1. Operating procedures and choice of monetary policy instrument

2. Intermediate targets in policymaking

Literature: Walsh (Chapter 11, pp. 512–530)
Introductory remarks

• In models so far, the choice variables, or instruments, of the central bank have been
  – Nominal money supply, (nominal interest rate), inflation

O.k. for getting various points through

• In the real world, things are more complicated:
  – What is the actual instrument of a central bank?
  – What is the best, given the uncertainties that inevitable are a part of policymaking?
    . . . which *operating procedures* should be used?

• 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 target value
  of the nominal interest rate
  – This a case of an interest rate target procedure

• Alternatively, it could adjust the money base to attain some desired value of a broader money
  aggregate (M1, M2, M3)
  – This a case of a money supply target procedure
• What is “best”?

General lessons of today:

– It depends on the ultimate goals of monetary policy
– It depends on the relative variability of shocks to the economy when these cannot be observed
– It depends on which variables provide information about the ultimate goal variables

Moreover, examples reveal:

– 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
  
  Here: The money supply vs. nominal interest rate

- Simple IS/LM model ($p_t = 0$ by normalization):

  \[ y_t = -\alpha i_t + u_t, \quad \alpha > 0 \]  
  \[ m_t = -c i_t + y_t + v_t, \quad c > 0 \]

  Shocks $u_t$ and $v_t$ are mean zero, independent shocks with variances $\sigma_u^2$ and $\sigma_v^2$, respectively

- Simple objective of policy: Minimize output variance

  \[ \text{E}[y_t]^2 \]

  Policy of under either operating target is conducted before shocks $u_t$ and $v_t$ hit
• 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:

$$E_m [y_t]^2 = \frac{c^2 \sigma_u^2 + \alpha^2 \sigma_v^2}{(\alpha + c)^2}$$ (11.4)

• 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:

$$E_i [y_t]^2 = \sigma_u^2$$ (11.5)
Comparison:

Interest rate operating procedure is preferred iff

$$E_i [y_t]^2 < E_m [y_t]^2$$

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

or

$$\left(1 + \frac{2c}{\alpha}\right)\sigma_u^2 < \sigma_v^2$$  \hspace{1cm} (11.6)

Hence, choose an interest rate targeting procedure whenever there is

– relatively high money demand volatility
– relatively low aggregate demand volatility

Hence, 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 broad money supply (M1):

\[ m_t = b_t + h i_t + \omega_t, \quad h > 0 \]  \hspace{1cm} (11.7)

Here, \( b_t \) is the monetary base

- \( m_t - b_t \) is the (log) money multiplier. \( \omega_t \) is mean-zero money multiplier shock

Money multiplier is increasing in interest rate (banks want to lend more/consumers want to hold less cash \( \Rightarrow \) expanding deposits are possible)

Note that we now have an “LM curve” in \( b_t \):

\[ b_t = -(c + h) i_t + y_t + v_t - \omega_t \]
• The interest rate as an instrument gives output variance as before; $E_i [y_t]^2 = \sigma_u^2$

• 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:

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

• 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: 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, but one may still under an interest rate 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:

  \[ b_t = \mu i_t \]  

  \(-\mu = 0\): A base money operating procedure
  \(-\mu = -h\): A (broad) money supply operating procedure
  \(-\mu \to \infty\): An interest rate operating procedure
  - The “LM curve” becomes

  \[ 0 = - (c + h + \mu) i_t + y_t + \nu_t - \omega_t \]  

  Solution for output [combine (*) with IS-curve]:

  \[ y_t = \frac{(c + \mu + h) u_t - \alpha (\nu_t - \omega_t)}{c + h + \mu + \alpha} \]

  Associated variance:

  \[ E_{\mu} [y_t]^2 = \frac{(c + \mu + h)^2 \sigma_u^2 + \alpha^2 (\sigma_v^2 + \sigma_\omega^2)}{(c + h + \mu + \alpha)^2} \]
What is the optimal base rule (in terms of minimizing output variance)?

Solve

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

Solution is [see note “Equivalence of (11.11)....” on web]:

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

(11.10)

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

Note, however, that even \(\sigma_v^2 = \sigma_\omega^2 = 0\) does not warrant a “pure” base rule operating procedure \((\mu = 0)\)

- With \(u_t > 0\), causing an increase in \(i\), one can do better by contracting \(b_t\) so as to further increase the nominal interest rate \((\mu^* < 0)\)

With \(\sigma_v^2, \sigma_\omega^2 > 0\) “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 $\mu^*$ in policy rule and a “signal extraction” problem (like in Lucas’ Island model)

Central bank observes the nominal interest rate, but not the shocks. Hence, it forecasts 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

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

Output-stabilizing rule:

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

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

$$b_t = -\frac{c + h}{\alpha} \hat{u}_t + \hat{v}_t - \hat{\omega}_t \quad (11.11 \text{ First part})$$

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

• We get

$$b_t = \left(-\frac{c + h}{\alpha} \delta_u + \delta_v - \delta_\omega\right) i_t \quad (11.11 \text{ Second part})$$

