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**INTEREST RATE POLICIES AND INFORMATIONAL EFFICIENCY**

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# Interest Rate Policies and Informational Efficiency

Laurence Weiss\*

## Abstract

Monetary policy may be implemented either by controlling the nominal money supply or by fixing the nominal interest rates. This paper investigates the effects on available information of both kinds of policies in the equilibrium rational expectations model presented in Grossman-Weiss (1980). A necessary and sufficient condition for informational efficiency is that agents have homogeneous expectations about the real interest rate. Interest rate policies can be first best in the sense of yielding higher quality information than any feasible money growth feedback policies. Unlike desirable money growth rules, interest rate policies do not require more information on behalf of the policy authority prior to period  $t$  than was held by a representative trader at  $t-1$ . In general, it is desirable to set the interest rate target so that the expected price level is constant.

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## Interest Rate Policies and Information Efficiency

The idea that monetary policy alters the structure of available information and thereby has real effects is a major innovation of rational expectations macroeconomic models. In some examples (Lucas (1972)), such considerations imply the desirability of constant money growth policies, but in other formulations (Weiss (1980a,b)) there are benefits to active feedback policies. The general message of this sort of analysis is that policy can make a contribution by insulating movements in money prices from purely "monetary" disturbances. When such disturbances emanate from the demand side, it is both feasible and desirable for the quantity of fiat money to accommodate such shocks so as to leave the price level unaffected. In this way, nominal prices are better able to disseminate information about real factors.

The present analysis investigates the normative role of policy in a model with an economy wide bond market. The principal analytic result is that policies which peg the nominal interest rate can be optimal on grounds of informational efficiency. Furthermore, this property is not shared by any feasible money growth feedback policy. As in previous examples, the model suggests that the particular choice of either current period money supply or nominal interest rates is less crucial than how agents believe future money supply or interest rates are chosen.

The desirability of interest rate rules on grounds of informational efficiency is, at first examination, somewhat surprising. Such a policy eliminates the current interest rate as a source of structural information and makes the money supply unpredictable. The benefit of this policy is that by accommodating current and future money demand disturbances through changes in nominal quantities, both the current and expected future price levels are insulated from

these types of shocks. It is precisely because this policy eliminates two sources of "noise" while removing only one signal that it can yield higher quality aggregate information than can passive policies.

The paper is organized as follows: Section I outlines the structural features of the model and states the equilibrium conditions which are the basis for understanding the normative role for policy. The model is identical to that presented in Grossman-Weiss (1980), except for the specification of policy. Section II discusses the benefits and limitations of money growth feedback rules. Section III shows how interest rate policies can be first best and lead to the same real allocation as if information were complete. In Section IV, several modifications to the structural model are introduced to examine their effect on appropriate interest rate feedback rule. The fifth section is the conclusion.

#### I) The Model

To assess the desirability of a particular policy on grounds of informational efficiency requires a specification of the kinds of shocks which, if known, would alter real decision variables, and restrictions on available information which makes policy potent. The present analysis focuses upon the role of nominal prices and interest rates for current period labor supply decisions when there is possible confusion between aggregate and relative productivity disturbances. The model assumes that all current nominal prices are directly observable, thus ignoring the possible confusions between aggregate and relative demand disturbances which have been emphasized in some previous works (cf. Lucas (1972)). The model emphasizes the effects of exogenous changes in money demand (LM shifts) which are not directly observable. Such shifts are captured analytically by the assumption that the utility of real balances is subject to random shocks, with both aggregate and individual specific components.

The structural elements of the model are the specifications of tastes, technology, available information and financial structure.

