Monetary Economics: Macro Aspects, 24/3 2004
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Plan for today:

"0". Delegation and independent central banks (see slides from March 22)

1. Operating procedures and choice of monetary policy instrument
2. Intermediate targets in policymaking

Literature: Walsh (Chapter 9, pp. 429-448)

3. Plan for next lectures

Introductory remarks

- In models so far, the choice variables, or **instruments**, of the central bank has been
  - Nominal money supply
    - (nominal interest rate)
  - Inflation
- O.k. for getting various points through
- In real world things are more complicated:
  - What is the actual instrument of a central bank?
  - What is the **best** to use given the uncertainties that inevitable are a part of policymaking?
  - I.e., which *operating procedures* should one use?
- In reality, the central bank can only exercise close control over the money base and the (very) short term nominal interest rate
- Even though the money base is the actual instrument, the central bank can very well behave as if the market nominal interest rate is its instrument: It will adjust the base to attain some desired value of the nominal interest rate
  - This would be an example of an **interest rate target procedure**
- Alternatively it could adjust the money base to keep stable some broader money aggregate (M1)
  - This would be an example of a **money supply target procedure**

- But what is best to do?
- General lesson from today's examples:
  - It depends on the ultimate goals of monetary policy (i.e., what are the relevant policy objectives?)
  - It depends on the relative variability of the shocks hitting the economy when shocks cannot be observed directly
  - It depends on which variables provide good information about the ultimate goal variables

- The exercises reveal that
  - changes in monetary aggregates (broad money supply, nominal interest rates) **tell little about deliberate monetary policy shifts** if one does not take into account under which operating procedures the central bank acts!!
  - (cf. the identification problems in the empirical VAR literature)

Operating procedures and choice of monetary policy instrument

The Poole (1970) model of instrument choice

- Highlights how the relative variances of shocks affect the optimal choice of policy instrument
- I.e., what is the optimal operating target of monetary policy? The money supply or the interest rate?
- Simple IS/LM model ($p_t = 0$ by normalization):

$$y_t = -\alpha i_t + u_t, \qquad \alpha > 0 \tag{9.1}$$
$$m_t = -c i_t + y_t + v_t, \qquad c > 0 \tag{9.2}$$

Note: slope of LM curve is $1/c$. Slope of IS curve is $-1/\alpha$.

- Shocks u_t and v_t are mean zero, independent shocks with variances σ_u^2 and σ_v^2, respectively
- Simple objective of policy: Minimize output variance

$$\mathrm{E}\,[y_t]^2 \tag{9.3}$$

- Policy of under either operating target is conducted **before** shocks u_t and v_t hits

- When money supply is instrument, y_t is solved in terms of m_t:

$$y_t = \frac{\alpha m_t + c u_t - \alpha v_t}{\alpha + c}$$

- Optimal policy: $m_t = 0$.
- Output variance:

$$\mathrm{E}_m \left[y_t\right]^2 = \frac{c^2\sigma_u^2 + \alpha^2\sigma_v^2}{(\alpha + c)^2} \tag{9.4}$$

- When the interest rate is the instrument, IS curve gives output immediately:

$$y_t = -\alpha i_t + u_t$$

- Optimal policy: $i_t = 0$.
- Actual output:

$$y_t = u_t$$

- Output variance:

$$\mathrm{E}_i \left[y_t\right]^2 = \sigma_u^2 \tag{9.5}$$

- Interest rate operating procedure is preferred iff

$$\mathrm{E}_i \left[y_t\right]^2 < \mathrm{E}_m \left[y_t\right]^2$$

$$\sigma_u^2 < \frac{c^2\sigma_u^2 + \alpha^2\sigma_v^2}{(\alpha + c)^2}$$

or

$$\left(1 + \frac{2c}{\alpha}\right)\sigma_u^2 < \sigma_v^2$$

- Hence, in favor of interest rate targeting procedure is
  - High money demand volatility
  - Low aggregate demand volatility
  - A flat IS curve (high α)
  - A steep LM curve (low c)

- Example of how relative variances of macroeconomic shocks matter for optimal choice of instrument

