Implications for Determinacy with Average Inflation Targeting

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Midwest Economics Research Group 2022 Meetings
La Crosse, WI, August 4 2022

Monetary Policy Strategy, August 2020

August 27, 2020

Statement on Longer-Run Goals and Monetary Policy Strategy by the FOMC:

> *"In order to anchor longer-term inflation expectations at this level, the Committee seeks to achieve inflation that averages 2 percent over time, and therefore judges that, following periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time."*

August 27, 2020 - Jackson Hole, Wyoming

"... our new statement indicates that we will seek to achieve inflation that **averages** *2 percent over time. Therefore, following periods when inflation has been running below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time.*

In seeking to achieve inflation that averages 2 percent over time, **we are not tying ourselves to a particular mathematical formula that defines the average**. *Thus, our approach could be viewed as a flexible form of average inflation targeting."- Jerome Powell*

Research Question

Question(s): What is the impact of Average Inflation Targeting - AIT?

- How is the 'average' measure of inflation constructed?
  - Is it an (weighted) average of past inflation terms?
  - Is it an (weighted) average of expected future inflation?
  - Is the measure a hybrid?
- Are there implications for determinacy?
- Does the length of the 'window' used to construct the average impact stability?
- If we consider a hybrid, what happens if the window lengths (forward vs backwards) are asymmetric?
- What is the impact of a monetary policy shock under AIT?

New Keynesian Framework

There are 3 key equations of interest in the NK framework with monetary policy

- The key equations include:
  - The IS Curve - derived from the Household's utility maximization problem
  - The Phillips Curve - derived from the Firm's problem
  - The monetary policy rule (e.g. a Taylor-type rule)
- We log-linearize the model around the (long-run) steady state.

New Keynesian Framework

- The IS Equation:

$$x_t = x^e_{t+1|t} - \frac{1}{\sigma}\left(r_t - \pi^e_{t+1|t} - r^n\right) + \xi^x_t, \tag{1}$$

- We assume that a fraction of agents, $\lambda \in [0, 1)$, form naïve expectations, so aggregate expectations are given by,

$$\begin{aligned} x^e_{t+1} &= \lambda x_t + (1-\lambda)\,\mathbb{E}_t\, x_{t+1}, \\ \pi^e_{t+1} &= \lambda \pi_t + (1-\lambda)\,\mathbb{E}_t\, \pi_{t+1}. \end{aligned} \tag{2}$$

- Expectations are fully rational when $\lambda = 0$. We allow $\lambda \neq 0$.

New Keynesian Framework

- The Phillips Curve:

$$(\pi_t - \pi^*) = \beta(\pi^e_{t+1|t} - \pi^*) + \kappa x_t + \xi^\pi_t, \tag{3}$$

- The monetary policy rule:

$$\begin{aligned} r_t &= (1-\rho_r)(r^n + \pi^*) + \rho_r r_{t-1} \\ &\quad + (1-\rho_r)\left[\psi_\pi(\pi^A_t - \pi^*) + \psi_x x_t\right] + \epsilon^r_t, \end{aligned} \tag{4}$$

Average Inflation Targeting

- We assume that monetary policy targets an average value of inflation over a target window that may include backward- and forward-looking terms for inflation.

- The average inflation target is:

$$\pi_t^A = \gamma \pi_t^B + (1-\gamma)\pi_t^F, \tag{5}$$

where $\gamma \in [0, 1]$ is the relative weight given to past average inflation, π_t^B, versus expected future average inflation, π_t^F.

Backwards window for AIT

- The past average inflation, π_t^B, is given by:

$$\pi_t^B = \delta_B \pi_t + (1 - \delta_B)\pi_{t-1}^B, \tag{6}$$

where $\delta_B \in (0, 1)$ is the weight given to the most recent observation.

- Substituting recursively, we obtain:

$$\pi_t^B = \delta_B \sum_{j=0}^{\infty} (1 - \delta_B)^j \pi_{t-j},$$

where $\sum_j \delta_B (1 - \delta_B)^j = 1$, and $\lim_{j \to \infty} \delta_B (1 - \delta_B)^j = 0$.

- A weight of δ_B approximates monetary policy behavior using an equally-weighted finite window of length $1/\delta_B$ periods.

