The evolution of monetary policy rules and regimes

- Monetary policy rules (systematic monetary policy)
  Rule: a prescribed guide for conduct or action
  - Instrument rules (narrow sense of monetary policy rule): Commitment to a particular reaction function
    - Explicit/implicit instrument rules
    - Simple instrument rules
    - Main example: Taylor rule
  - Targeting rules (broader sense of monetary policy rule)
    - General: Commitment to particular loss function
    - Specific: Commitment to particular condition (target criterion) for (forecasts of) target variables (first-order condition, Euler condition)

- Alternative monetary policy strategies
  - Informal strategy/monetary policy rule
  - Suggested/actual monetary policy rules
    - Fixed exchange rate
      Monetary policy determined by "center country", passively adopted by pegging countries
    - Wicksell (1898 (1936), 1907), stabilize price level
    - Price level targeting (Sweden in 1930s)
    - Friedman's $i = 0$ rule (optimum quantity of money)
    - Friedman's $k\%$ rule, money-growth targeting
    - Nominal-income targeting (stabilize nominal income or nominal income growth)
    - Instrument rules: Monetary-base rule, Taylor rule
    - Inflation targeting

Wicksell: stabilize the price level (*Geldzins und Güterpreise* 1898 (*Interest Rates and Prices* 1936), EJ 1907)

"If prices rise, the rate of interest is to be raised; and if prices fall, the rate of interest is to be lowered; and the rate of interest is henceforth to be maintained at its new level until a further movement of prices calls for a further change in one direction or the other (1936, p. 189)."

- Model: Flexible prices, exogenous output
  Additively separable utility function, $U(C_t) + \tilde{U}(\frac{M_t}{P_t})$, $U_{c\frac{M}{P}} = 0$.

$$\frac{1}{1+\tilde{\imath}_t} = \mathrm{E}_t \frac{\delta U_C(C_{t+1})/P_{t+1}}{U_C(C_t)/P_t}$$

$$\frac{1}{1+\tilde{r}_t} = \mathrm{E}_t \frac{\delta U_C(C_{t+1})}{U_C(C_t)}$$

$$C_t = Y_t, \quad Y_t \text{ exogenous}$$

$$\frac{1}{1+\tilde{r}_t} = \mathrm{E}_t \frac{\delta U_C(Y_{t+1})}{U_C(Y_t)} \quad \text{exogenous}$$

Approximation: $\ln \mathrm{E}[x] = \mathrm{E}[\ln x]$ (disregard inflation risk premia/Jensen's inequality, Svensson 93)

$i_t = \ln(1+\tilde{\imath}_t),\ \bar{r}_t = \ln(1+\tilde{r}_t),\ p_t = \ln P_t$

$$i_t = \bar{r}_t + p_{t+1|t} - p_t$$

Rewrite

$$p_t = p_{t+1|t} + \bar{r}_t - i_t$$

(p_t forward-looking, $\bar{r}_t$ exogenous and predetermined, i_t instrument)

- Interpretation: Commitment to instrument rule, i_t respond to price level (implicit, equilibrium condition)

$$i_t = a_t + bp_t, \quad b > 0$$

$$p_t = p_{t+1|t} + \bar{r}_t - a_t - bp_t$$

$$\begin{aligned} p_t &= \frac{1}{1+b} p_{t+1|t} + \frac{1}{1+b}(\bar{r}_t - a_t) \\ &= \left(\frac{1}{1+b}\right)^T p_{t+T|t} + \frac{1}{1+b} \sum_{\tau=0}^{T-1} \left(\frac{1}{1+b}\right)^\tau (\bar{r}_{t+\tau|t} - a_{t+\tau|t}) \end{aligned}$$

Assume $b > 0$, $p_{t+T|t}$ bounded $\Rightarrow \lim_{T\to\infty} \left(\frac{1}{1+b}\right)^T p_{t+T|t} = 0$, exclude bubbles

$$p_t = \frac{1}{1+b} \sum_{\tau=0}^{\infty} \left(\frac{1}{1+b}\right)^\tau (\bar{r}_{t+\tau|t} - a_{t+\tau|t})$$

Price-level target p^*

$$p^* = p_t = \frac{1}{1+b} \sum_{\tau=0}^{\infty} \left(\frac{1}{1+b}\right)^\tau (\bar{r}_{t+\tau|t} - a_{t+\tau|t})$$

Guess

$$a_t = a + \bar{r}_t$$

$$p^* = \frac{1}{1+b} \sum_{\tau=0}^{\infty} \left(\frac{1}{1+b}\right)^\tau (-\,a) = -\,\frac{1}{b} a$$

$$a = -\,bp^*$$

Instrument rule (implicit, equilibrium condition, respond to forward-looking variable)

$$i_t = \bar{r}_t + bp_t - bp^* = \bar{r}_t + b(p_t - p^*)$$

Price level

$$p_{t+\tau} = p^*, \quad \tau \geq 0$$

$b > 0$, commitment to out-of-equilibrium behavior
Sophisticated Wicksell rule, $a_t \equiv \bar{r}_t$ time-varying
Simple Wicksell rule, $a_t = \bar{r} \equiv \mathrm{E}[\bar{r}_t]$
Explicit instrument rule, $i_t = \bar{r}_t + b(p_{t-1} - p^*)$
Alternative interpretation: $i_t = a_t + b\pi_t$

- Price-level targeting in Sweden during 1930s
  Fisher 34, Berg-Jonung 99
- Loss function, p_t^* target path (Vestin 03, Batini-Yates)

$$\mathrm{E}_t \sum_{\tau=0}^{\infty} (1-\delta)\delta^\tau L_{t+\tau}$$

$$L_t = \frac{1}{2}[(p_t - p_t^*)^2 + \lambda x_t^2]$$

$$p_t^* = p_{t-1}^* + \pi^*, \quad \pi^* \geq 0$$

Friedman: "optimum quantity of money" (Friedman 69)
Asset-pricing equations derived before

$$\frac{1}{1+\tilde{\imath}_t} = \mathrm{E}_t \frac{\delta U_C(C_{t+1}, \frac{M_{t+1}}{P_{t+1}})P_t}{U_C(C_t, \frac{M_t}{P_t})P_{t+1}}$$

$$\frac{1}{1+\tilde{r}_t} = \mathrm{E}_t \frac{\delta U_C(C_{t+1}, \frac{M_{t+1}}{P_{t+1}})}{U_C(C_t, \frac{M_t}{P_t})}$$

$$\frac{U_{\frac{M}{P}}(C_t, \frac{M_t}{P_t})}{U_C(C_t, \frac{M_t}{P_t})} = \frac{\tilde{\imath}_t}{1+\tilde{\imath}_t} \tag{1}$$

$$M_t/P_t = f(C_t, \tilde{\imath}_t)$$

Optimum quantity of money (real balances)

$$\max_{\frac{M_t}{P_t}} U(C_t, \frac{M_t}{P_t})$$

First-order condition

$$U_{\frac{M}{P}}(C_t, \frac{M_t}{P_t}) = 0 \tag{2}$$

Hence

$$\tilde{\imath}_t = 0$$

$\ln \mathrm{E}_t x \approx \mathrm{E}_t \ln x$, $i_t = \ln(1+\tilde{\imath}_t),\ r_t = \ln(1+\tilde{r}_t),\ p_t = \ln P_t,\ \pi_t = p_t - p_{t-1}$

$$i_t = r_t + \pi_{t+1|t}$$

Optimum quantity of money

$$\begin{aligned} i_t &= 0 \\ \pi_{t+1|t} &= -r_t \end{aligned}$$

In steady state (C_t, $\frac{M_t}{P_t}$ constant)

$$\begin{aligned} \pi_t &= \bar{\pi} = -\bar{r} \\ m_t - m_{t-1} &= -\bar{r} \end{aligned}$$

