Adopting price level targeting under imperfect credibility in ToTEM

Gino Cateau, Oleksiy Kryvstov, Malik Shukayev, Alexander Ueberfeldt

Monetary Policy Studies division
Bank of Canada
Inflation targeting

Currently practiced in more than 20 countries
- New Zealand, UK, Canada

Successful in stabilizing inflation and the real economy
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Yet, *from a theoretical perspective*, price level targeting may be superior
- Svensson (JMCB 1999), Vestin (JME 2006)
Inflation versus price level targeting
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Why does PT dominate IT

- Expectations
- Under PT, policy-maker can better exploit expectations to influence economy
Why does PT dominate IT

- Expectations
- Under PT, policy-maker can better exploit expectations to influence economy

If policy *can credibly commit* to bring price level back to target after a shock
  - Agents expect shocks to price level to be reversed
  - Less need for households to ask for increase in wages
  - Less need for firms to alter their prices
Should policy-maker switch from IT to PT?
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Two caveats

- Theory versus quantitative implications?
  - Most papers that focus on the IT vs PT debate do so in small-scale models e.g. Svensson (JMCB 1999), Vestin (JME 2006)
  - May be quantitatively misleading
Should policy-maker switch from IT to PT?

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- Credibility
  - Switching from IT to PT may not be costless. Agents may take time to understand.
  - Imperfect credibility may affect ability of policy-maker to exploit expectations
What we do

Question: What are the quantitative gains of switching from IT to PT?
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- Large scale model: ToTEM
  - Canada is currently in the process of determining whether to switch to PT in 2011

- Imperfect credibility
  - Upon switching from IT to PT at time 0, agents assign a probability that policy-maker will switch back to IT at time 1
What we find

- Gains from PT are significant
  - ToTEM: Gains from PT can range from 30 to 50 per cent of standard deviation of CPI in Canada
  - Clarida, Gali, Gertler (1999): 10 per cent of standard deviation of CPI

- Imperfect credibility must be very long lasting for PT to not be worthwhile
  - A minimum of 13 years of low credibility for gains to be eroded
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- Caveat
  - Gains from PT are related to persistence in inflation
  - ToTEM generates too much persistence relative to inflation targeting era
Policy Problem

- Choose policy instrument: \( i_t \)
- Welfare
  \[ E_{-1} \sum_{t=0}^{\infty} \beta^t \left\{ \pi_t^2 + \omega x_t^2 + \nu \Delta i_t^2 \right\} \]
- Model
  \[ H_1 z_{t-1} + H_2 z_t + H_3 E_t z_{t+1} + B i_t + C u_t = 0 \]
  \[ u_{t+1} = \Omega u_t + \epsilon_{t+1} \]
- Commitment
  Solution would be a function of \( z_{t-1} \) and co-state variables associated to forward-looking variables
Policy Problem under discretion

- Inflation targeting
  - loss criterion depends on inflation, $\pi_t$

$$E_{-1} \sum_{t=0}^{\infty} \beta^t \{ \pi_t^2 + \omega x_t^2 + \nu \Delta i_t^2 \}$$
Policy Problem under discretion

- Inflation targeting
  - loss criterion depends on inflation, $\pi_t$
  - $E_{-1} \sum_{t=0}^{\infty} \beta^t \{ \pi_t^2 + \omega x_t^2 + \nu \Delta i_t^2 \}$

- Price level targeting
  - loss criterion depends on price level, $p_t$
  - $E_{-1} \sum_{t=0}^{\infty} \beta^t \{ (1 - \lambda_x - \lambda_i) p_t^2 + \lambda_x x_t^2 + \lambda_i \Delta i_t^2 \}$
  - $\lambda_x$ and $\lambda_i$ optimally chosen to maximize social welfare
Imperfect credibility

- Policy-maker switches from IT to PT at time t
- However private agents assign a positive probability, \((1 - \theta_t)\) to the event that the policy-maker will revert back to IT next period
- Because of imperfect credibility, expectations next period are
  \[ E_t z_{t+1} = \theta_t E_t(z_{t+1}|PT) + (1 - \theta_t) E_t(z_{t+1}|IT) \]
Imperfect credibility

- Policy-maker switches from IT to PT at time $t$
- However private agents assign a positive probability, $(1 - \theta_t)$ to the event that the policy-maker will revert back to IT next period
- Because of imperfect credibility, expectations next period are
  - $E_t z_{t+1} = \theta_t E_t(z_{t+1}|PT) + (1 - \theta_t) E_t(z_{t+1}|IT)$
- $\theta_t$ evolves as a Markov chain over two states $\{\theta_L, \theta_H\}$
- Transition matrix: $\Pi = \begin{bmatrix} p & 1 - p \\ 1 - q & q \end{bmatrix}$
Putting all pieces together

