamics and alternative specifications for trend and transitory innovations
- Real-time trend estimation with monthly inflation rates

Appendix

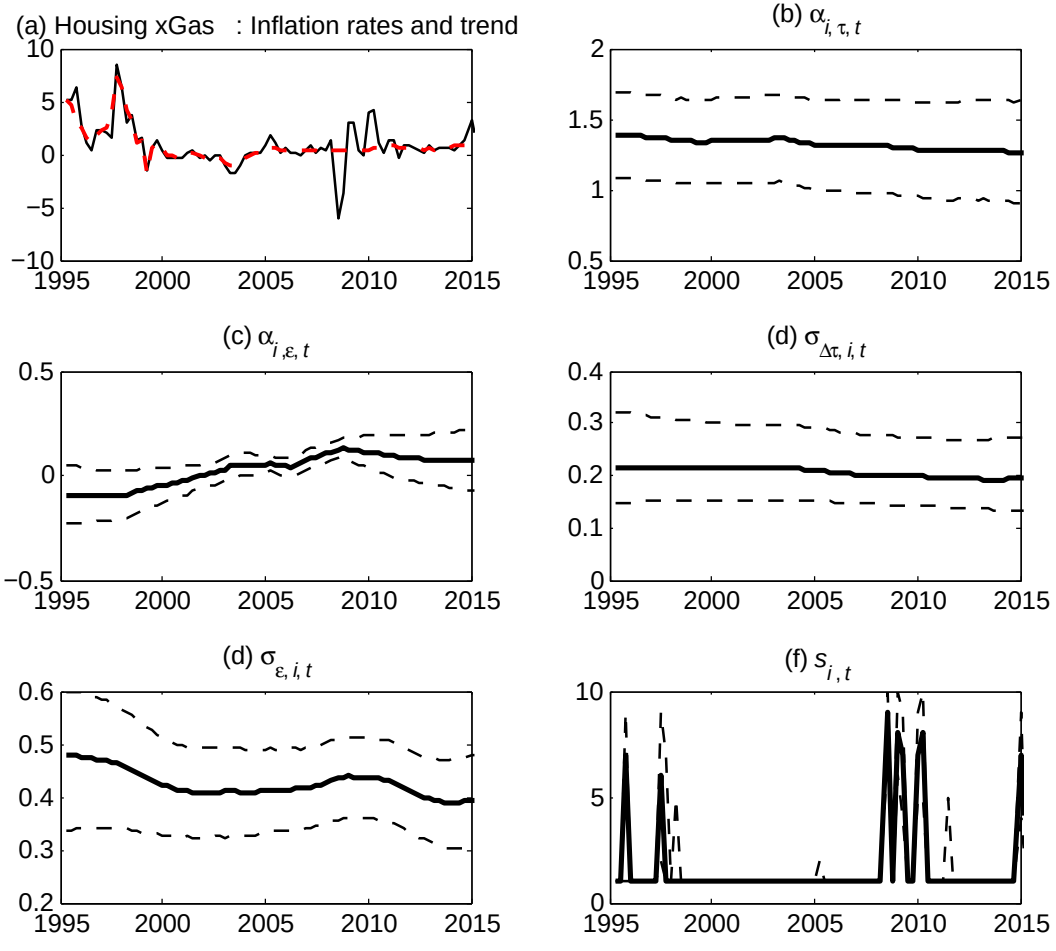
Food in Core


(a) Food in Core : Inflation rates and trend
(b) $\alpha_{i,\tau,t}$
(c) $\alpha_{i,\varepsilon,t}$
(d) $\sigma_{\Delta\tau,i,t}$
(d) $\sigma_{\varepsilon,i,t}$
(f) $s_{i,t}$
1995
2000
2005
2010
2015

