A Horse Race of Monetary Policy Regimes: An Experimental Investigation

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Views expressed in this presentation are that of the authors and do not represent views of the Bank of Canada
Motivation

• Inflation targeting has dominated monetary policy since the early 1990s

• Many worthwhile policy options on the table for central banks, especially at the ZLB

• Bank of Canada’s mandate renewal (2021-2025)
  • Adopted inflation targeting framework in 1991 to guide monetary policy
  • Aims to keep total CPI inflation at the 2 percent midpoint of a target range of 1-3 percent over the medium term.
Consumer Price Index
Percentage change over the past 12 months
Motivation

Many worthwhile policy options on the table for central banks, especially at the ZLB

- Flexible inflation targeting (IT)
- Dual mandate (equal weight on inflation and output) (DM)
- Average inflation targeting (AIT-4, AIT-10)
- Price level targeting (PLT)
- Nominal GDP level targeting (NGDP)
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Many worthwhile policy options on the table for central banks, especially at the ZLB

- Flexible inflation targeting (IT) – **lots of evidence**
- Dual mandate (equal weight on inflation and output) (DM) – **limited evidence**
- Average inflation targeting (AIT-4, AIT-10) - **U.S. 2020-2021**
- Price level targeting (PLT) – **Sweden 1930s**
- Nominal GDP level targeting (NGDP) – **no evidence**
Related literature

- **IT vs. PLT: Evidence is mixed**
  - PLT outperforms IT: Salle (2021)
  - Depends: Hommes and Makarewicz (2021)

- **IT vs. AIT: Evidence is mixed**
  - Cobion et al. (2020), Hoffmann et al. (2021), Salle (2021)

- **Inflation volatility can be lowered if the central bank employs a DM and responds to the output gap**
  - Hommes, Massaro and Weber (2019)

- **Deflationary episodes can occur at the ELB without sufficient policy intervention**
5 Policy Frameworks in the Experimental Horse Race

- Flexible inflation targeting (IT)
- Dual mandate (equal weight on inflation and output) (DM)
- Average inflation targeting (AIT-4, AIT-10)
- Price level targeting (PLT)
- Nominal GDP level targeting (NGDP)

Examine effect of policies on expectation formation during periods of stability and at the ELB.
Experimental Horserace

Main questions

Can people understand history-dependent monetary policy regimes?

Does the horizon that monetary policy respond to matters? AIT-4 vs. AIT-10

Does the framing of targets matter? AIT-10 vs. PLT
Design of experiments

- Learning-to-forecast structure with groups of participants incentivized to forecast accurately

- Macroeconomic dynamics driven by subject-supplied expectations and exogenous shocks

- Between-subject treatment variation in the policy rule
Model

Simple New Keynesian model used as part of the Bank of Canada’s own horse race (Swarbrick and Zhang, 2021):

IS curve: \[ x_t = x_{t+1} - \frac{1}{\sigma} (i_t - \pi^e_{t+1} - r^n_t) \]

Phillips curve: \[ \pi_t = \beta \pi^e_{t+1} + \kappa x_t \]

Natural rate: \[ r^n_t = \rho r^n_{t-1} + \varepsilon^r_t \]

Steady state and central bank’s targets: \( \pi^* = x^* = 0 \)
Policy rules / Treatments

Policy rules are parameterized to optimize loss function:

\[ L = \sum (\pi_t^2 + x_t^2 + 0.5i_t^2) \]

