Measures of core inflation in Switzerland

An evaluation of alternative calculation methods for monetary policy

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Overview

Motivation

"Traditional" measures of core inflation

- Exclusion-based measures
- Limited-influence estimators
- Volatility-weighted measures

Generalized dynamic factor model

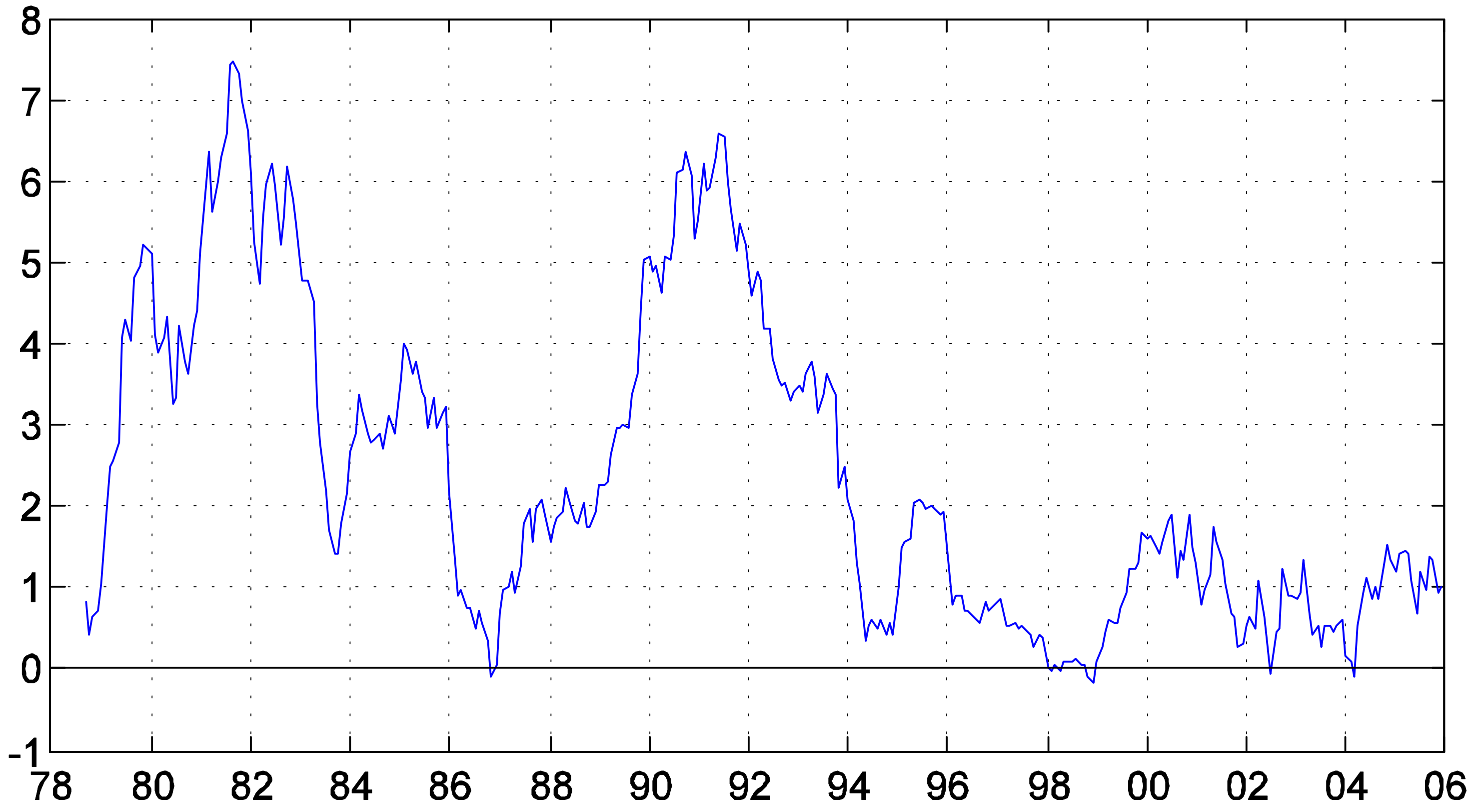
Evaluation

Conclusion

Motivation

- CPI inflation is often contaminated by three main types of transitory disturbances:
  - seasonal fluctuations, e.g. unprocessed food, package holidays
  - supply shocks, e.g. energy, sale prices
  - other non-monetary factors, e.g. indirect taxes, administered prices
- Monetary policy makers need a “filtered” version of CPI inflation reflecting the medium and long-run part of inflation.
- A measure of core inflation removes those fluctuations associated with short-run developments that should be disregarded for monetary policy purposes.
- Key question: “What part of each monthly observation on inflation is durable and what part is fleeting?” (Blinder 1997)