It is assumed that there are J infinitely long lived agents with preferences

$$(1) \quad U^j = \sum_{t=0}^{\infty} \beta^t \left( \frac{1}{\alpha} (C_t^j)^\alpha + \frac{\theta_j \rho_t^j}{a} (m_t^j)^a - L_t^j \right)$$

where  $C_t^j$  = consumption of j at t

$m_t^j$  = real balances of j at t

$L_t^j$  = labor input of j at t

$0 > \beta > 1$                        $a, \alpha < 1$

Agents have access to a private technology which transforms labor input at t into the single perishable consumption good at the denoted  $X_{t+1}^j$  according to the (stochastic) technology

$$(2) \quad X_{t+1}^j = (\tilde{N}_t e_t^j) \frac{1}{\sigma} (L_t^j)^\sigma \quad \sigma > 0$$

where  $\tilde{N}_t$  = (random) aggregate productivity shock at t (I.I.D.)

$e_t^j$  = (random) relative productivity shock  $(\frac{1}{J} \sum_j e_t^j \equiv 1)$

Individuals can trade money for consumption at a price of \$P and are permitted to borrow on an economy wide bond market whereby \$1 at t can be exchanged for \$R at t+1.

Each individual j can observe in period t his own productivity disturbance  $N_t e_t^j$ , his own shock to money demand for period t,  $\theta_t \rho_t^j$ , and t+1,  $\theta_{t+1} \rho_{t+1}^j$ . His private information does not permit him to identify separately aggregate from relative disturbances. At the time labor supply for period t is chosen, each agent also observes the nominal interest rate, the price

level, as well as aggregate current consumption  $C_t$ . He can observe all past period information, but cannot observe either current aggregate labor supply  $L_t$  or current period nominal money  $M_t$ .<sup>1</sup>

In each period, each agent must choose desired labor supply, consumption and money holding so as to maximize expected utility in accord with his budget constraint and available information. In Grossman-Weiss it was shown that there exists a formulation of the budget constraint so that it was both feasible and desirable for all agents to use the bond market to "insure" against relative productive disturbances and thereby consume per capita consumption.

An equilibrium for this economy is a mapping from the state of current and past exogenous random variables to the values of current prices and quantities. With the formulation that leads to each agent consuming per capita output,  $C_t$ , the conditions which characterize equilibrium in the money market, the bond market, the labor market, and the product market are given by equations 3-6, in log-linear form, (neglecting constant terms).<sup>2</sup>

$$(3) \quad M_t = P_t - m_2 R_t + m_1 C_t + \theta_t ,$$

$$(4) \quad R_t = -\ln\beta + (\alpha-1)C_t - P_t + E^*[(1-\alpha)C_{t+1} + P_{t+1}]$$

$$(5) \quad L_t = \frac{1}{1-\sigma} N_t + \frac{1}{1-\sigma} E^*[(\alpha-1)C_{t+1}]$$

$$(6) \quad C_{t+1} = N_t + \sigma L_t$$

where  $E^*$  denotes the average over the  $j$  agents of the expected value at the expression in the parenthesis, conditional on  $j$ 's information.

Equation (3) is a straightforward money demand equation. Note that money demand for each agent depends only upon observed magnitudes; the nominal interest rate is a sufficient statistic for the opportunity cost of money

holding. Equation (4) characterizes the condition for per capita consumption  $C_t$  to be willingly consumed -- each consumer must be indifferent to using a bond to change his consumption today for a change in consumption tomorrow. Equation (5) is derived from the condition that each agent chooses labor supply optimally. Since this relationship captures the essential channel by which alternative information structures have real effects, it warrants closer explanation. At an interior optimum, each agent must be indifferent to a small change in current labor supply and using the proceeds to change tomorrow's consumption. This gives rise to the first order condition  $-\partial U^j / \partial L_t^j = E^j [(\partial x_{t+1}^j / \partial L_t^j) (\partial U^j / \partial C_{t+1}^j)]$ . From the utility function (1) and production function (2) this implies  $0 = E^j [(N_t + e_t^j) + (\sigma-1)L_t^j + (\alpha-1)C_t^j]$ . Since each agent knows his own productivity shock and labor supply, these terms can be taken outside the expectation operator;  $(1-\sigma)L_t^j = (N_t + e_t^j) + E^j [(\alpha-1)C_t^j]$ . Setting  $C_t^j$  equal to per capita consumption  $C_t$  and aggregating across agents yields equation (5) under the condition  $\frac{1}{J} \sum_j e_t^j \equiv 0$ . Equation (6) is derived from the condition that the aggregate supply of perishable consumption goods is equal to the demand for consumption.

Equations 3-6 are not final reduced forms, since they contain expectations of future endogenous variables which depend upon the policy regime.

Nevertheless, there are some qualitative properties of the equilibrium which are invariant to changes in policy. From equation (4), knowledge of current  $R_t$ ,  $C_t$ , and  $P_t$  is sufficient to communicate average expectations of  $((1-\alpha)C_{t+1} + P_{t+1})$ . A result of previous work is that whenever average rational expectations of some random variable is directly observable to each agent, and each agent conditions his own expectations optimally on this signal as well as any private information, the resulting outcome is as if each agent knew everyone else's information relevant to the expected value of this random

variable.<sup>3</sup> Market signals are sufficient statistics for the expected value  $((1-\alpha)C_{t+1} + P_{t+1})$  no matter what the policy regime.

However, this is not sufficient to insure informational efficiency. Informational efficiency is achieved when the real allocation of labor supply and consumption is identical to that when agents have complete (i.e. homogenous) current period information. Computation of the full information equilibria is straightforward. Combining equations (6) and (5) and recognizing that the aggregate productivity shock,  $N_t$ , and aggregate current labor supply,  $L_t$ , are in the full information set at  $t$  yields  $C_{t+1} = \frac{1}{1-\sigma\alpha} N_t$ . Thus informational efficiency is achieved when each agent can infer the aggregate shock  $N_t$  from available market signals. In this way he will know the full information value of tomorrow's per capita consumption, necessary for current labor supply decisions.

The test for informational efficiency may be stated in terms of agents' perceptions of the expected real interest rate,  $E^j[R_j + P_t - P_{t+1}]$ . A necessary and sufficient condition for informational is that agents have homogenous rational expectations of the real rate of interest. From equation (4) and the preceding discussion this will be true if and only if agents have homogenous expectations of  $C_{t+1}$ , since they all have the same (full information) expectations of the term  $((1-\alpha)C_{t+1} + P_{t+1})$ . Necessity is obvious. Sufficiency is only slightly less so. Assume each agent has common expectations of next period per capital consumption  $\hat{C}_{t+1}$ . Combining equations (5) and (6),  $C_{t+1} = \frac{1}{1-\sigma} N_t + \frac{\sigma(\alpha-1)}{1-\sigma} C_{t+1}$ . Unless  $\hat{C}_{t+1} = C_{t+1} = \frac{1}{1-\sigma\alpha} N_t$ , agents are not using the valuable information in their own productivity shock  $(N_t + e_t^j)$  when forming their expectations, which establishes the proposition.



The main result of Grossman-Weiss is that informational efficiency is not possible under a monetary policy which holds constant the supply of nominal balances. To see this, imagine the artificial economy in which all traders have complete current period information. In such an economy for some set of  $\Pi$  coefficient,  $E(P_{t+1} | \text{all period } t \text{ information}) = \Pi_{10}N_t + \Pi_{11}\theta_{t+1}$ . Nominal interest rates and prices therefore reveal  $((\frac{1-\alpha}{1-\sigma\alpha} + \Pi_{10})N_t + \Pi_{11}\theta_{t+1})$ . From this information structure, the exact value of  $N_t$  is not revealed and therefore this cannot be a rational expectation equilibrium for the actual economy. Future money demand shocks cause independent movement in expected prices which are partly revealed by nominal interest rates. Because they are misperceived with real shocks they detract from the signalling aspect of nominal interest rates for communicating aggregate productivity disturbances.

## II) The Role of Money Growth Feedback Rules

The preceding discussion suggests that the aim of policy is to yield an equilibrium price path unaffected by money demand shocks. Can this be achieved by a policy which sets nominal money at  $t$ ,  $M_t$  on the basis of lagged available information? Clearly, if it is feasible it would be desirable to set  $M_t = \theta_t$ , i.e. full accommodation of shocks to current money demand. From equation (3), the equilibrium price path would then be given by  $P_t = m_2R_t - m_1C_t$  and the price level would be independent of past, current, and future money shocks. It may be verified that such a policy would yield an equilibrium price mapping  $P_t = \Pi_{10}N_{t-1} + \Pi_{11}N_t$  and interest rate mapping  $R_t = \Pi_{20}N_{t-1} + \Pi_{21}N_t$ . From these two signals agents could infer the exact value of  $N_t$  necessary for labor supply decisions. However such a policy is not feasible given the informational constraints of the policy authority. For if such a policy were to be enacted, no market signal (price or quantity) would reveal  $\theta_t$  prior to period  $t$  trade.

However, some feedback policies are both feasible and preferable to purely passive policies. Consider the policy rule  $M_t = (1-\delta)\theta_t$ , where  $\delta \neq 0$ . From equation (3), the equilibrium price path must satisfy  $P_t = m_2 R_t - m_1 C_t - \delta \theta_t$ . By making  $\delta$  arbitrarily small, the influence of current money demand shocks on the equilibrium price level can be made close to zero. However, so long as  $\delta \neq 0$ , observation of aggregate labor supply at  $t-1$ ,  $L_{t-1}$ , (which is not directly observable to agents at time  $t-1$ ), when combined with available price data will reveal  $\theta_t$  prior to period  $t$ .<sup>4</sup> Monetary feedback rules can come arbitrarily close to yielding the necessary information for the full communication real allocation, but cannot duplicate it exactly.<sup>5,6</sup>

### III) Interest Rate Policies

This section investigates the effects on available information, with implications for real decision variables of a policy which sets  $R_t$  on the basis of available information prior to  $t$ . In this context, the nominal money supply is determined endogenously. Operationally, it could be imagined that the policy authority stands by to borrow or lend at an interest rate  $R_t$ . However such a specification of the adjustment process is beyond the scope of the model. The equilibrium conditions require that  $M_t$ ,  $P_t$ ,  $L_t$ ,  $C_t$  satisfy equations 3-6 for the predetermined value  $R_t$  and each possible realization of the exogenous shocks; they do not specify the mechanism by which equilibrium is attained.

The relevance of this analysis for policies which peg the nominal price of government debt would seem to depend on the condition that the quantity of government itself does not affect individuals' behavior.

Sargent-Wallace (1975) argued that policies which controlled nominal interest rates without regard to nominal quantities could not produce a determinate price level in a model similar to that under study. The reason for this is obvious. Since only  $(M_t - P_t)$  enters the structural equations, there is no way to restrict either  $M_t$  or  $P_t$  separately. McCallum (1980) showed that this result was somewhat misleading. He proved that if the authority uses a feedback interest rule so as to achieve a desired money stock then an equilibrium price level could be determined. That analysis, however, did not deal with issues of informational efficiency, and did not suggest such a policy was necessarily desirable.

However this type of policy can lead to informational efficiency. Following McCallum, suppose the authority sets  $R_t$  at the beginning of period  $t$  so as to achieve an expected money stock  $\mu_t$ . From equation (3),  $R_t$  must be set so that

$$(7) \quad R_t = \frac{1}{m_1} (-\mu_t + E(P_t) + m_1 E(C_t) + E(\theta_t))$$

It will be shown that this policy yields an equilibrium price path

$$(8) \quad P_t = \Pi_{10} + \Pi_{11}N_{t-1} + \Pi_{12}N_t$$

and nominal money path

$$(9) \quad M_t = \Pi_{20} + \Pi_{21}N_{t-1} + \Pi_{22}N_t + \Pi_{23}\theta_t$$

which satisfies equations 3-6 for some  $\Pi$  coefficients. Substituting the full information value  $C_{t+1} = \frac{1}{1-\sigma\alpha} N_t$ , and  $E(P_t) = \Pi_{10} + \Pi_{11}N_{t-1}$ ,  $E(C_t) = \frac{1}{1-\sigma\alpha} N_{t-1}$  and  $E(\theta_t) = 0$  into equation (7) and combining with equation (4) yields