- Optimal rate of deflation
  - Never applied in practice (voluntarily). Involuntary liquidity trap? (Japan?)
  - Complication: Distortionary taxation, optimal inflation tax, optimal $\bar{\imath} > 0$, $\bar{\pi} > -\bar{r}$ (Phelps)

Money-growth targeting

- Friedman $k\%$, Brunner-Meltzer, German economists
  - Friedman 68
    - ∗ Two requirements for monetary policy:
      (a) Aim at what it can control, nominal variables: Exchange rates, price level, monetary aggregates
      Fixed exchange rates undesirable for US (small share of trade)
      Price level most desirable to control, but long and variable lags between action and effect, variable magnitude of effect, less predictable. Attempts to control price level directly would be source of disturbances.
      Monetary aggregates, shorter lag, more predictable effect
      (b) Avoid sharp swings
    - ∗ Hence, $k\%$ steady growth in (broad) money (3–5%/yr), $\mathrm{E}[\pi] \approx 0$

- Bundesbank (Swiss NB, abandoned Dec 99)

$$m_{t+1} - m_t = \mu^*$$

Buba determination of μ^* (for each year)

$$\mu^* = \pi^* + (y^n_{t+1,t} - y^n_t) - \text{ velocity trend}$$

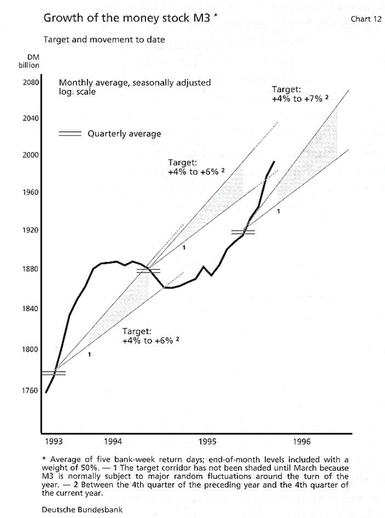
Rationale: Quantity equation, definition of velocity (logs)

$$p_t + y_t \equiv m_t + v_t$$

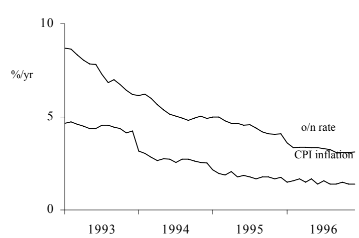
$$\Delta m_t \equiv \Delta p_t + \Delta y_t - \Delta v_t$$

Eurosystem reference value (money-growth *indicator*, not target)

- Problems: velocity not stable
  - Short-run/medium-run $\mathrm{Corr}(\Delta m_t, \Delta p_t)$ too low (Estrella-Mishkin 97, Stock-Watson 99,
    Rudebusch-Svensson 02, Gerlach-Svensson 03)
  - Hence, bad intermediate target
  - Buba in practice inflation targeter (Bernanke-Mihov 97, Clarida-Gertler 97, CGG 98, Laubach-Posen 97, BLMP 99)

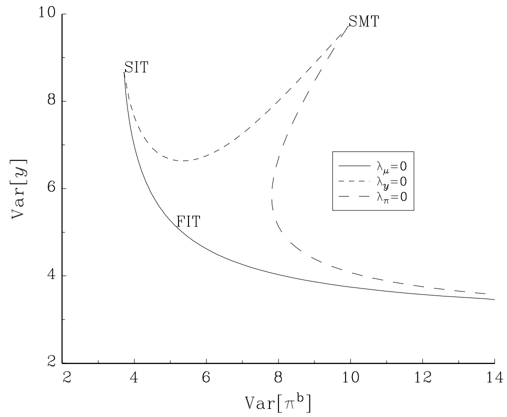


German M3 (Chart 12 in Buba Annual Report 1996)



German overnight rate and CPI inflation, 1993–1996

- Other countries tried, real money growth unstable, abandoned (most recently SNB).
  - “It is not the Bank of Canada that has abandoned money, it is money that has abandoned the Bank of Canada.”
- More knowledge about transmission mechanism now than in Friedman 68.