- Policy-maker switches from IT to PT at time $t$
- Choose policy instrument $i_t$ to minimize

PT criterion: \[ E_{-1} \sum_{t=0}^{\infty} \beta^t \{(1 - \lambda_x - \lambda_i)p_t^2 + \lambda_x x_t^2 + \lambda_i \Delta i_t^2 \} \]

Model

\[
H_1 z_{t-1} + H_2 z_t + H_3 E_t z_{t+1} + B i_t + C u_t = 0
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Imperfect credibility: expectations next period are

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E_t z_{t+1} = \theta_t E_t(z_{t+1}|PT) + (1 - \theta_t) E_t(z_{t+1}|IT)
\]

$\theta_t$ evolves as a Markov chain over two states \{\theta_L, \theta_H\}
Solving the model

- Solve Bellman equation

\[ V(z_{t-1}, u_t, \theta_t) = \min_{i_t} \lambda p p_t^2 + \lambda x x_t^2 + \lambda_i \Delta i_t^2 + \beta E_t V(z_t, u_{t+1}, \theta_{t+1}) \]

- Model

  - \[ H_1 z_{t-1} + H_2 z_t + H_3 E_t z_{t+1} + B i_t + C u_t = 0 \]
  - \[ u_{t+1} = \Omega u_t + \epsilon_{t+1} \]

- Imperfect credibility: expectations next period are

  - \[ E_t z_{t+1} = \theta_t E_t(z_{t+1}|PT) + (1 - \theta_t) E_t(z_{t+1}|IT) \]

- \( \theta_t \) evolves as a Markov chain over two states \( \{\theta_L, \theta_H\} \)

- initial conditions
Solution

By virtue of a quadratic objective and the Markov chain evolution of $\theta_t$, solution remains linear quadratic in the states $X_{t-1} = \begin{bmatrix} z_{t-1} \\ u_t \end{bmatrix}$

- **value:** $V(z_{t-1}, u_t, \theta_t) = X_{t-1}P(\theta_t)X_{t-1} + r(\theta_t)$
- **policy instrument:** $i_t = f(\theta_t)X_{t-1}$
- **endogenous states:** $z_t = n(\theta_t)X_{t-1}$
- **expectations:** $E_t z_{t+1} = h(\theta_t)X_{t-1}$

Finding a solution involves solving fixed point problems to obtain $P(\theta_t), f(\theta_t), n(\theta_t), h(\theta_t)$ for $\theta_t = \theta_L$ and $\theta_t = \theta_H$.
Beliefs about PT: $\theta_L = 0, \theta_H = 1$

Upon switch to PT, agents either believe that PT will be completely abandoned next period ($\theta_L = 0$) or will be completely adopted ($\theta_H = 1$)

How beliefs evolve:

Transition matrix: $\Pi = \begin{bmatrix} p & 1-p \\ 0 & 1 \end{bmatrix}$

High credibility state is an absorbing state which implies that everybody eventually believes

Expected time taken to transit to high credibility state:

$$\tau = \frac{1}{1-p}$$
Results: By how much does PT dominate IT with full credibility?

\[ W = E_1 \sum_{t=0}^{\infty} \beta^t \left\{ \pi_t^2 + \omega x_t^2 + \nu \Delta i_t^2 \right\} \]

<table>
<thead>
<tr>
<th>$\omega$</th>
<th>$\nu$</th>
<th>$\sigma_{IT}^\pi - \sigma_{PT}^\pi$</th>
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</thead>
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<tr>
<td>0</td>
<td>0.1</td>
<td>0.13</td>
</tr>
<tr>
<td>0.05</td>
<td>0.1</td>
<td>0.14</td>
</tr>
<tr>
<td>0.5</td>
<td>0.1</td>
<td>0.14</td>
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Data: \( \text{sd(core CPI inflation)} = 0.206 \text{ pp, sd(total CPI inflation)} = 0.33 \text{ pp} \)

Gains from moving to PT equivalent to 65% and 40% lower sd of core and total CPI respectively.
What if there is imperfect credibility

Adopting price level targeting under imperfect credibility – p. 16/18
Results under imperfect credibility

- PT is worthwhile unless imperfect credibility is very long lasting

Caveat

- Kryvtsov, Shukayev, and Ueberfeldt (2008) analyze switch from IT to PT
  - Clarida, Gali, Gertler (1999) calibrated to Canada
  - Even under full credibility gains are small i.e. 10% reduction of sd (total CPI inflation)
  - Gains increases with persistence of cost-push shock e.g. \( \rho = 0.96 \) lead to 60% reduction

- ToTEM over-estimates inflation persistence over inflation targeting era (0.9 vs 0.65)
Conclusion

- ToTEM: Gains from PT can range from 30 to 50 per cent of standard deviation of CPI in Canada
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