Monetary Economics: Macro Aspects, 19/5 2004
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Plan for today:

Inflation Targeting (II)
1. Example of a dynamic modeling inflation targeting
2. The importance of inflation forecasts
Literature: Svensson (1997, *European Economic Review*).
Supplementary reading: Svensson (1999, 2000a,b).

Introductory remarks

- Potential problem of inflation targeting:
  - Inflation is only controllable with a "long and variable" lag
  - What constitutes target misses?
  - "Misconduct," or shocks outside the bank's control?
- Problem for monitoring and associated accountability => credibility problems

- Not a problem if target variable is closely controllable and readily verifiable
- Insurmountable problem?
- Not according to Svensson (1997):
  - Inflation targeting implies **inflation forecast targeting**
  - The inflation forecast is the **intermediate targeting variable**
  - It can become publicly known immediately, and form immediate basis for evaluation of policy performance
  - ....accountability and credibility restored

- When output fluctuations are of concern, one sees that the horizon for which inflation is expected to reach target increases
  - The definition of horizon length becomes proxy for output weight in central bank's loss function

Example of a dynamic modeling of inflation targeting: The role of inflation forecasts

- Simple AS/AD model with **control lags:**
  - Monetary policy (interest rate setting) affects demand with a one-period lag (say a year)
  - Demand affects inflation with a one-period lag (say a year)
  - Two year control lag from policy to inflation
  - Captures realism and lack of controllability:
    - Inflation today is result of various shocks having hit the economy over the past years AND monetary policy two years back
    - => Inflation today says NOTHING about the quality of current monetary policy
    - => No basis of using current inflation as a measure of the success of the inflation targeting regime

- What then?
  - The relevant measure of the "success" of current policy is whether inflation is **expected** to hit the target **at the control lag horizon**
  - (...assuming inflation is all that matters for policy...)

- The model (excluding the exogenous variable x_t):

$$\pi_{t+2} = \pi_{t+1} + \alpha_1 y_{t+1} + \epsilon_{t+2} \tag{2.1'}$$

$$y_{t+1} = \beta_1 y_t - \beta_2 (i_t - \pi_t) + \eta_{t+1} \tag{2.2'}$$

$$\begin{aligned} \alpha_1 &> 0 \\ 0 &< \beta_1 < 1 \\ \beta_2 &> 0 \end{aligned}$$

- Exclusive aim of monetary policy: Attain the inflation target π^*
- Modelled as minimization of

$$\mathrm{E}_t \sum_{\tau=t}^{\infty} \delta^{\tau-1} L(\pi_\tau), \qquad 0 < \delta < 1, \tag{2.4}$$

$$L(\pi_\tau) \equiv \frac{1}{2}(\pi_\tau - \pi^*)^2$$

- "Strict inflation targeting" — not realistic; cf. last lectures, but to make things simple for the moment
- Solution for inflation controllable by i_t:

$$\begin{aligned} \pi_{t+2} &= [\pi_t + \alpha_1 y_t + \epsilon_{t+1}] + \alpha_1 y_{t+1} + \epsilon_{t+2} \\ &= [\pi_t + \alpha_1 y_t + \epsilon_{t+1}] + \alpha_1 [\beta_1 y_t - \beta_2 (i_t - \pi_t) + \eta_{t+1}] + \epsilon_{t+2} \\ &= a_1 \pi_t + a_2 y_t - a_4 i_t + (\epsilon_{t+2} + \epsilon_{t+1} + \alpha_1 \eta_{t+1}) \end{aligned} \tag{2.6'}$$

- Solution to policy problem
- Choose sequence of interest rates that minimizes the intertemporal loss function
- A series of one-period problems:
  - i_t affects π_{t+2} and inflation onwards; i_{t+1} affects π_{t+3} and onwards; etc.
  - i_t should then make $\pi_{t+2} = \pi^*$ in expectation; i_{t+1} should then make $\pi_{t+3} = \pi^*$ in expectation; etc.