IT: \[ i_t = i^* + 3x_t + 5.5(\pi_t - \bar{\pi}) \]
DM: \[ i_t = i^* + 4.5x_t + 4.5(\pi_t - \bar{\pi}) \]
AIT-4: \[ i_t = i^* + 3x_t + 5.5\left(\frac{1}{4}\sum_{j=0}^{3} \pi_{t-j} - \bar{\pi}\right) \]
AIT-10: \[ i_t = i^* + 3x_t + 5.5\left(\frac{1}{10}\sum_{j=0}^{9} \pi_{t-j} - \bar{\pi}\right) \]
PLT: \[ i_t = i^* + 1.3x_t + 0.8(p_t - \bar{p}_t) \]
NGDP Level Targeting: \[ i_t = i^* + 1.1 \left[(y_t + p_t^y) - (\bar{y}_t + \bar{p}_t^y)\right] \]

where interest rates are bounded below at zero bps.
Experimental Timeline

**Information:**
- Period t shock
- Historical information up to period t-1
- DGP

**Simultaneous Decisions:**
- Inflation forecast for t+1
- Output forecast for t+1

**Outcome for Period t:**
- Inflation
- Output
- Nominal interest rate

Median forecasts selected
Design of experiments

IS curve: $y_t = \text{median} \left( x_{t+1}^{i,e} \right) - \frac{1}{\sigma} \left( i_t - \text{median} \left( \pi_{t+1}^{i,e} \right) - r_t^n \right)$

Phillips curve: $\pi_t = \beta \text{median} (\pi_{t+1}^{i,e}) + \kappa x_t$

Natural rate: $r_t^n = \rho r_{t-1}^n + \epsilon_t^{rn}$

Policy rule: $i_t = f(\pi_t, x_t)$ with a ZLB

• Each experimental session lasts 50 periods.
  • Periods 1-19: Pre-shock phase
  • Periods 20-50: Large negative demand shock followed by recovery
Experiments were conducted online with students from Simon Fraser University and Texas A&M University.

- 6 sessions for each monetary policy regime.

7 subjects x 6 sessions x 6 treatments = 252 participants

With 50 periods = 12,600 observations
Simulations under RE

Inflation rate

Output

Interest rate

Shock (ln)
Results
Dual mandate
Inflation targeting
AIT short horizon, IT policy coefficients

Inflation (AIT, short) vs Output (AIT, short)
AIT long horizon, IT policy coefficients
Nominal GDP level targeting
NGDP level targeting: remaining periods
Price level targeting
PLT: remaining periods
Ranking of policy regimes – Pre-shock

\[ L = \sum (\pi_t^2 + x_t^2 + 0.5i_t^2) \]
Ranking of policy regimes – Post-shock

\[ L = \sum \left( \pi_t^2 + x_t^2 + 0.5i_t^2 \right) \]
Why do level targeting policy rules not work better?

- Lack of basic rationality? Don’t get it? Don’t get it enough?
- Lack of credibility? Don’t believe it?
- Different forecasting heuristics?
Why do level targeting policy rules not work as well as rate targeting rules?

- Lack of basic rationality? Don’t get it? **COMPARABLE**
- Don’t get it *enough*? **YES**
- Lack of credibility? Don’t believe it?
- Different forecasting heuristics?
Median Inflation Forecasts and Basic Rationality

Large deviations from rationality pre-shock (75-200 bps)

**Insufficiently positive expectations in post-shock for those with basic rationality**

“Too little, too late”
Why do level targeting policy rules not work as well as rate targeting rules?

- Lack of basic rationality? Don’t get it? **COMPARABLE**
- Don’t get it *enough*? **YES**
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Why do level targeting policy rules not work as well as rate targeting rules?

- Lack of basic rationality? Don’t get it? **COMPARABLE**
- Don’t get it *enough*? **YES**
- Lack of credibility? Don’t believe it? **YES**
- Different forecasting heuristics? **ONLY AFTER ENTERING THE ELB**
  - Level targets encourage more heterogeneity, stronger trend-extrapolation, and larger deviations from rationality AT THE ELB
Inflation targeting: inflation forecasting rules

Before shock

\[ i_t = i^* + 3\hat{x}_t + 5.5(\pi_t - \bar{\pi}) \]
PLT: inflation forecasting rules

Before shock

\[
i_t = i^* + 1.3\bar{x}_t + 0.8(p_t - \bar{p}_t)
\]

After shock
Trend-chasing in inflation forecasts becomes stronger after shock in history-dependent rules

Before shock

After shock

\[ E_{it}\pi_{t+1} = \pi_{t-1} + \tau_i(\pi_{t-1} - \pi_{t-2}) \text{ where } \tau_i \in [0,1.5] \]
Any hope for level targeting policy rules?