CPI inflation: 1978-2005



“Traditional” measures of core inflation

- Starting point: CPI inflation is a weighted average of individual price changes:

$$\Pi_t = \sum_{i=1}^{N} w_{i,t} \cdot \pi_{i,t}$$

- Strategy: Reducing the impact of “noisy” index items, i.e. their weights are modified according to the “inflation signal”.
- Three approaches:
  - *a priori* exclusion of most volatile prices: CPI excluding food and energy prices (sometimes: administered prices)
  - limited-influence estimators: trimmed means and weighted median
  - volatility-weighted price index: each index item receives a weight which is inversely correlated with its volatility

Data

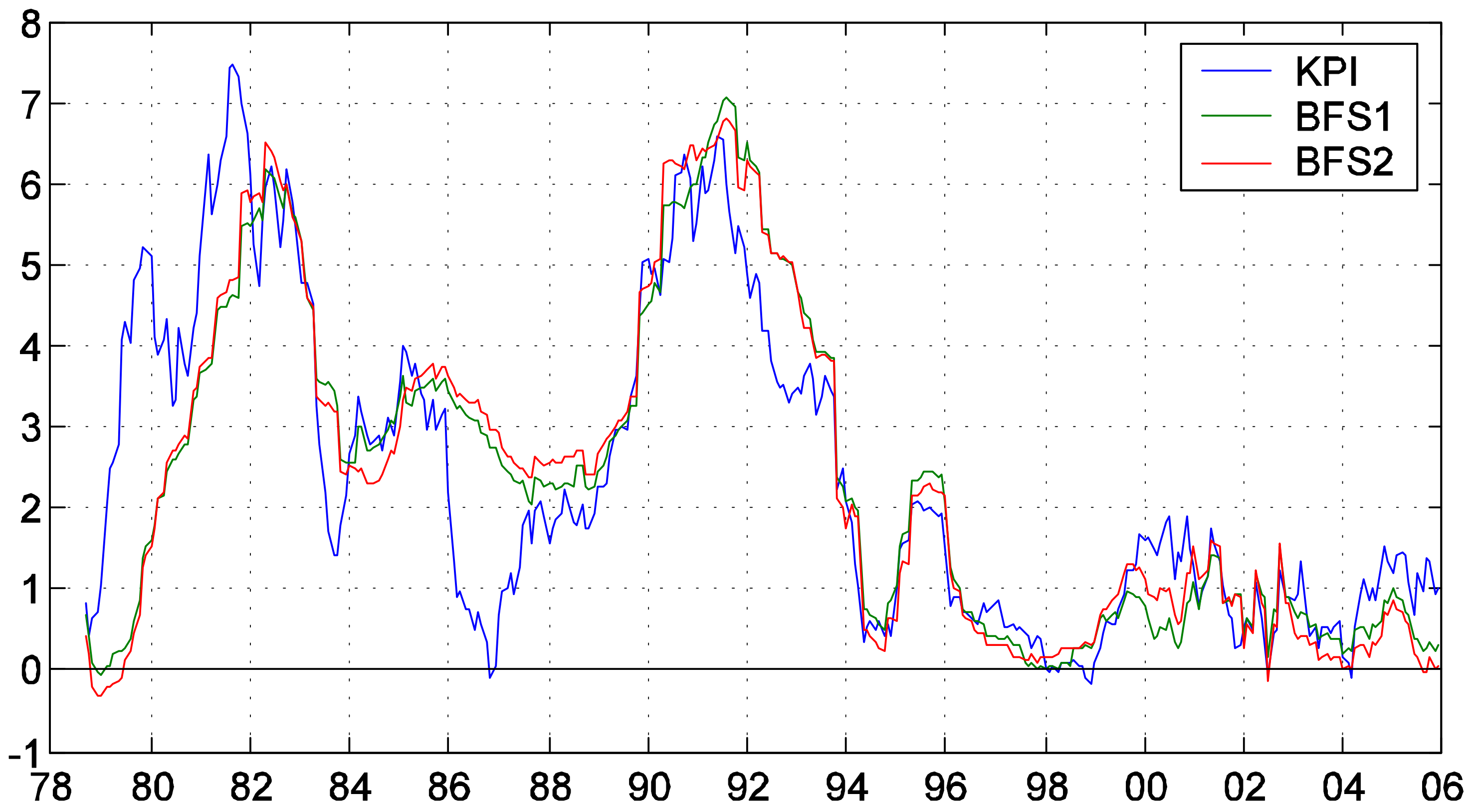
- Disaggregated price series of the Swiss CPI (4-digit level of COICOP) for the time period from 1977:09 to 2005:12.
- Data transformation:
  - For the majority of index items, prices are collected only quarterly (or even less often), so that month-on-month changes are not informative.
  - Therefore, our analysis relies on year-on-year growth rates (nsa).