Variance tradeoffs for $\bar{\pi}_t$ and y_t
(Svensson-Rudebusch 02)

Empirical model of the U.S.

$$L_t = \frac{1}{2}[\lambda_\pi \bar{\pi}_t^2 + \lambda_y y_t^2 + \lambda_\mu \mu_t^2 + 0.2(i_t - i_{t-1})^2]$$

$$\bar{\pi}_t \equiv p_t - p_{t-4} \text{ (4-qtr inflation)}$$

$$\mu_t \equiv m_t - m_{t-4} \text{ (4-qtr M2 growth)}$$

$$\lambda_\pi + \lambda_y + \lambda_\mu + 0.2 = 1 \qquad (\lambda_\pi, \lambda_y, \lambda_\mu \geq 0)$$

Simple instrument rules

- Monetary base: McCallum, Meltzer. Interest rate: Wicksell, Henderson-McKibbin, Taylor
- Taylor-type rule

$$i_t = \bar{r} + \pi^* + f_\pi(\pi_t - \pi^*) + f_x x_t$$

Interest rate smoothing

$$i_t = (1-\rho)[\bar{r} + \pi^* + f_\pi(\pi_t - \pi^*) + f_x x_t] + \rho i_{t-1} \qquad (3)$$

- Taylor 93

$$i_t = 2 + \tilde{\pi}_t + .5(\tilde{\pi}_t - 2) + 0.5\tilde{x}_t$$

$\bar{r} = 2\%/$yr, $\pi^* = 2\%/$yr, $f_\pi = 1.5$, $f_x = .5$,
$\tilde{\pi}_t$ is 4-quarter inflation, GDP deflator
$\tilde{x}_t \equiv \frac{Y_t - Y_t^*}{Y_t^*}$,
Y_t is (real) GDP, Y_t^* is trend real GDP (2.2%/yr 84:1-92:3)

- Good (but not exact) description of Fed policy when policy has been "successful" (successful deviations from rule seem to have occurred)
- Good robustness properties: Works reasonably well in simulations in different models (somewhat different coefficients) (gets reasonably close to efficient Taylor curve with $\mathrm{Var}[\pi_t]$, $\mathrm{Var}[x_t]$)

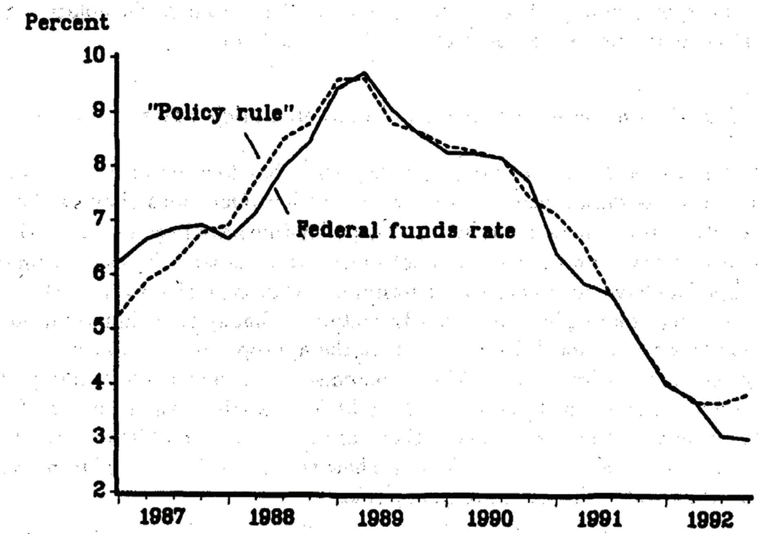


Figure 1. Federal funds rate and example policy rule.