- Increase the reaction coefficients in the policy rules to build credibility
  › Hommes & Makarewicz, 2021

- Provide precise central bank projections to guide expectations and quantitatively improve reactions
  › Mokhtarazadeh & Petersen, 2020
  › Petersen & Rholes, 2021
Price level targeting with inflation and output projections
If it ain’t broke, don’t fix it!

- A lot to still learn about level-targeting mandates
- Rate-targeting rules are more robust to the presence of non-rational expectations
  - Reacting to current economic conditions preserves credibility better than trying to play catch up
- Framing matters: Long horizon AIT is easier to understand the PLT
Thank you!
Level-targeting regimes require a high level of forward-looking expectations

Are participants using backward-looking heuristics more frequently in more complicated treatments?

Do level-targets create more confusion and disagreement?
Why go to the lab?

1. Experimental methods offer an alternative approach to studying the causal effects of monetary policy on expectations and decisions

2. Laboratory experiments fill important empirical gaps

3. Can explore new policy frameworks and communication strategies with low cost

4. Avoids making assumptions about how expectations are formed
Why go to the lab?

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Concerns about laboratory-generated data

1. External validity: model and subjects
Lack of common understanding?

c) dispersion of inflation forecasts, PLT and NGDP, post-shock

d) dispersion of output forecasts, PLT and NGDP, post-shock
How far from rational?

a) deviations of inflation forecasts

b) deviations of output forecasts
Basic Rationality

- Do subjects even understand the basic direction in which they should be forecasting?
  - IT and DM requires reacting to current fundamentals, ignoring past history
  - AIT, PLT and NGDP would require taking into consideration both current fundamentals and recent deviations from target

- Denote a person $i$ in period $t$ as exhibiting basic rationality if
  $\begin{cases}
  E_{it} \pi_{t+1} > \pi_{t-1} & \text{when } E_t^{REE} \pi_{t+1} > \pi_{t-1} \\
  E_{it} \pi_{t+1} < \pi_{t-1} & \text{when } E_t^{REE} \pi_{t+1} < \pi_{t-1}
  \end{cases}$
Basic Rationality

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Pre-shock,

- PLT and NGDP are not significantly less rational than DM and IT
- Roughly 50% of inflation and output forecasts are in the correct direction, but only ¼ to 1/3 of subjects forecast both correctly
On impact of shock,

- Rationality in inflation increases in all treatments
- Half of PLT and AIT-10 subjects understand the correct direction for both variables
- NGP subjects focus more on inflation than output
Median Inflation Forecasts and Basic Rationality

Deviations from rationality relatively small in IT, DM, AIT-4 (20-50 bps),
Larger in AIT-10 (10-120 bps)
Persistent upward bias even among those with basic rationality
After the shock,

- Rationality in inflation decreases in all treatments
- Decline in basic rationality in all treatments relative to pre-shock (except AIT-10).

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**Level and rate treatments do not differ meaningfully in terms of basic rationality**

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Persistent upward bias even among those with basic rationality
Median Inflation Forecasts and Basic Rationality

Even larger deviations from rationality pre-shock (75-200 bps)

Insufficiently positive expectations in post-shock for those with basic rationality

“Too little, too late”
Need to see it to believe it

- The central bank failed to achieve its targets in the level treatments pre-shock
Deviations of price level from (implied) target
Strong anchoring on target in IT, DM, AIT not present in PLT and NGDP

- The central bank failed to achieve its targets in PLT/NGDP pre-shock
- Pre-shock, less than 30% of participants are forecasting in the correct direction (lack of credibility?)
- When the large shock occurs, that jumps to roughly 50% in PLT, but declines quickly after.
- Insufficient improvement following the shock leads to a plummeting of credibility.
Forecasting heuristics

- Level-targeting regimes require a high level of forward-looking expectations
- Are participants using backward-looking heuristics more frequently in more complicated treatments?
- Do level-targets create more confusion and disagreement?
How are heuristics assigned?