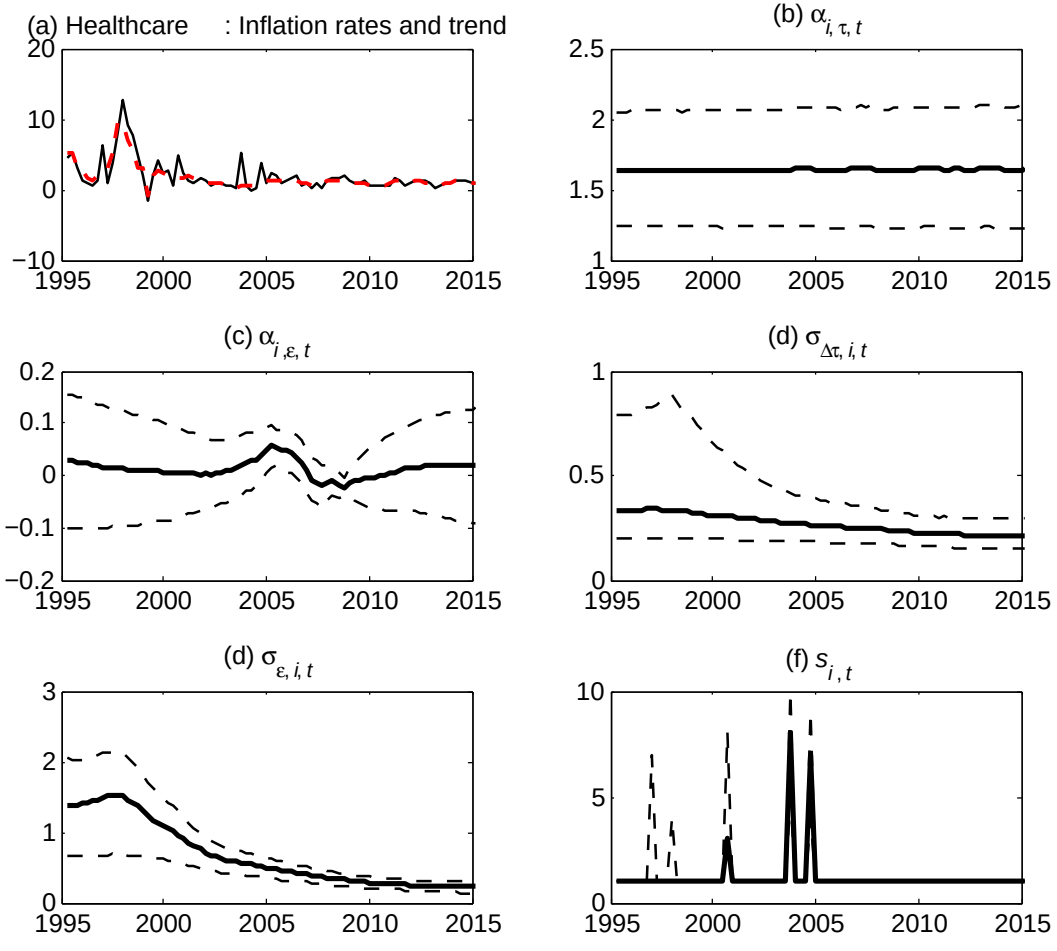
Clothing


(a) Clothing : Inflation rates and trend
(b) $\alpha_{i,\tau,t}$
(c) $\alpha_{i,\varepsilon,t}$
(d) $\sigma_{\Delta\tau,i,t}$
(d) $\sigma_{\varepsilon,i,t}$
(f) $s_{i,t}$
1995
2000
2005
2010
2015