- Optimal?
  - Taylor-type instrument rule optimal in backward-looking model, when π_t, x_t only predetermined variables)
  - Not optimal in forward-looking model (get close to optimal?)

- Taylor principle (Taylor 99, Woodford 03, chap. 2): $f_\pi > 1$ implies determinacy
  Example: Simple forward-looking model

$$\begin{aligned}
\pi_t - \mathrm{E}[\pi] &= \delta(\pi_{t+1|t} - \mathrm{E}[\pi]) + \kappa x_t \\
x_t &= x_{t+1|t} - \sigma(i_t - \pi_{t+1|t} - \bar{r}_t) \\
\bar{r}_t - \bar{r} &= \rho(\bar{r}_{t-1} - \bar{r}) + \eta_t \\
i_t &= \bar{r} + \pi^* + f_\pi(\pi_t - \pi^*) + f_x x_t
\end{aligned}$$

Rewrite:

$$\begin{bmatrix} \pi_{t+1|t} - \pi^* \\ x_{t+1|t} \end{bmatrix} = M \begin{bmatrix} \pi_t - \pi^* \\ x_t \end{bmatrix} + N(\bar{r}_t - \bar{r})$$

$$M = \begin{bmatrix} 1/\delta & -\kappa/\delta \\ -\sigma/\delta + \sigma f_\pi & 1 + \kappa\sigma/\delta + \sigma f_x \end{bmatrix}$$

Eigenvalues μ or M: $|\mu I - M| = 0$
$|\mu| > 1 \Longleftrightarrow$

$$f_\pi + \frac{1-\delta}{\kappa} f_x > 1 \tag{4}$$

$f_\pi > 1$, $f_x \geq 0$ implies determinacy

- One can show that (4) is also relevant for Taylor-rule with interest-rate smoothing, (3) (Woodford 03, chapt. 2). A sustained rise in π_t must result in a greater sustained rise in i_t (a sustained rise in r_t).

- Status of Taylor-type rules
  - Taylor 93, 00: Should not be followed mechanically. Provide guidlines for monetary policy, use judgment for deviations (stock-market crash 87, oil-price shock 90).
  - Many academic authors advocate or assume Taylor-type rules.
  - Reduced form, outcome of optimization, endogenous? Or exogenous, starting point, commitment to, mechanical?
  - Bernanke (2006, Testimony to Congress):
    "As always, however, translating the Federal Reserve's general economic objectives into operational decisions about the stance of monetary policy poses many challenges. Over the past few decades, policymakers have learned that no single economic or financial indicator, *or even a small set of such indicators*, can provide reliable guidance for the setting of monetary policy." [Italics added.]

- Role of simple instrument rules in general and Taylor rules in particular (Svensson 03)
  - Advantages of commitment to simple instrument rule
    - Simplicity makes commitment technically feasible
    - Relatively robust
  - Disadvantages of commitment to simple instrument rule
    - May be far from optimal in some circumstances
    - No room for judgemental adjustments/deviations
    - No central bank has committed itself to a simple instrument rule.
      "Rarely does society solve a time-inconsistency problem by rigid precommitment... Enlightened discretion is the rule." (Blinder, 98, p. 49)
      "Implicit in any monetary policy action or inaction, is an expectation of how the future will unfold, that is, a forecast.
      The belief that some formal set of rules for policy implementation can effectively eliminate that problem is, in my judgement, an illusion. There is no way to avoid making a forecast, explicitly or implicitly." (Greenspan, 94, p. 244)
      "Mechanical policy rules are not credible... No rule could be written down that describes how policy would be set in all possible outcomes. Some discretion is inevitable. But that discretion must be constrained by a clear objective to which policy is directed..." (King, 99, p. 2)