Forward window for AIT

- Similarly, the forward window includes expected future average inflation, π_t^F:

$$\pi_t^F = \delta_F \, \mathbb{E}_t \, \pi_{t+1} + (1 - \delta_F) \, \mathbb{E}_t \, \pi_{t+1}^F \tag{7}$$

$$\implies \pi_t^F = \delta_F \sum_{j=0}^{\infty} (1 - \delta_F)^j \, \mathbb{E}_t \, \pi_{t+1+j}$$

  where $\delta_F \in (0, 1)$ is the weight given to next period's expected inflation and $\sum_j \delta_F (1 - \delta_F)^j = 1$, and $\lim_{j \to \infty} \delta_F (1 - \delta_F)^j = 0$.

- Similarly, $1/\delta_F$ approximates the length of an equally-weighted finite forward-looking window.

Summary of Key Parameters

- We vary the parameters below and explore the implications for determinacy:
  - $\{\delta_B, \delta_F\}$ - the weights on the previous/next period's (expected) inflation
  - γ - the relative weight on past vs expected future inflation
  - λ - the share of the population that form naïve expectations
  - $\{\psi_\pi, \psi_x\}$ - the weights on the inflation and output gap terms in the policy rule
  - ρ_r - the persistence of monetary policy
- Note that a standard Taylor-type rule emerges as a special case with $\gamma = 1.0$ and $\delta_B = 1.0$.

Key Model Equations I

1. The IS Equation:

$$x_t = x^e_{t+1|t} - \frac{1}{\sigma}\left(r_t - \pi^e_{t+1|t} - r^n\right) + \xi^x_t,$$

2. The Phillips Curve:

$$(\pi_t - \pi^*) = \beta(\pi^e_{t+1|t} - \pi^*) + \kappa x_t + \xi^\pi_t,$$

3. Evolution of the expected output gap

$$x^e_{t+1} = \lambda x_t + (1-\lambda)\,\mathbb{E}_t\, x_{t+1}$$

4. Evolution of the expected inflation

$$\pi^e_{t+1} = \lambda \pi_t + (1-\lambda)\,\mathbb{E}_t\, \pi_{t+1}$$

Key Model Equations II

5. The monetary policy rule:

$$r_t = (1-\rho_r)(r^n + \pi^*) + \rho_r r_{t-1} + (1-\rho_r)\left[\psi_\pi(\pi_t^A - \pi^*) + \psi_x x_t\right] + \epsilon_t^r,$$

6. The average inflation target:

$$\pi_t^A = \gamma \pi_t^B + (1-\gamma)\pi_t^F,$$

7. Past average inflation:

$$\pi_t^B = \delta_B \pi_t + (1-\delta_B)\pi_{t-1}^B,$$

8. Expected future average inflation:

$$\pi_t^F = \delta_F \mathbb{E}_t \pi_{t+1} + (1-\delta_F)\mathbb{E}_t \pi_{t+1}^F$$

Our Approach

- Following Sims (2002), the model can be expressed as:

$$\Gamma_0 y_t = \Gamma_1 y_{t-1} + \Psi z_t + \Pi \eta_t \tag{8}$$

  where y_t is a vector that includes x_t, π_t, r_t, π_t^A, π_t^B, and π_t^F; z_t is a vector of the shocks, ξ_t^x, ξ_t^π, and ξ_t^r; and $\eta_t \equiv y_t - E_{t-1} y_t$ equals the ex-post rational expectations forecast errors.

- We use the method in Sims (2002) to explore regions of indeterminacy.

Calibration

Description	Parameter	Value
Discount rate (quarterly)	β	0.99
Inverse intertemporal elasticity	σ	0.72
Phillips curve coefficient	κ	0.178
Steady state inflation rate (quarterly)	π^*	0.005

Baseline Parameters	Parameter	Value(s)
AIT weight past inflation	γ	$\{0.0, 0.25\}$
Backward-looking weight	δ_B	1.0
Monetary policy: average inflation	ψ_π	1.5
Monetary policy: output gap	ψ_x	0.5
Monetary policy: persistence	ρ_r	0.0

Table: Parameter Calibrations

The End!

References I

Sims, C. (2002). Solving linear rational expectations models. *Computational Economics*, 20(1-2):1–20.