Detecting a Change in Inflation Persistence in the Presence of Long Memory: A New Test

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Why care about (a change in) inflation persistence?

- Response to shocks depends on the degree to which their effect on inflation is persistent.
- Inflation persistence is an important ingredient of inflation forecasts.
- Inflation persistence reveals central bank’s credibility & communic. skills.
- For more details: Altissimo et al. (2006)
Agenda

1. Methodology
2. New test against a break in persistence
3. Testing against a change in U.S. inflation persistence
4. Concluding remarks
How to detect a change in persistence?

In general, using

- Auto-regressive coefficients (short run persistence)
- Order of fractional integration (long run persistence)

In case of a fractionally integrated process,

- Sum of AR coeff. = 1 for any order of integration > 0, i.e. unable to detect change in long run persistence (Gadea and Mayoral, 2006)
- Hassler and Wolters (1995) and others established that inflation is FI
- Use order of fractional integration for inflation persistence!
Fractional integration/long memory as measure for persistence

Inflation $\pi$ is fractionally integrated of order $d$, $I(d)$:

$$(1 - L)^d \pi_t = \epsilon_t ; \quad t = 1, \ldots, T; \quad \epsilon \sim I(0)$$

- E.g. in classical unit root tests: $I(1)$ vs $I(0)$
- Fractional integration or long memory: $I(d)$, e.g. $0 < d < 1$
- What does long memory have to do with persistence?
  The autocorrelation function of $\pi$ with lag $h$ being large:

$$\rho_y(h) \sim \rho h^{2d-1}$$

$\Rightarrow$ The higher $d$ the slower past shocks die out
Existing Literature on a change in long memory

- Beran and Terrin (1996) propose test using Whittle estimator; Not applicable in empirical work.
- Shimotsu (2006) establishes normality of Wald-type test for known break; extension to unknown timing fails (no $\sqrt{T}$ consistency), see Hassler and Olivares (2008).
- Sibbertsen and Kruse (2008) propose test for an unknown break relying on preliminary consistent estimation $d'$; potentially unreliable.
- Ray and Tsay (2002) estimate the posterior probability and size of a change in $d$.

Need for a test estimating timing & significance of a break in $d$. 

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The new test

We modify the regression-based LM test of Demetrescu et al. (2008), where \( x_t = (1 - L)^d \hat{\pi}_t \) and \( x_{t-1}^* = \sum_{j=1}^{t-1} \frac{x_{t-j}}{j} : \)

\[
x_t = \hat{\phi} x_{t-1}^* + \hat{\psi} D_t(\lambda) x_{t-1}^* + \sum_{j=1}^{p} \hat{a}_j x_{t-j} + \hat{\varepsilon}_t
\]

with step dummy

\[
D_t(\lambda) = \begin{cases} 
0, & t = 1, \ldots, \lfloor \lambda T \rfloor \\
1, & t = \lfloor \lambda T \rfloor + 1, \ldots, T
\end{cases}
\]

- Grid search over \( \lambda \), e.g. \( \lambda \in [0.15, 0.85] \)
- Potential break where squared \( t \)-statistic of \( \hat{\psi} \) is largest
- Significance is determined using Andrews (1993) CV
Monte Carlo study: Small sample properties

- $T=1000$; $y \sim I(0)$ before $T=500$, $y \sim I(\theta)$ after $T=500$.
- Figure: Rejection rates plotted against $\theta$
- Power and size are satisfactory!
Monte Carlo study: Variations

- Timing of break: 200, 300, 400, 500, 600, 700, 800.
- Adding short memory: AR(1) with $a=0$, $a=0.5$, $a=0.75$.
- Misspecifying $d$ a priori: $-0.4$, $-0.3$, ..., $0.4$.

⇒ Power and size are satisfactory!
Existing Literature on a change in inflation persistence

- no change:
  - Pivetta and Reis (2007): using AR
  - Stock and Watson (2007): when using AR

- change:
  - Kumar and Okimoto (2007): in 1980s using FI
  - Halunga et al. (2009): in 1973 and 1982 using I(0) vs I(1) testing.
Sample

- US inflation: change in monthly CPI
- Seasonally adjusted, mean shift adjusted (Hsu, 2005)
- Time period: 1966-2008
Test against a break in $d$

Figure: Evolution of $t^2$-statistic and CV $\Rightarrow$ Significant break 1973
Repeating analysis on 1973-2008: significant break in 1980
Repeating analysis on 1980-2008: insignificant break in 1996
### Empirical results

<table>
<thead>
<tr>
<th>Period</th>
<th>$\hat{d}$</th>
<th>95%-CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-1973</td>
<td>0.14</td>
<td>[-0.06, 0.35]</td>
</tr>
<tr>
<td>1973-1980</td>
<td>0.55</td>
<td>[ 0.37, 0.73]</td>
</tr>
<tr>
<td>1980-2008</td>
<td>0.09</td>
<td>[-0.02, 0.19]</td>
</tr>
</tbody>
</table>

ELW estimates of $d$ for different periods. Bandwidth $m = T^{0.70}$. 95%-CI in brackets.
Concluding remarks

Econometric inference:
- New test to determine timing & significance of break in $d$
- The test has very good size and power in diff. settings

Monetary economics:


