How Important is Money in the Conduct of Monetary Policy?

Michael Woodford

Columbia University

Money and Monetary Policy, ECB, November 2006

- The Historical Significance of Monetarism

- Are Moneyless Models Incomplete, or Inconsistent with Basic Economic Theory?

- Implications of the Long-Run Relationship Between Money and Prices

- Pitfalls of Phillips-Curve-Based Policy

Crucial Achievements of Monetarism

- Establishing that the central bank can be held accountable for inflation

- Emphasizing the importance of a verifiable commitment to non-inflationary policy

Questions About Models without Money

- Can they determine the level of money prices?
- Can they determine the long-run inflation trend, or only short-run departures from trend?
- Are they inconsistent with the principle of monetary neutrality?
- Are they inconsistent with the observation that open-market operations matter?

A Model without Money

$$\pi_t - \bar{\pi}_t = \kappa \log(Y_t/Y_t^n) + \beta E_t[\pi_{t+1} - \bar{\pi}_{t+1}] + u_t$$

$$\log(Y_t/Y_t^n) = E_t[\log(Y_{t+1}/Y_{t+1}^n] - \sigma[i_t - E_t\pi_{t+1} - r_t^n]$$

$\bar{\pi}_t$ = indexation rate (CB inflation target)

Y_t^n = natural rate of output

r_t^n = natural rate of interest

u_t = “cost-push” shock

- Monetary policy:

$$i_t = r_t^* + \bar{\pi}_t + \phi_\pi(\pi_t - \bar{\pi}_t) + \phi_y \log(Y_t/Y_t^n)$$

$$\bar{\pi}_t = \bar{\pi}_{t-1} + \nu_t^\pi, \qquad \nu_t^\pi \text{ i.i.d. mean zero}$$

- Policy shifts (exogenous):

$\bar{\pi}_t$ = inflation target

r_t^* = CB view of natural rate

- Alternative view of indexation by price-setters: indexation to perceived *inflation trend:*

$$\bar{\pi}_t \equiv \lim_{T \to \infty} E_t \pi_T$$

— well-defined if inflation difference-stationary (with zero expected change)

— with policy of specified type, in equilibrium this will *equal* the CB's inflation target at each date

- Equilibrium determination:

  — system of equations

$$z_t = A\, E_t z_{t+1} + a\,(r_t^n - r_t^*), \qquad z_t \equiv \begin{bmatrix} \pi_t - \bar{\pi}_t \\ \log(Y_t / Y_t^n) \end{bmatrix}$$

  — has a determinate solution if A has both eigenvalues inside unit circle; holds if

$$\phi_\pi + \frac{1-\beta}{\kappa}\phi_y > 1$$

- Solution:

$$z_t = \sum_{j=0}^{\infty} A^j a \, E_t[r^n_{t+j} - r^*_{t+j}]$$

- solution for inflation:

$$\pi_t = \bar{\pi}_t + \sum_{j=0}^{\infty} \psi_j E_t[r^n_{t+j} - r^*_{t+j}]$$

— stationary fluctuations around stochastic trend $\bar{\pi}_t$

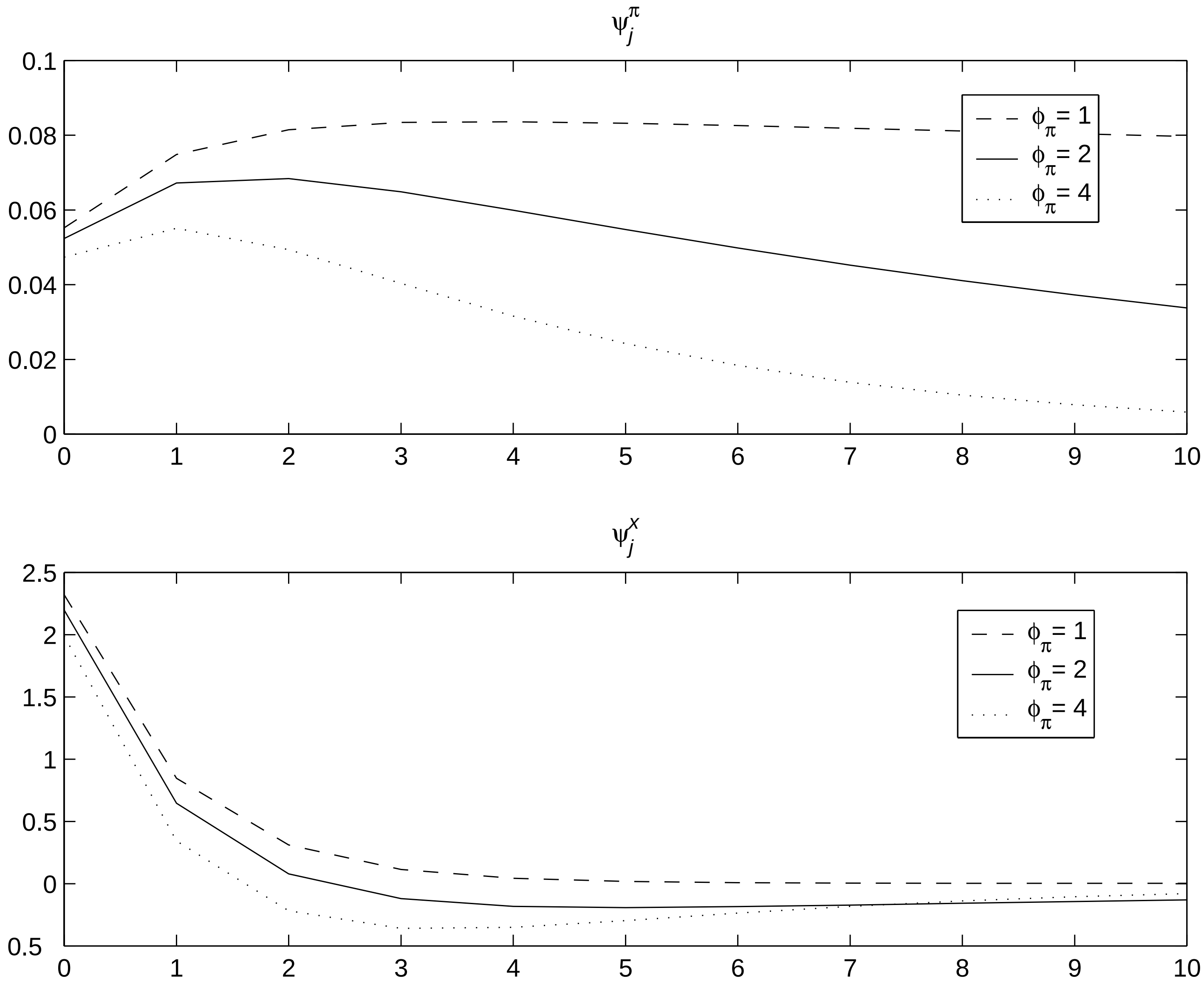


Figure 1: Consequences of varying the coefficient ϕ_π.

- The model involves no “rejection of the quantity theory of money,” in the sense of any denial of empirical regularities implied by that theory

- Can adjoin to the above equations a standard money-demand relation

$$\log(M_t/P_t) = \eta_y \log Y_t - \eta_i i_t + \epsilon_t^m$$

without changing any of the above analysis of consequences of following a Taylor rule

— this equation simply tells what the associated evolution of money supply must be

— this equation may or may not indicate how interest-rate targets are actually *implemented*

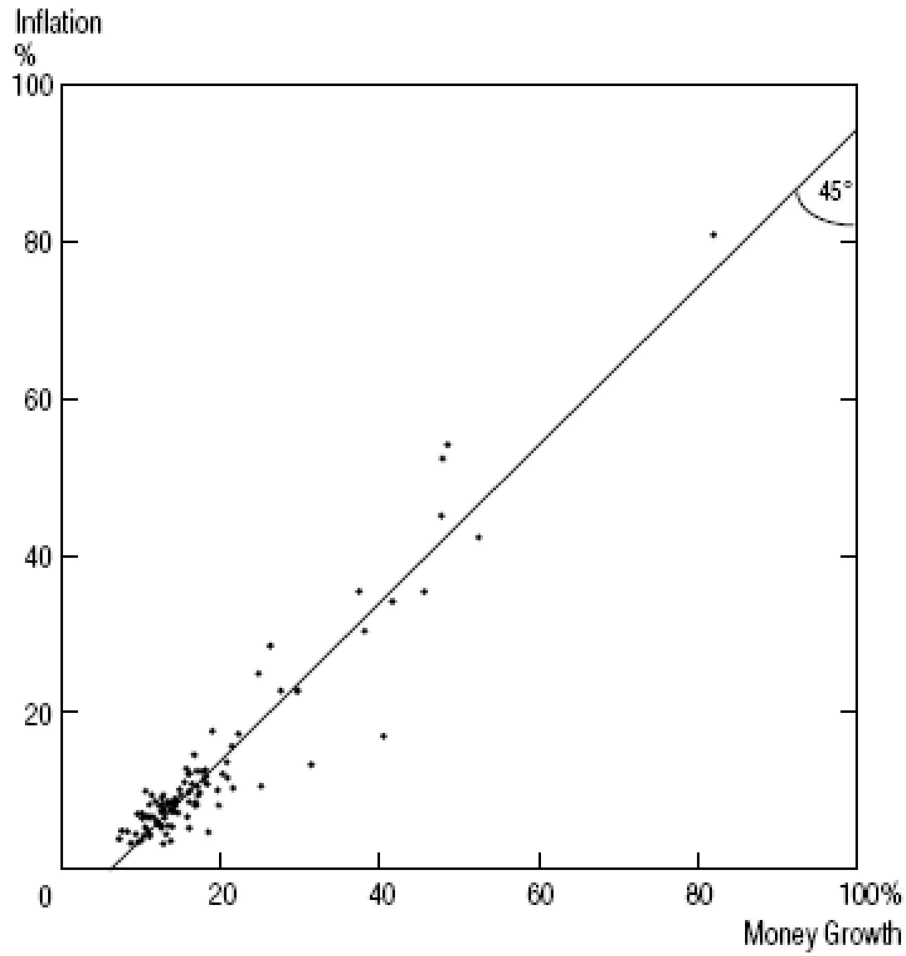
Money and Prices: Long-Run Evidence

- Cross-country comparisons of money growth and inflation, over long periods

- Money growth and inflation over time in a single country: low-frequency data

- Cointegration analysis: common “stochastic trend” for money growth and inflation

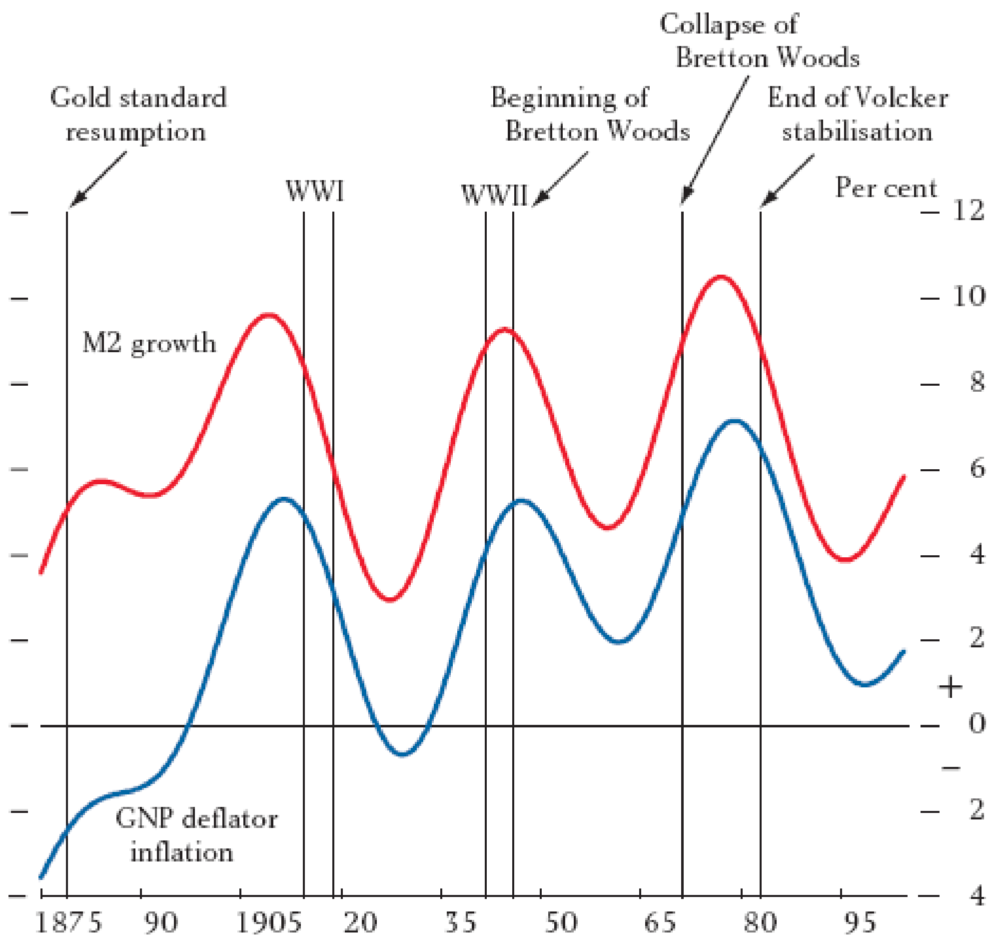
Average Annual Rates of Growth in M2 and in Consumer Prices During 1960-1990 in 110 Countries



Source: McCandless (1995)

United States, Low Frequency components of inflation and money growth

M2 growth and GNP deflator inflation (annualized quarterly changes)



Source: Benati (2005)

Implications:

- Moneyless models not a sound basis for policy analysis?
- Money-growth target the most reliable way to ensure desired long-run inflation rate?
- Money growth the best way to forecast long-run inflation trends?

- Implication of the money-demand relation:

$$\mu_t - \pi_t = \eta_y \Delta \log Y_t - \eta_i \Delta i_t + \Delta \epsilon_t^m$$

- As long as $\log Y_t, i_t, \epsilon_t^m$ are all at least *difference-stationary,* above solution of the NK model implies that

  — μ_t and π_t are both $I(1)$

  — and are *cointegrated:* common stochastic trend given by $\bar{\pi}_t$

- Hence NK model above would *predict* exactly the sort of long-run relation between money and prices that is found

  — yet inflation determination can nonetheless be understood in that model without any reference to money

“Two-Pillar” Phillips Curves

- Idea: different determinants of inflation at different frequencies
- Assenmacher-Wesche and Gerlach (2006a) estimate a forecasting model

$$\pi_t = \alpha_\mu \mu_t + \alpha_y \gamma_t + \alpha_\rho \rho_t + \alpha_g g_{t-1} + \epsilon_t$$

  using band-spectral regression methods, so that the coefficients can be different for different frequency ranges

- See also Gerlach (2003), Neumann (2003), Neumann and Greiber (2004), Hofmann (2006).

- Hypothesis: can decompose

$$\pi_t = \pi_t^{LF} + \pi_t^{HF},$$

where

$$\pi_t^{HF} = \alpha_g g_{t-1} + \epsilon_t^{HF}$$

$$\pi_t^{LF} = \alpha_\mu \mu_t^{LF} + \alpha_y \gamma_t^{LF} + \alpha_\rho \rho_t^{LF} + \epsilon_t^{LF}$$

Freq. range		HF	LF
Period (yrs)		0.5-8	8-∞
Money Growth		-0.02	0.96**
		(0.30)	(0.19)
Output Growth		-0.03	-0.98
		(0.07)	(0.97)
RR Change		1.10	3.01
		(0.46)	(6.92)
Output Gap		0.12**	—
		(0.03)	

An Example

- Model: basic NK model, augmented by money-demand relation ($\eta_y = 1$)

- Shocks: r_t^n, ϵ_t^m white noise

  — no u_t, r_t^* shocks ($r^* = E[r^n]$)

  — log Y_t^n diff-stationary (with LF variation in growth rate)

- Taylor rule coeffs satisfy determinacy condition

- Equilibrium:

$$\begin{aligned}\pi_t &= \bar{\pi}_t + a\hat{r}_t^n, \\ \log Y_t &= \log Y_t^n + b\hat{r}_t^n, \\ i_t &= r^* + \bar{\pi}_t + c\hat{r}_t^n,\end{aligned}$$

$$\mu_t - \pi_t = \gamma_t^n + (b - \eta_i c)\Delta r_t^n - \eta_i \nu_t^\pi + \Delta\epsilon_t^m.$$

- Properties of the solution:

  — $\pi_t,\ \mu_t$ are $I(1)$, co-integrated

  — common stochastic trend = $\bar{\pi}_t$

  — low-frequency fluctuations in $\pi_t - \mu_t$ mainly due to variations in $\Delta \log Y_t^n$; same true of γ_t

  — little low-frequency variation in $\log(Y_t/Y_t^n)$: white noise

  — "cyclical" inflation, $\pi_t - \bar{\pi}_t$, is perfectly correlated with $\log(Y_t/Y_t^n)$

- Thus would be consistent with "2-pillar PC" regressions

- Does this mean money growth is useful for forecasting inflation?

- Optimal forecast of inflation, at any horizon $j \geq 1$:

$$E_t \pi_{t+j} = \bar{\pi}_t = \pi_t + (a/b) \log(Y_t / Y_t^n)$$

The Quest for Robustness

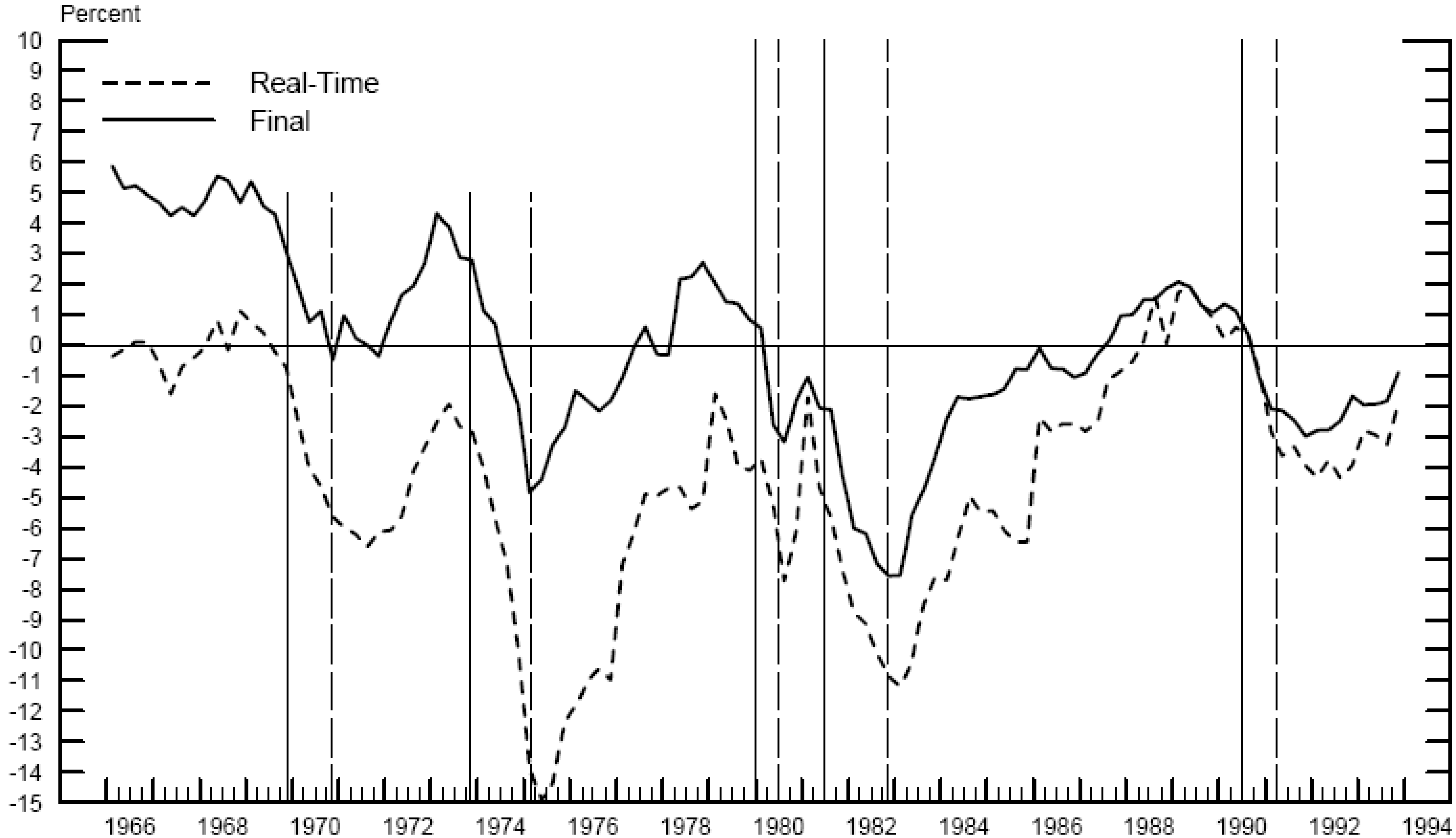
“The two-pillar approach is designed to ensure ... that appropriate attention is paid to different perspectives and the cross-checking of information.... It represents, and conveys to the public, the notion of diversified analysis and ensures robust decisionmaking” (ECB, 2004, p. 55).

Possible risks of reliance upon “economic analysis” of near-term inflation risks alone:

- The Pitfall of Reliance upon an Inaccurate Forecast

- The Pitfall of Ignoring the Endogeneity of Expectations

United States, The Output Gap in Real-Time and Final Data



Source: Orphanides (2000)

- Alternative approach to guarding against persistent inflation target misses: commitment to aim policy at *correcting* past target misses

  — advantage of a *price level* target (or target path)

- This is a feature of an optimal policy commitment, even when CB model is known to be perfectly accurate, in case of NK model presented above

- Also means less problems created by inaccuracy of CB real-time estimate of state (e.g., productivity): Gorodnichenko and Shapiro (2006)

- And a rule more robust to CB model mis-specification: Aoki and Nikolov (2005)

- Sub-optimality of discretionary policy: suppose each period, CB acts to minimize

$$(\pi_t - \pi^*)^2 + \lambda(x_t - x^*)^2$$

given the tradeoff

$$\pi_t - \bar{\pi}_t = \kappa x_t + \beta E_t[\pi_{t+1} - \bar{\pi}_{t+1}],$$

taking the values of $\bar{\pi}_t$ [current PS perception of inflation trend] and current inflation expectations as *given,* independent of current policy choice

- If $\lambda, x^* > 0$, choose each period an inflation rate satisfying the FOC

$$(\pi_t - \pi^*) + \frac{\lambda}{\kappa}(x_t - x^*) = 0$$

$$\Rightarrow \quad \pi = \pi^* + \frac{\lambda}{\kappa}x^* > \pi^*$$

- But an optimal inflation commitment would be to $\pi = \pi^*$, as no *long-run* PC tradeoff

- Note that the CB is *not mistaken* about the consequences of the policy that it chooses!

  — nor about the consequences of *deviating now* from that pattern of conduct, given that will behave later as specified in discretionary equilibrium

- Mistake is failure to correctly judge what would follow from *systematic* insistence upon lower inflation

- Would monitoring money growth solve the problem?

Advantages of a 2-Pillar Strategy

- Emphasizes commitment to ensuring *outcome* (price stability) rather than to a particular *formula*
- Incorporates some concern for *error-correction*

— but a sophisticated form of *inflation targeting* can incorporate both as well

— and a *unitary* target criterion improves transparency and accountability