[The note “Equivalence of (11.11) . . .,” on web, shows that when the $\delta$s are chosen to minimize squared forecast errors, the coefficient on $i_t$ becomes $\mu^*$]
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 is to minimize inflation variance around a target (here normalized to $\pi^* = 0$):

  $$ V = E[\pi_t]^2 $$  \hspace{1cm} (11.15')
The AS/IS/LM model:

\[ y_t = a (\pi_t - E_{t-1} \pi_t) + z_t, \quad a > 0 \]  \hspace{1cm} (AS 11.12)

\[ y_t = -\alpha (i_t - E_t \pi_{t+1}) + u_t, \quad \alpha > 0 \]  \hspace{1cm} (IS 11.13)

\[ m_t - p_t = m_t - \pi_t - p_{t-1} = y_t - c_i + v_t, \quad c > 0 \]  \hspace{1cm} (LM 11.14)

Shocks follow AR(1) processes:

\[ z_t = \rho_z z_{t-1} + e_t, \quad 0 < \rho_z < 1, \]
\[ u_t = \rho_u u_{t-1} + \varphi_t, \quad 0 < \rho_u < 1, \]
\[ v_t = \rho_v v_{t-1} + \psi_t, \quad 0 < \rho_v < 1, \]

All innovations, \( e_t, \varphi_t \) and \( \psi_t \), are mean-zero, independent shocks (with variances \( \sigma_e^2, \sigma_{\varphi}^2, \sigma_{\psi}^2 \))

Policy instrument is the nominal interest rate

With the simple policy goal, solution of model is simplified as \( E_{t-1} \pi_t = E_t \pi_{t+1} = 0 \)

AS and IS curves provides solution for inflation as function of interest rate

\[ \pi_t = \frac{-\alpha i_t + u_t - z_t}{a} \]  \hspace{1cm} (11.16’)

Clearly, optimal shock-contingent interest rate is

\[ i_t = \left( \frac{1}{\alpha} \right)(u_t - z_t) \]  \hspace{1cm} (11.17’)

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If interest rate must be set before period $t$ innovations are realized, the optimal interest rate is

$$\hat{\nu}_t = \frac{1}{\alpha} (\rho_u \nu_{t-1} - \rho_z z_{t-1})$$ (11.18’)

- Given this policy, actual inflation becomes

$$\pi_t (\hat{\nu}_t) = \frac{\varphi_t - e_t}{a}$$

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

Associated inflation variance

$$V (\hat{\nu}_t) = \frac{\sigma_a^2 + \sigma_e^2}{a^2}$$

- One can find the money supply that gives the same inflation and interest rate (all relevant derivations are provided in the note “Deriving (11.21)...”; see web page):

$$\hat{m}_t = p_{t-1} - \frac{c}{\alpha} \rho_u \nu_{t-1} + \left(1 + \frac{c}{\alpha}\right) \rho_z z_{t-1} + \rho_v v_{t-1}$$ (11.19)

- 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 $m_t$ provides information about the shocks—a signal

Adjusting the interest rate such that actual $m_t$ becomes equal to $\hat{m}_t$ may improve policymaking (it takes into account information about the unobservable shocks)

- $m_t$ becomes an intermediate target for policymaking
• Example: $\sigma^2_{\psi} = \sigma^2_e = 0$; only aggregate demand shocks matter
  
  – $u_t > 0$ will, for a 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 $\hat{m}_t$
  
  – Intermediate targeting is therefore appropriate policy

• Example: $\sigma^2_{\psi} = \sigma^2_\varphi = 0$; only aggregate supply shocks matter
  
  – $z_t > 0$ will, for a given interest rate, be reflected in lower inflation and lower $m_t$
  
  – Lower $m_t$ thus provides information about $z_t > 0$, and the interest rate should be decreased to bring inflation back towards target, i.e., to bring back $m_t$ to $\hat{m}_t$
  
  – Intermediate targeting is therefore appropriate policy

• Example: $\sigma^2_e = \sigma^2_\varphi = 0$; only money demand shocks matter
  
  – $v_t > 0$ will, for a given interest rate, be reflected in higher $m_t$ and no change in inflation
  
  – Higher $m_t$ thus provides information about $v_t > 0$, and the interest rate should be left unchanged

  and leave $m_t$ different from $\hat{m}_t$
  
  – Intermediate targeting would therefore be inappropriate policy
• Overall, the desirability of a certain policy regime, here monetary intermediate targeting, will depend upon the relative variances of the shocks

• A simple interest rate procedure to keep \( m_t = \hat{m}_t \) improves on keeping \( i_t = \hat{i}_t \) if \( \sigma_e^2 \) and \( \sigma_\varphi^2 \) are relatively high, and \( \sigma_\psi^2 \) is relatively low

• 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

\[
i_t = \hat{i}_t + \mu x_t
\]

(11.22)

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

• Optimal \( \mu \) will, e.g., be decreasing in \( \sigma_\psi^2 \)

• In this sense, new information used by observing the intermediate target is used optimally

  – It will improve over a policy aimed at attaining \( m_t = \hat{m}_t \)
Plan for next lectures

Tuesday, April 16, Lectures: Interest rate policies (I)

1. Price level (in)determinacy
2. Liquidity traps
3. The term structure of interest rates

Literature: Walsh (Chapter 10, pp. 453–475)

Tuesday, April 23, Lectures: Interest rate policies (II)

1. Optimal interest rate rule in simple model for policy analysis
2. Application: Inflation targeting

Literature: Jensen (2011, “Optimal Interest-Rate Setting in a Dynamic IS/AS Model” — available on course page)