- Solve

$$\min_{i_t} \mathrm{E}_t \delta^2 L\left(\pi_{t+2}\right)$$

subject to (2.6')

- First-order condition:

$$\frac{\partial \mathrm{E}_t \delta^2 L\left(\pi_{t+2}\right)}{\partial i_t} = -\mathrm{E}_t \delta^2 a_4 \left(\pi_{t+2} - \pi^*\right) = 0$$

- Simple solution:

$$\mathrm{E}_t \pi_{t+2} = \pi^*$$

or in alternative notation:

$$\pi_{t+2|t} = \pi^* \tag{2.9}$$

- The interest rate is set such that the period t two-period ahead inflation forecast equals the inflation target

- A policy problem that yields the same result:

$$\min_{i_t} \delta^2 L^i\left(\pi_{t+2|t}\right)$$

$$L^i \equiv \frac{1}{2}\left(\pi_{t+2|t} - \pi^*\right)^2$$

- Hence, inflation targeting is equivalent of **inflation forecast targeting**
  - This is intermediate targeting, with the inflation forecast being the intermediate target

- Implied instrument setting:

$$i_t = \pi_t + b_1\left(\pi_t - \pi^*\right) + b_2 y_t \tag{2.13'}$$

- Same form as a Taylor rule
- Note: The variables in the instrument rule **are not those being targeted**!!!! But they help predict the target variable: $\pi_{t+2|t}$

- Simple policy prescription underlying this:
  - If $\pi_{t+2|t} > \pi^*$, increase the interest rate
  - If $\pi_{t+2|t} < \pi^*$, lower the interest rate

- Note that due to shocks arriving after policy implementation, actual inflation in period $t+2$ will deviate from the inflation target
- One has:

$$\pi_{t+2} = \pi^* + (\epsilon_{t+2} + \epsilon_{t+1} + \alpha_1 \eta_{t+1}) \qquad (2.15')$$

  I.e., deviations from target due to shocks occurring within the control lag
- These are **forecasting errors**, and should, of course, be kept at a minimum
- Here, they "are what they are," so by construction **the forecasting error variance is minimal**
- The central bank, however, should be judged on its ability of attaining $\pi_{t+2|t} = \pi^*$, rather than $\pi_{t+2} = \pi^*$, which is inherently impossible
- So, monitor the forecasts and see if they are in line with the inflation target given the lags in policy transmission. I.e., implement **transparency**
- Other intermediate targets can — at best — only be as good as inflation forecast targeting (e.g., money growth forecast targeting)

Monitoring with private goals

- In the above analysis there is no need for monitoring the central bank — it does a good job
- Monitoring is generally thought to improve accountability and credibility
  - Model is amended so as to create a role for monitoring
  - The central bank is assumed to have an **implicit time-varying** inflation target π^b; e.g., in order to capture occasional incentives for pushing output above the natural rate (cf. a Barro and Gordon story)
- Formally, the central bank's per-period loss function is

$$L_t^b(\pi_t) = \frac{1}{2}\left(\pi_t - \pi_t^b\right)^2 \qquad (3.1)$$

$$\pi_t^b = \pi^* + z_t \qquad (3.2)$$

$$z_{t+1} = (1-\rho)\,\widetilde{z} + \rho z_t + \xi_{t+1}, \quad 0 < \rho < 1, \qquad (3.3)$$

- So, if $\widetilde{z} > 0$ the central bank has a higher inflation target on average than what is assigned
- Economic model is the same
- Central bank's choice of interest rate is guided by first-order condition

$$-\delta^2 a_4 \left(\pi_{t+2|t} - \pi^* - z_{t+2|t}\right) = 0$$

  and thus

$$\pi_{t+2|t} = \pi^* + \left(1-\rho^2\right)\widetilde{z} + \rho^2 z_t \qquad (3.5)$$

- Corresponding period t interest rate and actual period $t+2$ inflation:

$$i_t = \pi_t + b_1\left(\pi_t - \pi^* - \left(1-\rho^2\right)\widetilde{z} - \rho^2 z_t\right) + b_2 y_t \qquad (3.6')$$

$$\pi_{t+2} = \pi^* + \left(1-\rho^2\right)\widetilde{z} + \rho^2 z_t + \left(\epsilon_{t+2} + \epsilon_{t+1} + \alpha_1\eta_{t+1}\right) \qquad (3.7')$$

  E.g., if $z_t > 0$ the **interest rate** will be **lower** and **inflation** two periods ahead be **higher** than socially optimal

- Will **monitoring of the central bank** secure that this will not occur???