Base month	Time period	Number of items	Weights
Dec. 1982	1977:09-1993:05	263	constant
May 1993	1993:06-2000:05	201	constant
May 2000	2000:06-2005:12	222	annual adjustment

Exclusion-based measures

	Weights in 1993	Weights in 2000	Weights in 2005
Total CPI	100.0%	100.0%	100.0%
./. food, beverages, tobacco, seasonal products	18.6%	15.3%	14.8%
./. energy and fuels	5.2%	7.0%	7.3%
= BFS1	76.2%	77.7%	77.9%
./. administered prices	14.5%	14.7%	16.1%
= BFS2	61.7%	63.0%	61.8%

Results



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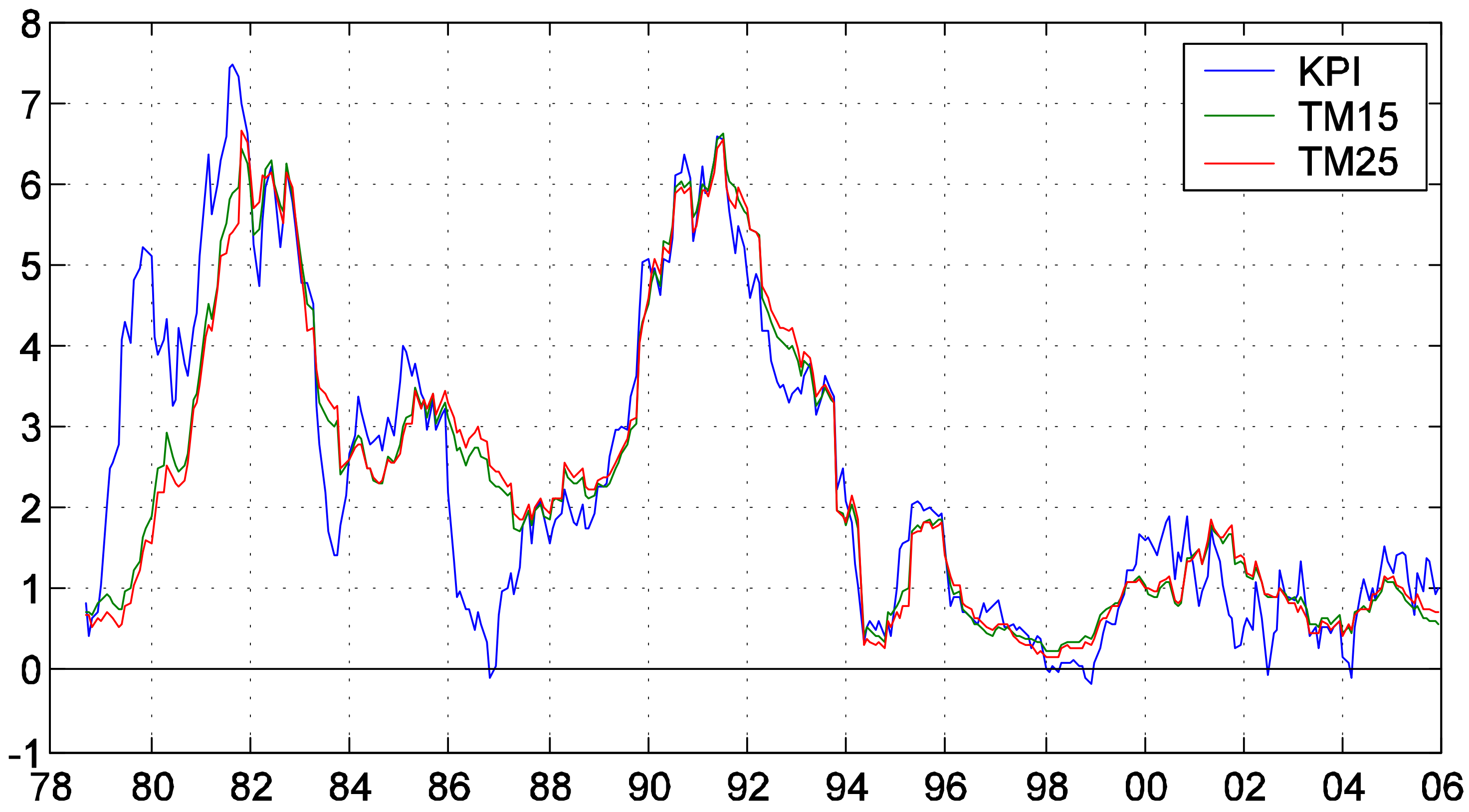
KPI
BFS1
BFS2

