Flexible Inflation Forecast Targeting: Evidence for Canada (and Australia)

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Introduction

What are the targets or objectives of central banks?

- Formal inflation targets
- Less (formal) information about other variables

2008 PTA (New Zealand)

*For the purpose of this agreement, the policy target shall be to keep future CPI inflation outcomes between 1 per cent and 3 per cent on average over the medium term.*

*In pursuing its price stability objective, the Bank shall implement monetary policy in a sustainable, consistent and transparent manner and shall seek to avoid unnecessary instability in output, interest rates and the exchange rate.*
With multiple targets and a single instrument, a central bank may have to trade-off various objectives.

- Flexible inflation targets: inflation plus other variables in target criteria
- Buiter (2006) argues for a lexicographic ordering of targets – with inflation ordered first

How successful are central banks at achieving their targets or objects?

Do we see predictable deviations from the (stated, estimated) target of the central bank?
Forecast Targeting Rules


We estimate and test following condition(s):

\[ E_t[(\pi_{t+h} - \pi^T) + \phi \Delta x_{t+h}] = 0 \quad h = 0, 1, \ldots, h^*, \ldots \]

\( \pi \) = inflation
\( \pi^T \) = inflation target
\( \Delta x \) = change in the output gap
\( \phi \geq 0 \) (relative) weight on activity

Optimal monetary policy rule for a particular New Keynesian model
New Keynesian Model

Central Bank Loss Function

$$\frac{1}{2} E_t \sum_{h=0}^{\infty} \beta^h [(\pi_{t+h} - \pi^T)^2 + \lambda x_{t+h}^2]$$

Phillips Curve

$$\pi_t = \beta E_{t-h} \pi_{t+1} + \kappa E_{t-h} x_t + E_{t-h} u_t$$

- Pricing decisions are pre-determined $h$ periods in advance
- Central bank optimises under the assumption that it can influence future expectations of inflation
- Implements “timelessly optimal” policy
- $\phi = \lambda / \kappa$
Generalization of Strict Inflation Targeting

\[ E_t(\pi_{t+h} - \pi^T) = 0 \quad h = 1, 2, 3 \ldots \]

Are future deviations of inflation from target predictable?

Rowe and Yetman (2002) test this condition on Canadian data (1992:4-2001:1)

- What is BOC’s inflation target? 1.6%
- How well does it achieve its target? Are deviations from the estimated target predictable? *Not at horizons of 6-8 quarters.*

Extension of Rowe and Yetman

- What does the BOC do at horizons less than 6 quarters?
- A more powerful test of strict inflation targeting?
Empirical Model

Replace output gap with output growth

\[ E_t[(\pi_{t+h} - \pi^T) + \phi \Delta x_{t+h}] = 0 \]
\[ E_t[(\pi_{t+h} - \pi^T) + \phi \Delta (y_{t+h} - y^*_{t+h})] = 0 \]
\[ E_t[(\pi_{t+h} - \pi^T) + \phi (\Delta y_{t+h} - \Delta y^*_{t+h})] = 0 \]

Assume \( \Delta y^*_{t+h} = \Delta y \)

\[ E_t[(\pi_{t+h} - \pi^T) + \phi (\Delta y_{t+h} - \Delta y)] = 0 \]
Generalized Nominal Income Growth Targeting Rule

\[ E_t [\pi_{t+h} + \phi \Delta y_{t+h}] = \pi^T + \phi \Delta y \]

If \( \phi = 1 \)

\[ E_t [\pi_{t+h} + \Delta y_{t+h}] = \pi^T + \Delta y \]
Estimation

\[ E_t \left[ (\pi_{t+h} - \pi^T) + \phi_h (\Delta y_{t+h} - \Delta y) \right] = 0 \quad h = 0, 1, \ldots \tilde{h}, \ldots H \]

- Estimate by GMM for a range of \( h \)
- Set of potential instruments is large
- Instrument quality matters – need good predictor of \( \pi_{t+h} \) or \( \Delta y_{t+h} \)

Re-normalize the condition as:

\[ E_t \left[ \Delta y_{t+h} + \frac{1}{\phi_h} \pi_{t+h} - a_{0h} \right] = 0 \]

\[ a_{0h} = \frac{\pi^*_h}{\phi_h} + \Delta y \]
Data

Bank of Canada adopted inflation targeting framework in 1991
Current target band is 1-3 percent inflation (adopted in 1995)

\[ \pi_t = \text{core inflation, 12-months ended} \]
\[ \Delta y_t = \text{output growth, 3-month ended, annual rate} \]
\[ \pi_t^{cm} = \text{commodity price inflation, 12-months ended} \]
\[ \Delta m_t = \text{M2 growth, 12-months ended} \]
Instruments

\[ E_t[\Delta y_{t+h} + \frac{1}{\phi_h} \pi_{t+h} - a_{0h}] = 0 \quad h = 1,2,3, ... ,18 \]

Instrument set

\[ z_t = (1, \pi_{t-2}, \pi_{t-2}^{cm}, \Delta m_{t-2}) \]

2-month lag

Newey-West estimator: \( m = h-1 \)

Use \( \widehat{\Delta y} = 3.37 \) to recover an estimate of inflation target
Results

- Stock and Yogo (2002) test for weak instruments. Reject weak instruments at 5% level for $h \leq 11$. Instrument quality may be more of an issue at longer horizons (not unexpected).

- Estimate of $\bar{h}$. At what horizon is targeting rule non-rejected? J-statistic. Targeting rule is not-rejected at $h \geq 10$ months.

- Interval estimates for $\phi_h$. Can reject $\phi = 0$. But estimates suggest that $\phi$ varies across forecast horizons.

  Test $\phi_{10} = \phi_{13} = \phi_{16}$ p-value = 0.002

- Sensitivity Analysis
Test for Weak Instruments (IV bias relative to OLS)
95% Interval Estimates of $\phi_h$
Identification Robust Methods

Anderson and Rubin (1949); Dufour (2003); Dufour, Khalaf and Kichian (2006)

Re-write targeting rule as a regression model

\[ \pi_{t+h} = \pi^T - \phi(\Delta y_{t+h} - \bar{\Delta y}) + u_{t+h} \]

If instruments are weak, we can still consider the condition that

\[ E(u_{t+h}z_t) = 0 \]

Basic Idea

\[ E([\pi_{t+h} - \pi^T + \phi(\Delta y_{t+h} - \bar{\Delta y})]z_t) = 0 \]

Search for values of \( \pi^T \) and \( \phi \) that make this condition hold
AR Regression

\[ \pi_{t+h} + \phi_h (\Delta y_{t+h} - \overline{\Delta y}) = \alpha + z_t \beta + \nu_{t+h} \]

\( z_t = \) vector of instruments

Test: \( \phi_h = \phi_h^0 \) implies \( \beta = 0 \) (F-test)

Search in range \( \phi_h = (0,1) \): Step size = 0.00001

- Report all p-values for F-statistics
- Use maximum p-value as AR estimate of \( \phi_h \)
- Use distribution of p-values to compute confidence intervals

Standard or Robust F-statistic?
AR 95% Interval Estimates of $\phi_h$ (h=12…18)
Australian Estimates

RBA inflation target 2-3 percent

Quarterly data from 1996:1-2010:2

\[ \pi_t = \text{Trimmed mean inflation, 4-qrt-ended} \]
\[ \Delta y_t = \text{Non-farm output growth, 4-qrt-ended} \]
\[ \Delta y_{rt} = \text{Real time output growth, 4-qrt-ended} \]
Regression Model

\[ \pi_{t+h} = c_h + \phi_h \Delta y_{t+h} + v_{t+h} \quad h = 1,2\ldots,6 \]

Instrument Set

\[ z_t = (1, \Delta y_{t-1}, i^c_{t-1}, un_{t-1}, \Delta cr_{t-1}) \]

- \( i^c_t \) = cash rate
- \( un_t \) = unemployment rate
- \( \Delta cr_t \) = credit growth, 4-qtr-ended
## Estimates of $\phi_h$ for Australia

<table>
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<th>$h$</th>
<th>$\pi^T$</th>
<th>$\phi_h$</th>
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<th>IQ</th>
<th>$IQ(NW, m=4)$</th>
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AR Estimate of $\phi_h$ for $h=4$
### Estimates of $\phi_h$ for Australia – Real Time GDP Data

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AR Estimate of $\phi_h$ for $h=4$: 2010:Q2 Vintage and Real Time Data

![Graph showing AR estimate for $\phi_h$ with two curves representing vintage and real-time data, along with a significance level at 0.05.](image)
Estimates of $\phi_h$ at One-Year Horizon
A Final Concern

Are our estimates biased?

True forecast targeting rule

\[ E_t[(\pi_{t+h} - \pi^T) + \phi_h(\Delta y_{t+h} - \Delta y) + \gamma_h X_{t+h}] = 0 \]

\(X =\) interest rate, exchange rate, omitted dynamics