- **Extension of the basic Poole model: Monetary base as potential instrument**
- Central banks control the money base, but not, say, M1
- Extend model with determination of money supply (M1):

$$m_t = b_t + hi_t + \omega_t, \qquad h > 0 \tag{9.7}$$

Here, b_t is the money base

  - $m_t - b_t$ is the (log) money multiplier. ω_t is mean-zero money multiplier shock

- Money multiplier is increasing in interest rate (banks want to lend more/consumers want to hold less cash => expanding deposits are possible)
- Note that we now has an "LM curve" in b_t:

$$b_t = -(c+h)\, i_t + y_t + v_t - \omega_t$$

- Now distinction between money base operating target and interest rate operating target.
- The interest rate as an instrument gives solution as before; $\mathrm{E}_i [y_t]^2 = \sigma_u^2$
- The money base as instrument (again optimal to set $b_t = 0$), yields output as:

$$y_t = \frac{(c+h)\, u_t - \alpha v_t + \alpha \omega_t}{\alpha + c + h}$$

- Associated output variance:

$$\mathrm{E}_b [y_t]^2 = \frac{(c+h)^2 \sigma_u^2 + \alpha^2 \sigma_v^2 + \alpha^2 \sigma_\omega^2}{(\alpha + c + h)^2}$$

- The interest operating target is preferred iff:

$$\left[1 + \frac{2\,(c+h)}{\alpha}\right] \sigma_u^2 < \sigma_v^2 + \sigma_\omega^2$$

- Reinforcement of simple Poole result: More volatility on money market/financial markets makes a base operating target less attractive
- Can explain why real-life central banks are using interest rate operating procedures as money demand is unstable and/or financial markets are volatile
- Note: Results hinge on the objectives of monetary policy; instrument choice is endogenous and depends on the objectives of the policymaker

Policy rules and information

- Normally, the monetary base is the *de facto* policy instrument (or a very short-term nominal interest rate), but one may still under an interest operating procedure think of the nominal interest rate as an instrument
- The Poole analysis took an "either or" perspective
- Something "in between" may be optimal
- Illustrated by money base **policy rule**, where the money base responds to the observed nominal interest rate:

$$b_t = \mu i_t \tag{9.8}$$

  - We get various operating procedures as special cases:
  - $\mu = 0$: A base money operating procedure
  - $\mu = -h$: A money supply operating procedure
  - $\mu \to \infty$: An interest rate operating procedure
    - The "LM curve" becomes $0 = -(c+h+\mu)\, i_t + y_t + v_t - \omega_t$
- Solution for output with this base rule:

$$y_t = \frac{(c+\mu+h)\, u_t - \alpha (v_t - \omega_t)}{c+h+\mu+h}$$

- Associated variance:

$$\mathrm{E}_\mu [y_t]^2 = \frac{(c+\mu+h)^2 \sigma_u^2 + \alpha^2 \left(\sigma_v^2 + \sigma_\omega^2\right)}{(c+h+\mu+h)^2}$$

- What is the optimal rule (in terms of minimizing output variance)?
- Solve

$$\min_\mu \frac{(c+\mu+h)^2 \sigma_u^2 + \alpha^2 \left(\sigma_v^2 + \sigma_\omega^2\right)}{(c+h+\mu+h)^2}$$

- Solution is

$$\mu^* = -(c+h) + \frac{\alpha \left(\sigma_v^2 + \sigma_\omega^2\right)}{\sigma_u^2}$$

- Again, dependent upon relative variances and slopes of IS and LM curves! Approaching an interest rate operating procedure requires
  - High money market volatility
  - Low aggregate demand volatility
  - Flat IS curve (high α)
  - Steep "LM curve" (low $c+h$)

- Note, however, that even $\sigma_v^2 = \sigma_\omega^2 = 0$ does **not** warrant a "pure" base rule operating procedure
  - With $u_t > 0$ one can do better by contracting b_t so as to further increase the nominal interest rate ($\mu^* > 0$)
- With σ_v^2, $\sigma_\omega^2 > 0$ "leaning against the wind" may become optimal, as an interest rate increase may reflect either $v_t > 0$ or $\omega_t < 0$ ($\mu^* < 0$)