Limited-influence estimators

- Empirical fact: Cross-sectional distribution of individual price changes is non-normal, but skewed and leptokurtic.
- In this case, the weighted mean, i.e. CPI inflation, is not an efficient estimator of the distribution’s central tendency (as it is very sensitive to outliers).
- Theory of robust estimators recommends using limited-influence estimators, which give no weight to outliers:
  - trimmed means
  - weighted median
  - Huber-type skipped mean
- Hypothesis: Extreme price fluctuations reflect temporary disturbances and not an underlying trend in prices.

Results



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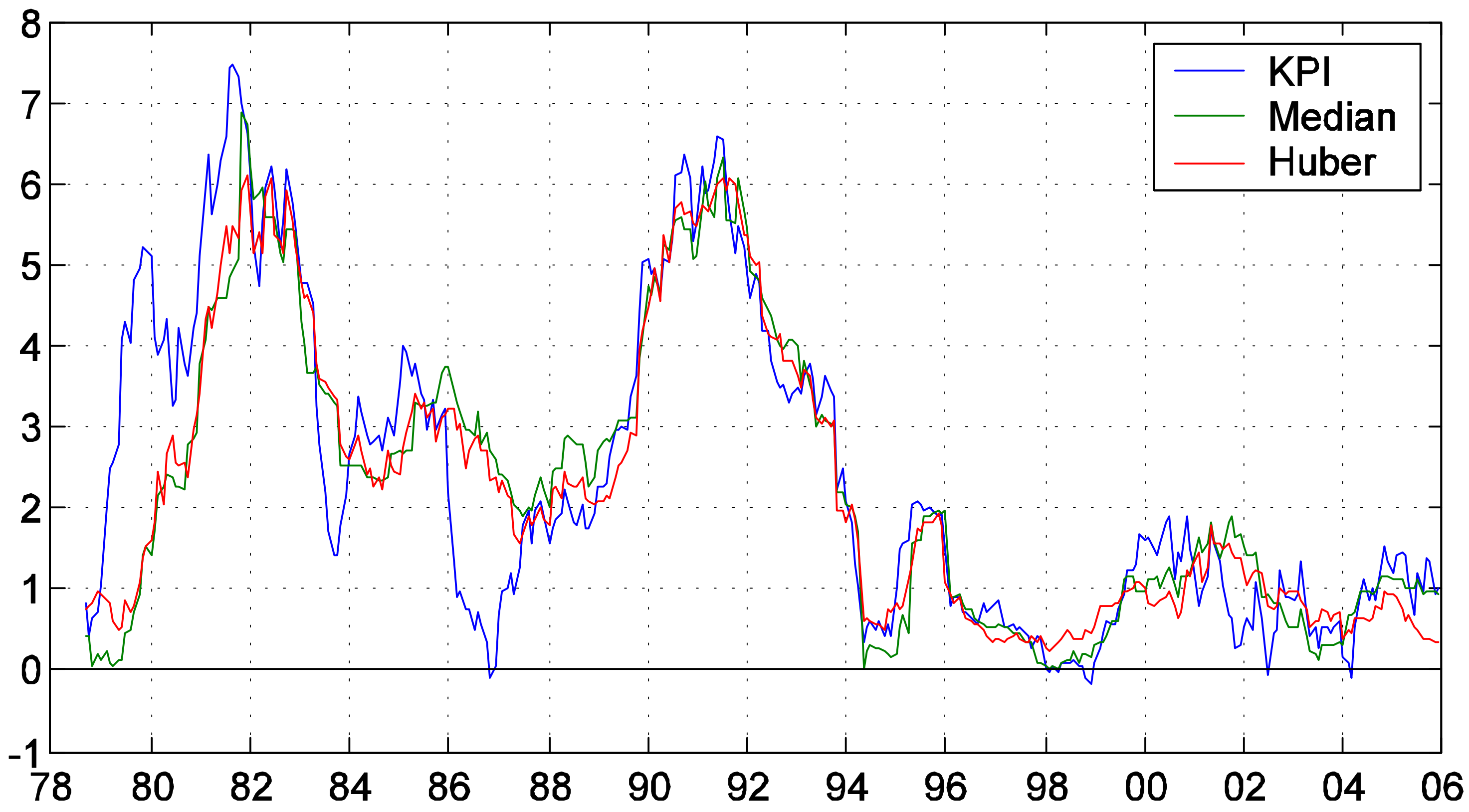
Results (cont'd)



