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).

<table>
<thead>
<tr>
<th>Base month</th>
<th>Time period</th>
<th>Number of items</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1993</td>
<td>1993:06-2000:05</td>
<td>201</td>
<td>constant</td>
</tr>
<tr>
<td>May 2000</td>
<td>2000:06-2005:12</td>
<td>222</td>
<td>annual adjustment</td>
</tr>
</tbody>
</table>
## Exclusion-based measures

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

\[ w_{i,t}^* = \frac{\frac{w_{i,t}}{\sigma_{i,t}}}{\sum_{i=1}^N \frac{w_{i,t}}{\sigma_{i,t}}} \]

where

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

and

\[ (\pi_{i,t} - \Pi_t) = \frac{1}{T} \sum_{t=1}^T (\pi_{i,t} - \Pi_t) \]
Results
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:

\[
\pi_{i,t} = \pi^*_{i,t} + \epsilon_{i,t} \quad \Rightarrow \quad \Pi_t^* = \sum_{i=1}^{N} \omega_{i,t} \pi^*_{i,t}
\]
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: \( x_{jt} = \frac{\pi_{jt} - \overline{\pi}_j}{s_j} \)
  - 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

\[ x_{1t} = x_{1t}^* + \varepsilon_{1t} = \chi_{1t}^L + \chi_{1t}^S + \xi_{1t} \]

common medium to long-run component

\[ x_{1t}^* = \chi_{1t}^L \]
Constructing the dynamic factor index (DFX)

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

\[ C_{orm}^m = \sum_{j=1}^{N} \omega_{j,t} \left( \chi_{jt}^L s_j + \bar{\pi}_j \right) \]

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

\[ C_{ory}^y = \prod_{k=0}^{11} \left( 1 + C_{orm}_{t-k} \right) - 1 \]
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

<table>
<thead>
<tr>
<th></th>
<th>CPI</th>
<th>BFS1</th>
<th>BFS2</th>
<th>TM15</th>
<th>Median</th>
<th>BC36</th>
<th>DFX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978:09-1993:05</td>
<td>3.62</td>
<td>3.63*</td>
<td>3.69**</td>
<td>3.50</td>
<td>3.41</td>
<td>3.46</td>
<td>3.73†</td>
</tr>
<tr>
<td>1993:06-2005:12</td>
<td>0.99</td>
<td>0.89**</td>
<td>0.84**</td>
<td>0.98</td>
<td>0.94</td>
<td>0.97</td>
<td>1.16</td>
</tr>
</tbody>
</table>

\[
\Pi_t = \alpha + \beta \Pi_t^* + \varepsilon_t \quad \Rightarrow \quad H_0 : \alpha = 0, \beta = 1
\]

†, * 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

<table>
<thead>
<tr>
<th></th>
<th>CPI</th>
<th>BFS1</th>
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<th>TM15</th>
<th>Median</th>
<th>BC36</th>
<th>DFX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978:09-1993:05</td>
<td>0.42</td>
<td>0.24**</td>
<td>0.26**</td>
<td>0.25**</td>
<td>0.30**</td>
<td>0.20**</td>
<td>0.08**</td>
</tr>
<tr>
<td>1993:06-2005:12</td>
<td>0.29</td>
<td>0.26</td>
<td>0.31</td>
<td>0.20**</td>
<td>0.24*</td>
<td>0.20**</td>
<td>0.08**</td>
</tr>
</tbody>
</table>

* 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 \( \pi_t \): \( H_0: \kappa = 0 \)
  ii. \( \pi^*_t \) is weakly exogenous: \( H_0: \lambda = 0 \)
  iii. \( \pi^*_t \) is strictly exogenous: \( H_0: \lambda = \gamma_1 = \ldots = \gamma_r = 0 \) (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:

<table>
<thead>
<tr>
<th></th>
<th>BFS1</th>
<th>BFS2</th>
<th>TM15</th>
<th>Median</th>
<th>BC36</th>
<th>DFX</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \kappa = 0 )</td>
<td>0.453</td>
<td>0.382</td>
<td>0.027*</td>
<td>0.128</td>
<td>0.027*</td>
<td>0.004**</td>
</tr>
<tr>
<td>( \lambda = 0 )</td>
<td>0.205</td>
<td>0.114</td>
<td>0.380</td>
<td>0.069</td>
<td>0.831</td>
<td>0.489</td>
</tr>
<tr>
<td>( \lambda = \gamma_1 = \ldots = \gamma_r = 0 )</td>
<td>0.062</td>
<td>0.011*</td>
<td>0.734</td>
<td>0.322</td>
<td>0.436</td>
<td>0.598</td>
</tr>
</tbody>
</table>

Conclusion: \( \times \quad \times \quad \text{ok} \quad \times \quad \text{ok} \quad \text{ok} \quad \text{ok} \)
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

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

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

Sub-sample from 1993:06 to 2005:12

<table>
<thead>
<tr>
<th></th>
<th>BFS1</th>
<th>BFS2</th>
<th>TM15</th>
<th>Median</th>
<th>BC36</th>
<th>DFX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unbiasedness</td>
<td>✗</td>
<td>✗</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>Lower volatility</td>
<td>✗</td>
<td>✗</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>Attractor of CPI inflation</td>
<td>✗</td>
<td>✗</td>
<td>ok</td>
<td>✗</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>Forecast ability</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
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.