1. Compute the mean absolute error of a participant’s expectations to a given heuristic.

E.g.

$$\text{MAE}_{i}^{\text{Rational}} = \frac{1}{T} \sum_{t=1}^{T} |E_{it}\pi_{t+1} - E_{t}^{\text{Rational}}\pi_{t+1}|$$

2. Assign the heuristic that produces the lowest MAE.
## Forecasting rules

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<td>Ex–Ante Rational</td>
<td>$E_{i,t}x_{t+1} = f(r_{t-1}^n, \epsilon_t)$</td>
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<td>$E_{i,t}\pi_{t+1} = f(r_{t-1}^n, \epsilon_t)$</td>
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<td>M2</td>
<td>Cognitive Discounting</td>
<td>$E_{i,t}x_{t+1} = \alpha f(r_{t-1}^n, \epsilon_t)$</td>
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<td>M3</td>
<td>Constant Gain</td>
<td>$E_{i,t}x_{t+1} = E_{i,t-1}x_t - \gamma (E_{i,t-2}x_{t-1} - x_{t-1})$</td>
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<td>M5</td>
<td>Trend Chasing</td>
<td>$E_{i,t}x_{t+1} = x_{t-1} + \tau (x_{t-1} - x_{t-2})$</td>
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Models of expectations as functions of exogenous or historical data. 

$\alpha \in [0.1, 0.9]$, $\gamma$ and $\tau \in [0, 1.5]$ in increments of 0.1.
Dual mandate: inflation forecasting rules

DM policy rule: $i_t = i^* + 4.5\bar{\pi}_t + 4.5(\pi_t - \bar{\pi})$
Inflation targeting: inflation forecasting rules

Before shock

IT policy rule: $i_t = i^* + 3\hat{x}_t + 5.5(\pi_t - \bar{\pi})$
AIT-4: inflation forecasting rules

Before shock

After shock

AIT policy rule: \( i_t = i^* + 3\bar{x}_t + 5.5 \left( \frac{1}{4} \sum_{j=0}^{3} \pi_{t-j} - \bar{\pi} \right) \)
AIT-10: inflation forecasting rules

Before shock

After shock

AIT policy rule: \( i_t = i^* + 3\bar{\pi}_t + 5.5(1/10 \sum_{j=0}^{9} \pi_{t-j} - \bar{\pi}) \)
NGDP level targeting: inflation forecasting rules

Before shock

NGDP Level Targeting policy rule: \( i_t = i^* + 1.1[y_t + p_t^Y] - (\bar{y}_t + \bar{p}_t^Y) \)
PLT: inflation forecasting rules

Before shock

After shock

PLT policy rule: \( i_t = i^* + 1.3\bar{x}_t + 0.8(p_t - \bar{p}_t) \)
For each subject classified as trend-chasing, what is their degree of trend-extrapolation?

\[ E_{it} \pi_{t+1} = \pi_{t-1} + \tau_i (\pi_{t-1} - \pi_{t-2}) \]

What is the best fitting \( \tau_i \in [0,1.5] \) for each subject?

Does this change across policy rules?
Trend-chasing in inflation forecasts becomes stronger after shock in history-dependent rules

Before shock

After shock

\[ E_{it} \pi_{t+1} = \pi_{t-1} + \tau_i (\pi_{t-1} - \pi_{t-2}) \text{ where } \tau_i \in [0,1.5] \]
Trend-chasing in output forecasts becomes stronger after shock in history-dependent rules.
Trend-chasing in output forecasts becomes stronger after shock in history-dependent rules

Before shock

![Graph showing trend-chasing parameter (tau), output forecasts for periods 1-19.](image)

After shock

![Graph showing trend-chasing parameter (tau), output forecasts for periods 20-50.](image)