- In principle yes!
- Even if π^b is private information, the public observes i_t, π_t, and y_t and can infer $\left(1-\rho^2\right)\widetilde{z} + \rho^2 z_t$
- The public can also form $\pi_{t+2|t}$ and see how it deviates from π^* when $\left(1-\rho^2\right)\widetilde{z} + \rho^2 z_t \neq 0$

- I.e., the private sector can monitor a deviation in policymaking that compromises the inflation target π^*
- This can give rise to public criticism, firing of the governor(s); etc.
- Modelled by adding a loss from deviation of the inflation forecast from π^*:

$$\varphi L^i\left(\pi_{t+2|t}\right), \qquad \varphi > 0.$$

- Central bank's first-order condition is thus

$$-\delta^2 a_4\left(\pi_{t+2|t} - \pi^* - \left(1-\rho^2\right)\widetilde{z} - \rho^2 z_t\right) - \varphi a_4\left(\pi_{t+2|t} - \pi^*\right) = 0$$

  and the forecast is

$$\pi_{t+2|t} = \pi^* + \frac{\left(1-\rho^2\right)\widetilde{z} + \rho^2 z_t}{1 + \varphi/\delta^2}$$

- If a high φ can be imposed, the solution approaches the socially optimal
  - Note analogy with Walsh-contacts and Rogoff-conservativeness
  - The central bank's incentives are being shaped so as to induce better policymaking

"Strict" versus "flexible" inflation targeting

- The result $\pi_{t+2|t} = \pi^*$ follows easily from the assumed "strict" inflation targeting
- More realistic, inflation targeting is "flexible," i.e., output gap fluctuations are also considered costly
- Per-period loss function:

$$L(\pi_t, y_t) = \frac{1}{2}\left[(\pi_t - \pi^*)^2 + \lambda y_t^2\right],$$

  $\lambda > 0$ is proxy for flexibility
- Optimal monetary policy is characterized by (use dynamic programming) variant of familiar first-order condition:

$$\pi_{t+2|t} - \pi^* = -\frac{\lambda}{\delta\alpha_1 k} y_{t+1|t} \tag{6.6}$$

  with $k \geq 1$
- Conventional "leaning-against-the-wind" condition
  - If output is expected to contract at the control horizon (one period), the interest rate is set so as to allow for an overshooting of inflation target
  - The higher λ, the higher overshooting
  - Implication: The higher λ, **the longer time before inflation returns to target** in expectation

- Alternative exposition:
- From Phillips curve:

$$\pi_{t+2} = \pi_{t+1} + \alpha_1 y_{t+1} + \epsilon_{t+2}$$

$$\pi_{t+2|t} = \pi_{t+1|t} + \alpha_1 y_{t+1|t}$$

- Use first-order condition to eliminate $y_{t+1|t}$:

$$\pi_{t+2|t} = \pi_{t+1|t} - \frac{\delta\alpha_1^2 k}{\lambda}\left(\pi_{t+2|t} - \pi^*\right)$$

  and thus

$$\pi_{t+2|t} - \pi^* = \pi_{t+1|t} - \pi^* - \frac{\delta\alpha_1^2 k}{\lambda}\left(\pi_{t+2|t} - \pi^*\right)$$

$$\begin{aligned} \pi_{t+2|t} - \pi^* &= c\left(\pi_{t+1|t} - \pi^*\right) \\ 0 &< c \equiv \frac{\lambda}{\lambda + \delta\alpha_1^2 k} < 1 \end{aligned} \tag{6.8}$$

- Hence, $\lambda > 0$ implies a **gradual return** of the inflation forecast to target
- Higher λ, higher c and thus slower return

Concluding remarks

- Bands around inflation target?
  - Necessary if accountability is based on actual inflation
  - Should be proportional to forecast errors....
  - ...and thus widened when output stability is an objective
- Target rules versus instrument rules
  - Target rule: $\pi_{t+2|t} = \pi^*$
  - Instrument rule: $i_t = \pi_t + b_1 (\pi_t - \pi^*) + b_2 y_t$
  - The former much simpler and requires less information (holds also in case of output objective)
- Svensson's conclusion: Accountability can be attained and credibility secured by transparency and inflation forecast targeting
  - Lack of controllability of actual inflation not particular problem for the performance of inflation targeting
  - Openness about the inflation forecast and bands around the target can remedy the difficulties of accountability

Plan for next lecture

(**Final**) Lectures, Monday, May 24:
Transparency of Monetary Policymaking
1. A formal model of the effects of transparency
2. Pros and cons of transparency
Literature: Jensen (2002, *Scandinavian Journal of Economics*).
Supplementary reading: Faust and Svensson (2001); Geraats (2002).