- Analogy between optimal value of μ in policy rule and a "signal extraction" problem (like in Lucas' island model)
- Central bank observes the nominal interest rate, but the underlying shocks — hence, it attempts to forecast the shocks based on the "signal," the nominal interest rate
- Formally, **assume** that the policy rule could respond to shocks:

$$b_t = \mu_u u_t + \mu_v v_t + \mu_\omega \omega_t$$

- Output satisfies

$$y_t \left(1 + \frac{c}{a} + \frac{h}{\alpha}\right) = (\mu_v - 1) v_t + \left(\mu_u + \frac{h}{\alpha} + \frac{c}{\alpha}\right) u_t + (1 + \mu_\omega) \omega_t$$

- Hence,

$$b_t = -\frac{c+h}{\alpha} u_t + v_t - \omega_t$$

completely stabilizes output

- However, shocks **cannot** be observed, so *estimates* of the shocks are made

$$b_t = -\frac{c+h}{\alpha} \widehat{u}_t + \widehat{v}_t - \widehat{\omega}_t$$

- Estimates are made conditional on observed i_t :

$$\widehat{u}_t = \mathrm{E}[u_t | i_t] = \delta_u i_t, \quad \widehat{v}_t = \mathrm{E}[v_t | i_t] = \delta_v i_t, \quad \widehat{\omega}_t = \mathrm{E}[\omega_t | i_t] = \delta_\omega i_t,$$

- We get

$$b_t = \left(-\frac{c+h}{\alpha} \delta_u + \delta_v - \delta_\omega\right) i_t \qquad (9.11)$$

- The note "Equivalence of (9.11)....", **see web-page**, shows that when the δs are chosen to minimize squared forecast errors, the coefficient on i_t becomes μ^*

Intermediate targets in policymaking

- Lesson from previous analysis: Forecasts of shocks may determine optimal monetary policy (and forecasts depend on relative variances of shocks)
- In real life, central banks must rely on best possible information
- Provides scope for adjusting policy in light of movements in variables that provides good information about movements in goal variables
- This is **intermediate targeting**
- Illustrated in simple AS/IS/LM model with imperfect information about current shocks
- Policy goal involves "strict inflation targeting" (just as illustration). Minimize inflation variance:

$$V = \mathrm{E}[\pi_t]^2 \qquad (9.15')$$

(as in previous analyses, normalize the value of the inflation target to zero; $\pi^* = 0$)

- The AS/IS/LM model:

$$\begin{aligned} y_t &= a\left(\pi_t - \mathrm{E}_{t-1}\pi_t\right) + z_t, \qquad a > 0 && \text{(AS 9.12)} \\ y_t &= -\alpha\left(i_t - \mathrm{E}_t\pi_{t+1}\right) + u_t, \qquad \alpha > 0 && \text{(IS 9.13)} \\ m_t - p_t &= m_t - \pi_t - p_{t-1} = y_t - ci_t + v_t, \qquad c > 0 && \text{(LM 9.14)} \end{aligned}$$

- Shocks follow AR(1) processes:

$$\begin{aligned} z_t &= \rho_z z_{t-1} + e_t, \qquad 0 < \rho_z < 1, \\ u_t &= \rho_u u_{t-1} + \varphi_t, \qquad 0 < \rho_u < 1, \\ v_t &= \rho_v v_{t-1} + \psi_t, \qquad 0 < \rho_v < 1, \end{aligned}$$

  All innovations, e_t, φ_t and ψ_t, are mean-zero, independent shocks (with variances σ_e^2, σ_φ^2, σ_ψ^2)

- Policy instrument is the nominal interest rate
- With the simple policy goal, solution of model is simplified as $\mathrm{E}_{t-1}\pi_t = \mathrm{E}_t\pi_{t+1} = 0$
- AS and IS curves provides solution for inflation as function of interest rate

$$\pi_t = \frac{-\alpha i_t + u_t - z_t}{a} \qquad (9.16')$$

- Clearly, optimal shock-contingent interest rate is

$$i_t = (1/\alpha)\left(u_t - z_t\right) \qquad (9.17')$$

- But, if interest rate must be set before period t innovations are realized, the optimal interest rate is

$$\widehat{\imath}_t = (1/\alpha)\left(\rho_u u_{t-1} - \rho_z z_{t-1}\right) \qquad (9.18')$$