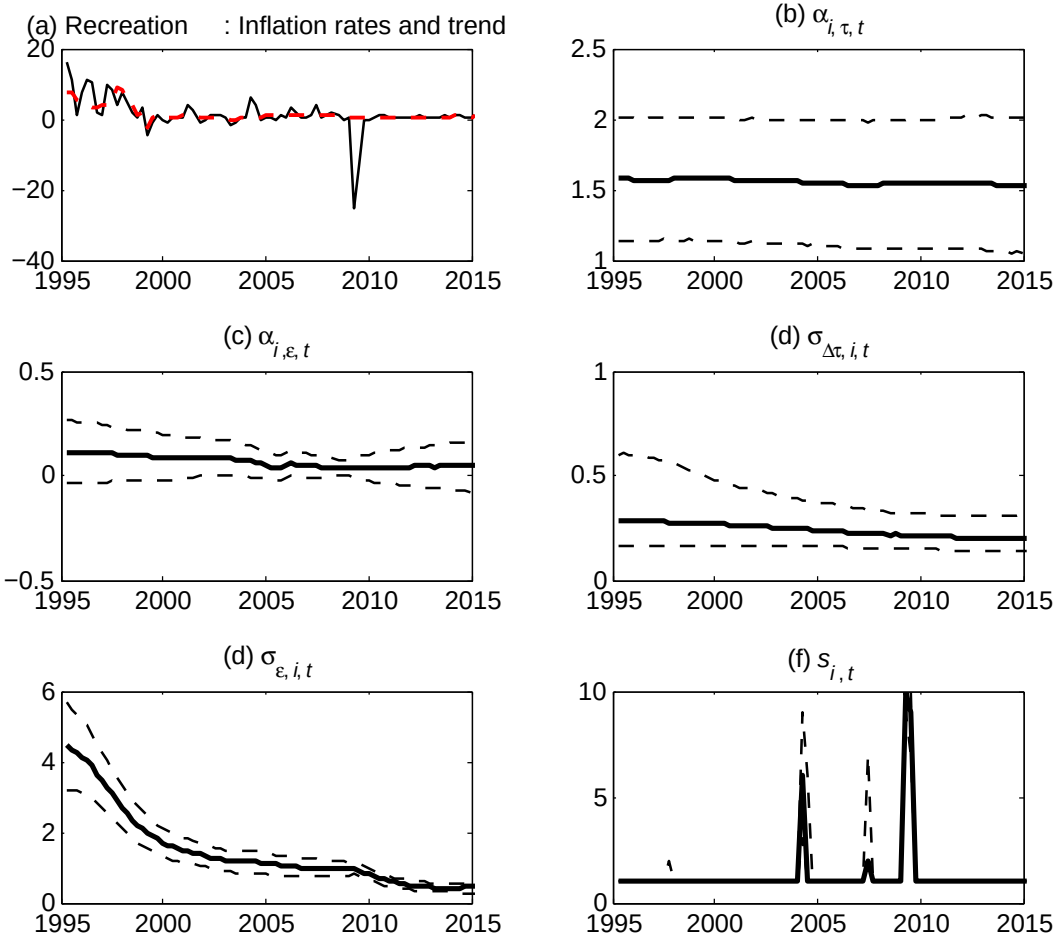
Housing Excluding Gas and Electricity



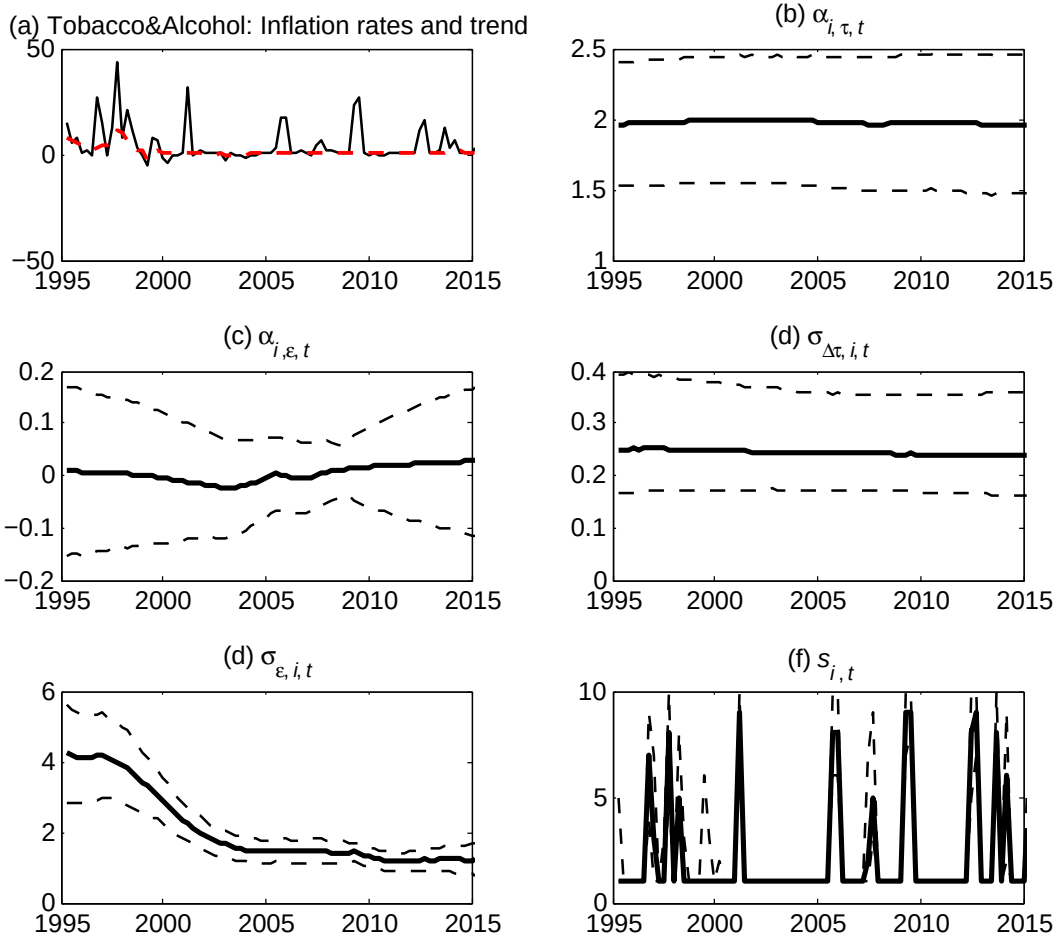
Healthcare


(a) Healthcare : Inflation rates and trend
(b) $\alpha_{i,\tau,t}$
(c) $\alpha_{i,\varepsilon,t}$
(d) $\sigma_{\Delta\tau,i,t}$
(d) $\sigma_{\varepsilon,i,t}$
(f) $s_{i,t}$
1995
2000
2005
2010
2015