Volatility-weighted measures

- Weights of index items are modified depending on the strength of their “inflation signal”.
- Hypothesis: The higher the relative price variability of a specific index item, the weaker its “inflation signal”.
- Weights can be adjusted in a systematic manner, when relative price variabilities change over time.
- No complete exclusion of index items, no loss of relevant information!

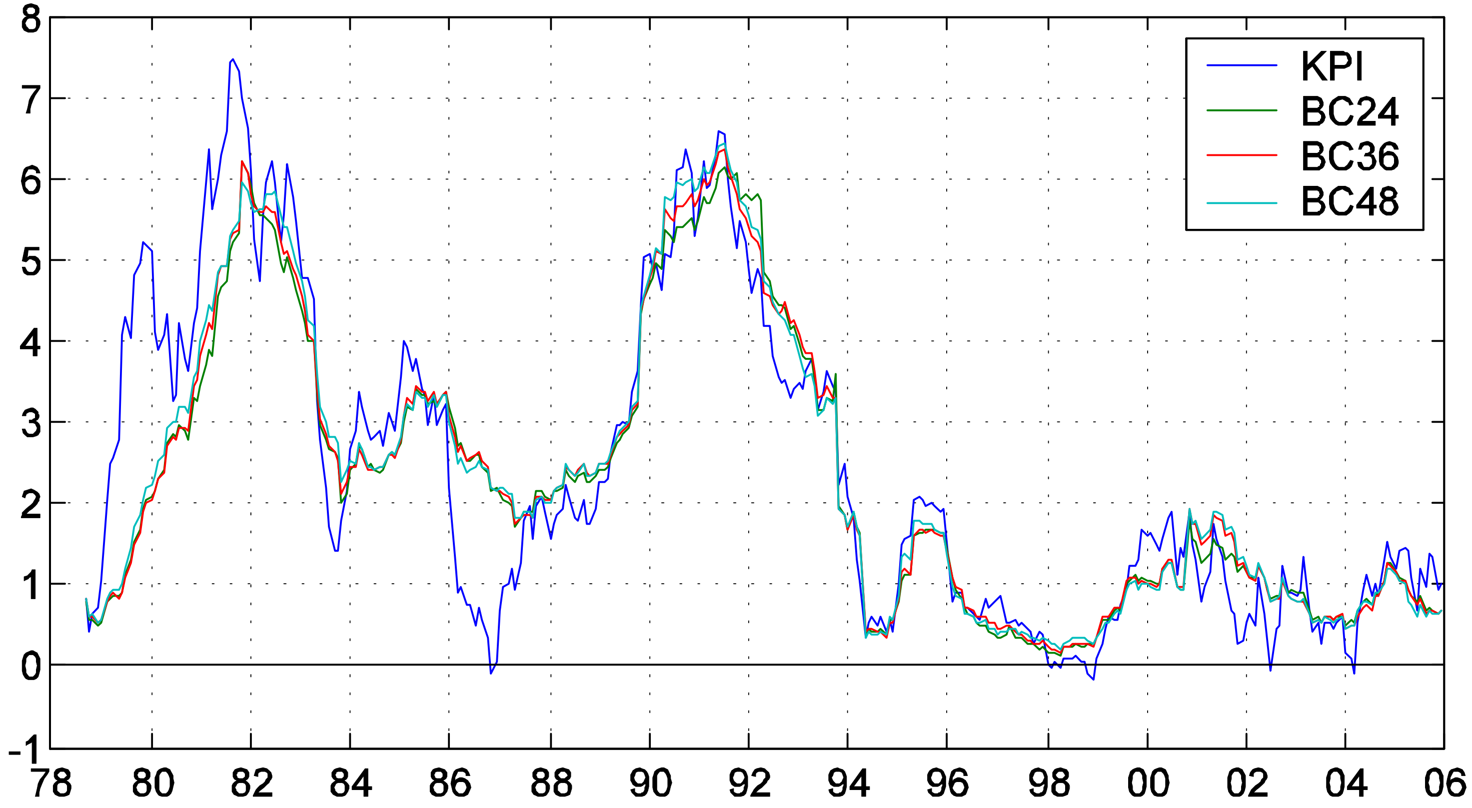
Weighting scheme used by the BoC

$$w_{i,t}^{*} = \frac{\dfrac{w_{i,t}}{\sigma_{i,t}}}{\displaystyle\sum_{i=1}^{N} \frac{w_{i,t}}{\sigma_{i,t}}}$$