– If guidline only, and judgemental deviations from rule are OK, what are the rules for deviations? Incomplete!
– *Not* substitute for forward-looking goal-directed monetary policy, at best complement

Inflation targeting

- RBNZ 90, Bank of Canada 91, Bank of England 92, Bank of Sweden 93, Finland 93, Australia 93, ..., Czech Republic, Brazil, ...
- Recent research, latter half of 90s. Practice before theory.
- Characteristics
  – Announced numerical inflation target
  NZ 1–3%/yr CPI, Canada 1–3%/yr, UK 2% CPI/HICP (2.5% RPIX - Dec 03), Sweden 2%/yr$\pm$1% CPI, Australia 2–3%/yr average over cycle.
  – Operating procedure: "Inflation-forecast targeting"
  Intermediate target: conditional inflation forecast $\approx$ 2 yrs ahead
  – High degree of accountability and transparency
  Accountability: NZ PTA, UK letter, Canada CB-Govt.
  Transparency: Monetary Policy Statements, Inflation Reports
    ∗ Inflation forecasts; output or output-gap forecast
    ∗ Instrument rate assumption/forecast
      · Constant
      · Market expectations (UK, SE)
      · Optimal (NZ, NO: *Inflation Report Nov 2005*)

– Commitment to optimizing monetary policy (more than other regimes):
Minimize (implicit) loss function
Inflation target π^*, stabilize inflation around π^*
No output target (other than natural rate), no average inflation bias? Stabilize output gap (flexible vs. strict IT)

$$\mathrm{E}_t \sum_{\tau=0}^{\infty} (1-\delta)\delta^{\tau} L_{t+\tau}$$

$$L_t = \frac{1}{2}[(\pi_t - \pi^*)^2 + \lambda x_t^2]$$

Interest-rate smoothing?

$$L_t = \frac{1}{2}[(\pi_t - \pi^*)^2 + \lambda x_t^2 + \lambda_i (i_t - i_{t-1})^2]$$

– Problems
  * Implementation: Imperfect control over inflation
  * Monitoring/evaluation/accountability
    · Ex post deviations unavoidable
    · Lags
– Solution: Conditional inflation forecast as intermediate target
  * Internal decision process ("forcast targeting," set instrument rate so inflation forecast "looks good")
  * Publish forecast, motivate policy
  * (Simple) "specific targeting rule": Set instrument rate so two-year-ahead inflation forecast is on target.
- Inflation targeting in emerging-market countries
  – IMF WEO Sep 2005, Chapt. IV, "Does Inflation Targeting Work in Emerging Market Countries?"

- Is IT the last word?
  - Price-level targeting next step?
    Inflation targeting: π_t stationary, $p_t = p_{t-1} + \pi_t$ non-stationary (base drift)
    $$\mathcal{L}_t = \frac{1}{2}\sum_{\tau=0}^{\infty}(1-\delta)\delta^{\tau}[(\pi_{t+\tau} - \pi^*)^2 + \lambda x_{t+\tau}^2]$$
    Price-level targeting: p_t stationary
    $$\begin{aligned} \mathcal{L}_t &= \frac{1}{2}\sum_{\tau=0}^{\infty}(1-\delta)\delta^{\tau}[(p_{t+\tau} - p_{t+\tau}^*)^2 + \lambda x_{t+\tau}^2] \\ p_{t+1}^* &= p_t^* + \pi^* \qquad (\pi^* \geq 0) \end{aligned}$$
  - Good when risks for liquidity trap
  - "If there is anything in the world which ought to be stable it is money, the measure of everything which enters the channels of trade. What confusion would there not be in a state where weights and measures frequently changed? On what basis and with what assurance would one person deal with another, and which nations would come to deal with people who lived in such disorder?" (François Le Blanc, *Traité historique des monnayes de France*, Paris 1690, quoted by Einaudi 1953, p. 233, and *Bank of Canada* 94, p. 12-13.)