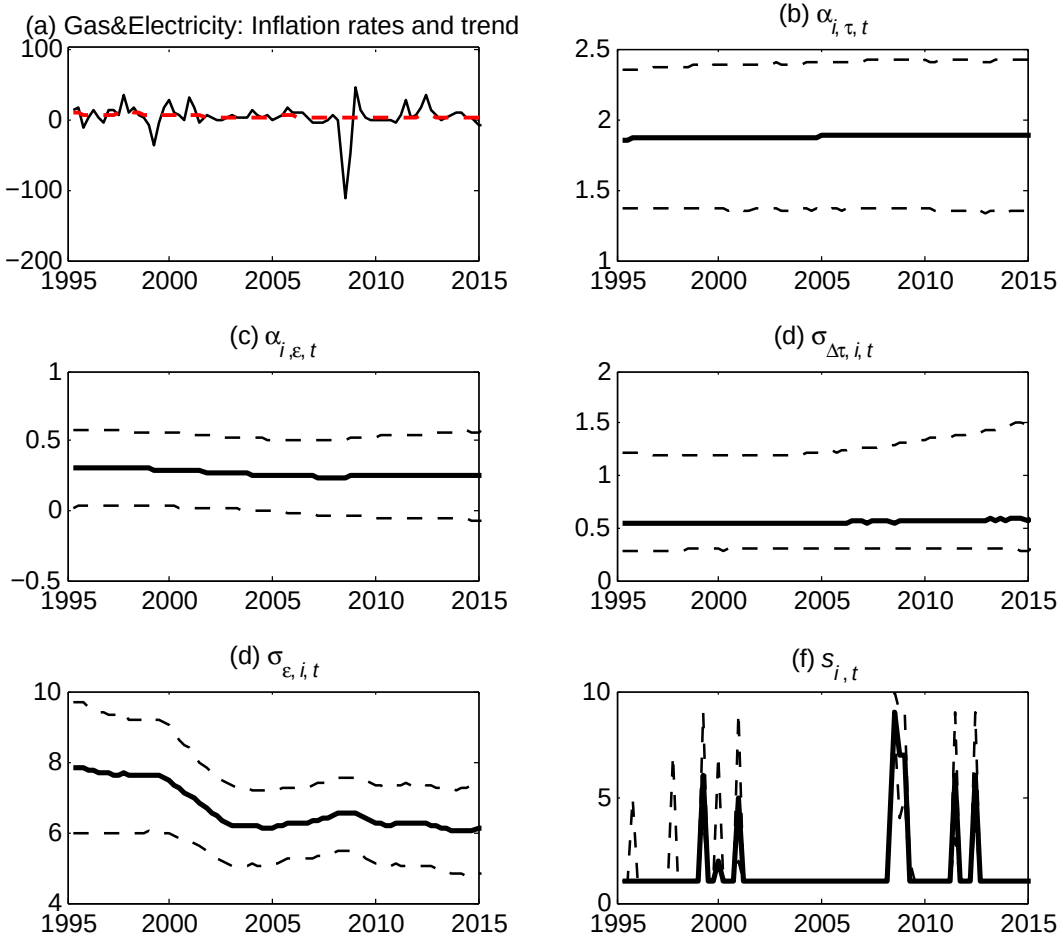
Recreation and Education



Tobacco and Alcohol



Gas and Electricity



Actual Inflation and Filtered Trend

Table 5: Actual Inflation and Filtered Trend

	Headline		Fuel		Raw food	
t	π_t	$\tau_{t\|t}$	π_t	$\tau_{t\|t}$	π_t	$\tau_{t\|t}$
2014Q1	3.113	2.678	10.140	7.223	2.725	5.613
2014Q2	3.778	3.031	1.758	7.027	8.816	6.184
2014Q3	-0.499	2.360	-9.135	5.701	-3.823	4.968
2014Q4	-1.973	1.830	-35.275	2.523	-0.256	4.463
2015Q1	-3.323	1.186	-51.604	-1.363	-3.539	3.459
2015Q2	1.278	1.087	1.853	-0.720	6.032	3.865
2015Q3	-0.431	0.926	-22.670	-2.284	3.628	3.838
2015Q4	-1.007	0.779	-20.325	-3.364	-0.353	3.418
2016Q1	-1.831	0.429	-31.350	-5.132	-3.264	2.695
2016Q2	4.473	0.840	32.840	-1.919	16.587	4.171