$$\textbf{where} \quad \sigma_{i,t} = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left[(\pi_{i,t} - \Pi_t) - \overline{(\pi_{i,t} - \Pi_t)}\right]^2}$$

$$\textbf{and} \quad \overline{(\pi_{i,t} - \Pi_t)} = \frac{1}{T}\sum_{t=1}^{T}(\pi_{i,t} - \Pi_t)$$

Results



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Shortcomings of “traditional” measures of core inflation

- Resulting indicators normally exhibit a relatively high volatility, so that conclusions on the trend in inflation remain difficult.
- By excluding index items not only their volatile components (“noise”) are removed, but also their trend components (“signal”). As a result, relevant information on the trend in inflation may be lost.
- Superior strategy: Instead of modifying weights, filter out idiosyncratic and short-run price movements of the index items:

$$\pi_{i,t} = \pi^*_{i,t} + \epsilon_{i,t} \;\Rightarrow\; \Pi^*_t = \sum_{i=1}^{N} w_{i,t}\pi^*_{i,t}$$

Generalized dynamic factor model proposed by Forni *et al.*

- The GDFM considers a large panel of variables and aims at extracting the driving forces ("factors") which are responsible for the co-movement of the variables.
- Idea: Each variable of the panel can be represented as the sum of two mutually orthogonal components:
  - common component: driven by a small number of common "factors"
  - idiosyncratic component: driven by variable-specific shocks
- By nature, both components are unobservable – the objective is to estimate them.
- Common components can be cleaned from short-run fluctuations ("high-frequency noise").
- Estimation of GDFM is based on dynamic principal component analysis of the covariance matrix (i.e. in the frequency domain).

Data

- Panel comprises 102 disaggregated price series of the Swiss CPI for the time period from 1977:09 to 2005:12.
- Data transformation:
  - Month-on-month growth rates (nsa)
  - Standardization: $x_{jt} = \dfrac{\pi_{jt} - \overline{\pi}_j}{s_j}$
  - Structural break in 1993:05 is taken into account.
- Unit root tests (such as ADF, PP and KPSS) indicate that all series are stationary.

Decomposition of individual price changes

$$x_{1t} = x^{*}_{1t} + \varepsilon_{1t}$$

idiosyncratic shocks, short-run dynamics, measurement errors

signal

$$x_{1t} = x^{*}_{1t} + \varepsilon_{1t} = \chi^{L}_{1t} + \chi^{S}_{1t} + \xi_{1t}$$

$$x^{*}_{1t} = \chi^{L}_{1t}$$

common medium to long-run component

Constructing the dynamic factor index (DFX)