- Given this policy, actual inflation becomes

$$\pi_t\left(\widehat{\imath}_t\right) = \frac{\varphi_t - e_t}{a}$$

  Fluctuates with the supply and demand shock innovations (**not** money demand shocks)

- Associated inflation variance

$$V\left(\widehat{\imath}_t\right) = \frac{\sigma_\varphi^2 + \sigma_e^2}{a^2}$$

- One can equivalently find the money supply that gives the same inflation and interest rate (all relevant derivations are provided in the note "Deriving (9.21)..."; see web-page):

$$\widehat{m}_t = p_{t-1} - \frac{c}{\alpha}\rho_u u_{t-1} + \left(1 + \frac{c}{\alpha}\right)\rho_z z_{t-1} + \rho_v v_{t-1}$$

- Now assume that the central bank when setting the interest rate observes the **actual value** of m_t
- The individual shocks are still unobservable, but m_t will provide information about the shocks — a signal
- Adjusting the interest rate such that actual m_t becomes equal to $\widehat{m}_t$ **may** improve policymaking (it takes into account **information about the unobservable shocks**)
  - m_t becomes **an intermediate target for policymaking**

- Example: $\sigma_\psi^2 = \sigma_e^2 = 0$; only aggregate demand shocks matter
  - $\varphi_t > 0$ will for given interest rate be reflected in higher output and inflation and higher m_t
  - Higher m_t thus provides information about $u_t > 0$, and the interest rate should be increased to dampen output and inflation, i.e., to bring back m_t to $\widehat{m}_t$
  - Intermediate targeting is therefore appropriate policy
- Example: $\sigma_\psi^2 = \sigma_\varphi^2 = 0$; only aggregate supply shocks matter
  - $e_t > 0$ will for given interest rate be reflected in lower inflation and lower m_t
  - Lower m_t thus provides information about $e_t > 0$, and the interest rate should be decreased to bring inflation back towards target, i.e., to bring back m_t to $\widehat{m}_t$
  - Intermediate targeting is therefore appropriate policy
- Example: $\sigma_e^2 = \sigma_\varphi^2 = 0$; only money demand shocks matter
  - $\psi_t > 0$ will for given interest rate be reflected in higher m_t and no change in inflation
  - Higher m_t thus provides information about $\psi_t > 0$, and the interest rate should be left unchanged and leave m_t different from $\widehat{m}_t$
  - Intermediate targeting would therefore be **in**appropriate policy

- Overall, the desirability of a certain policy regime, here monetary intermediate targeting, will depend upon the relative variances of the shocks
- An automatic interest rate procedure to keep $m_t = \widehat{m}_t$ improves on keeping $i_t = \widehat{\imath}_t$ if σ_e^2 and σ_φ^2 are relatively high, and σ_ψ^2 is relatively low (the intermediate target, m_t, must thus be "controllable")

- Note, the simple Poole model featured and "either or" choice which could be improved by an optimal policy rule, that optimally "processed" the new information about shocks
- Same logic applies here, where one can formulate interest rate rule like

$$i_t = \widehat{\imath}_t + \mu x_t \tag{9.22}$$

where x_t is the new information obtained by observing m_t (a linear combination of unobserved shocks)

- Optimal μ will, e.g., be decreasing in σ_ψ^2
- In this sense the **new information used by observing the intermediate target is used optimally**
  - It will improve over a policy aimed at attaining $m_t = \widehat{m}_t$

Plan for next lectures

Monday, March 29

Interest rate policies (I)

1. Price level (in)determinacy
2. The term structure of interest rates
3. Models for monetary policy analysis and the impact of interest rate rule parameters

Literature: Walsh (Chapter 10, pp. 473-480; pp. 488-499; pp. 499-507)

Wednesday, March 31

Interest rate policies (II)

1. Optimal interest rate rule in simple model for policy analysis
2. International evidence on interest rate rules

Literature: Walsh (Chapter 10, pp. 508-515); Clarida et al. (1998); Taylor (1993)