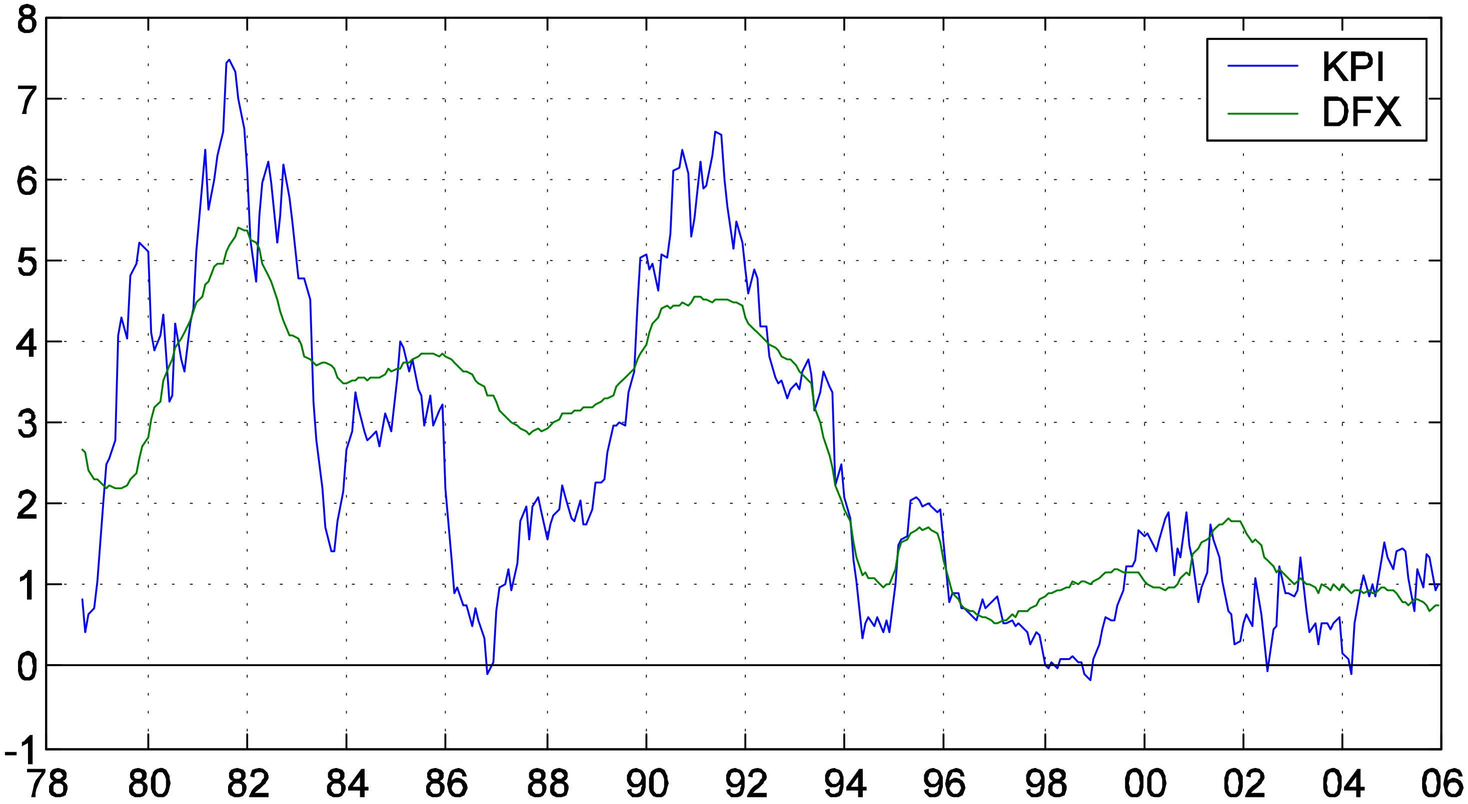
1. Month-on-month core inflation by reversing the standardization and aggregating:

$$Core_t^m = \sum_{j=1}^{N} \omega_{j,t} \left(\chi_{jt}^L \ s_j + \overline{\pi}_j \right)$$

2. Year-on-year core inflation by cumulating month-on-month core inflation:

$$Core_t^y = \prod_{k=0}^{11} \left(1 + Core_{t-k}^m \right) - 1$$

Result



Evaluation

Empirical criteria:

- Unbiasedness with respect to CPI inflation
- Lower variability relative to CPI inflation
- Attractor of CPI inflation
- Ability to forecast CPI inflation (“predictive power”)

➲ Information content for monetary policy can be assessed formally by conducting a set of statistical tests.

➲ In the following, results are presented for 6 selected indicators of core inflation only; complete results are available on request.

Unbiasedness

Average of monthly observations

	CPI	BFS1	BFS2	TM15	Median	BC36	DFX
1978:09-1993:05	3.62	3.63*	3.69**	3.50	3.41	3.46	3.73†
1993:06-2005:12	0.99	0.89**	0.84**	0.98	0.94	0.97	1.16

$$\Pi_t = \alpha + \beta \Pi_t^* + \varepsilon_t \;\Rightarrow\; H_0 : \; \alpha = 0, \; \beta = 1$$

†, * and ** : Rejection of null hypothesis at a 10%, 5% and 1% level of significance, based on a Wald test.

Lower variability

Standard deviation of change in the annual percentage change

	CPI	BFS1	BFS2	TM15	Median	BC36	DFX
1978:09-1993:05	0.42	0.24**	0.26**	0.25**	0.30**	0.20**	0.08**
1993:06-2005:12	0.29	0.26	**0.31**	0.20**	0.24*	0.20**	0.08**

* and ** : Rejection of null hypothesis of equal variance at a 5% and 1% level of significance, based on a F-test.

Attractor of CPI inflation

- Error correction model:

$$\Delta\Pi_t = \sum_{j=1}^{m} \alpha_j \Delta\Pi_{t-j} + \sum_{j=1}^{n} \beta_j \Delta\Pi^*_{t-j} + \kappa\left(\Pi_{t-1} - \Pi^*_{t-1}\right) + \varepsilon_t$$

$$\Delta\Pi^*_t = \sum_{j=1}^{r} \gamma_j \Delta\Pi_{t-j} + \sum_{j=1}^{s} \delta_j \Delta\Pi^*_{t-j} + \lambda\left(\Pi_{t-1} - \Pi^*_{t-1}\right) + \eta_t$$

- Test for unidirectional Granger causality
- Hypotheses:
  i. There exists an error correction mechanism for π_t : H_0: $\kappa = 0$
  ii. π^*_t is weakly exogenous: H_0: $\lambda = 0$
  iii. π^*_t is strictly exogenous: H_0: $\lambda = \gamma_1 = \dots = \gamma_r = 0$ (debatable!)

Results: *p*-values

In the sub-sample from 1978:09 to 1993:05, only DFX behaves as an attractor of CPI inflation.

Sub-sample from 1993:06 to 2005:12:

	BFS1	BFS2	TM15	Median	BC36	DFX
$\kappa = 0$	0.453	0.382	0.027*	0.128	0.027*	0.004**
$\lambda = 0$	0.205	0.114	0.380	0.069	0.831	0.489
$\lambda = \gamma_1 = \ldots = \gamma_r = 0$	0.062	0.011*	0.734	0.322	0.436	0.598
Conclusion	✗	✗	ok	✗	ok	ok

Ability to forecast CPI inflation

- To assess the out-of-sample forecast performance of core inflation measures, we use the following regression model:

$$(\Pi_{t+h} - \Pi_t) = \alpha + \beta(\Pi_t^* - \Pi_t) + u_t, \quad h = 6, 12, 18, 24$$

- Forecasting experiment:
  - 1. sub-sample: recursive estimation from 1987:01 to (1993:05-*h*)
  - 2. sub-sample: recursive estimation from 1999:01 to (2005:12-*h*)
  - To ensure a fair comparison, real-time estimates of DFX are used.
- In general, the predictive power of core inflation measures is very low!
  - A random-walk model or a simple mean-reversion model yield forecasts that are more accurate than a forecast equation based on measures of core inflation.
- Pivotal question: How relevant is this criterion to monetary policy in practice?

Results: Root mean squared errors

Sub-sample from 1993:06 to 2005:12

	BFS1	BFS2	TM15	Median	BC36	DFX	R.W.	M.R.
$h = 6$	0.62	0.63	0.58	0.59	0.62	0.58	0.53	0.48
$h = 12$	0.86	0.88	0.93	0.83	1.06	0.77	0.74	0.54
$h = 18$	0.96	0.92	1.04	1.01	1.21	0.77	0.75	0.55
$h = 24$	1.27	0.98	1.06	1.00	1.26	0.78	0.76	0.56

Sub-sample from 1978:09 to 1993:05: Results are qualitatively the same.

Summary of results

Sub-sample from 1993:06 to 2005:12

	BFS1	BFS2	TM15	Median	BC36	DFX
Unbiasedness	✕	✕	ok	ok	ok	ok
Lower volatility	✕	✕	ok	ok	ok	ok
Attractor of CPI inflation	✕	✕	ok	✕	ok	ok
Forecast ability	✕	✕	✕	✕	✕	✕

Conclusion

- Measures of core inflation are useful tools for price analysis. In particular, they serve as a systematic framework to identify the driving forces behind short-run developments of the CPI, i.e.
  - transitory price disturbances,
  - price movements specific to particular goods or sectors.
- Robust estimators provide an in-depth insight into the cross-sectional distribution of price changes of CPI items.
- According to statistical tests, none of the measures of core inflation satisfy all the empirical criteria desirable from a monetary policy perspective.
- It is advisable to monitor a whole range of measures of core inflation and treat them as complementary pieces of information.

Conclusion (cont’d)

- A thorough understanding of price developments always requires a broadly based macroeconomic analysis.
- Measures of core inflation do not embody any relevant information on price developments in the medium and long-run. To assess future risks to price stability, monetary policy should rely on
  - capacity utilisation, output gap, unit labour costs, monetary aggregates, bank lending, exchange rates, inflation expectations,
  - forecasts derived from various economic models.
- Periodical re-examinations of alternative core inflation measures are recommended, as their information content can change over time.