$$\begin{aligned}
 (10) \quad & \frac{1}{m_2} (-\mu + (\Pi_{10} + \Pi_{11}N_{t-1}) + \frac{m_1}{1-\sigma\alpha} N_{t-1}) \\
 & = -\ln\beta + \frac{\alpha-1}{1-\sigma\alpha} N_{t-1} - (\Pi_{10} + \Pi_{11}N_{t-1} + \Pi_{12}N_t) \\
 & \quad + \frac{1-\alpha}{1-\sigma\alpha} N_t + (\Pi_{10} + \Pi_{11}N_t)
 \end{aligned}$$

which holds as an identity for

$$\frac{1}{m_2} (-\mu + \Pi_{10}) = -\ln\beta$$

$$\frac{1}{m_2} (\Pi_{11} + \frac{m_1}{1-\sigma\alpha}) = \frac{\alpha-1}{1-\sigma\alpha} - \Pi_{11}$$

$$0 = -\Pi_{12} + \frac{1-\alpha}{1-\sigma\alpha} + \Pi_{11}$$

or

$$\Pi_{10} = \mu - m_2 \ln\beta$$

$$\Pi_{11} = \frac{-1}{1+m_2} \left( \frac{m_1 + m_2(1-\alpha)}{1-\sigma\alpha} \right)$$

$$\Pi_{12} = -\frac{1}{1+m_2} \left( \frac{m_1 - (1-\alpha)}{1-\sigma\alpha} \right)$$

Substituting (8) and (9) into (3) shows that  $\Pi_{23} = 1$ ; all variations in money demand are accommodated one for one with variations in money supply. The nominal price level is left unaffected by money demand shocks, but communicates the exact value  $N_t$  necessary for optimal labor supply.

The nominal interest target (equation (7)) will be set equal to

$$R_t = \frac{1}{m_1} \left( m_2 \ln \beta - \frac{m_2}{1+m_2} \frac{1-\alpha}{1-\sigma\alpha} N_{t-1} \right) .$$

Since the unexpected component of prices at  $t$  is

$$\frac{(1-\alpha) - m_1}{(1+m_2)(1-\sigma\alpha)} N_t$$

the interest rate target will respond positively to unexpected price rises for  $(1-\alpha) - m_1 < 0$ , and negatively for  $(1-\alpha) - m_1 > 0$ . It is worth emphasizing that this policy, unlike desirable money growth feedback policies considered in the previous section does not require more information on behalf of the policy authority prior to period  $t$  than was held by a representative trader at  $t-1$ . Particularly the past growth rate in nominal money has no significance for determining the current interest rate. Interest rate policies are desirable because they yield the desired dichotomy between money demand disturbances and nominal prices. Fluctuations in the current price level, assumed to be directly observable, will cause homogenous changes in the expected real rate of interest and hence lead to informational efficiency.

#### IV) The Appropriate Interest Rate Target

The preceding analysis demonstrated that some interest rate policy could lead to informational efficiency. This was consistent with a policy which set the nominal interest rate so as to yield a constant expected nominal money demand. The appropriate interest rate target was found to depend on unexpected past price changes, but not past money changes. In this section the structural model will be modified in several ways to see how robust these conclusions are.

Suppose the model is modified so that money demand shocks have some persistent aggregative components, i.e.  $\theta_t = \lambda\theta_{t-1} + \gamma_t$ . As before, agents cannot observe the contemporaneous money supply. However, revelation of money supply figures at the close of period  $t$  will inform everybody about the period  $t$  shock to money demand. If the authority followed the same type of policy in equation (7) which pegged expected nominal money demand, the nominal rate for  $t+1$  and thus the equilibrium price level for  $t+1$  would be functionally dependent upon  $\theta_t$ . Since agents have noisy private information about  $\theta_t$  in period  $t$ , the nominal price level in period  $t$  will be influenced by this disturbance and the full information value of  $N_t$  will not be revealed.

Under such circumstances it would be preferable for the authority to set interest rates so as to stabilize the expected price level, rather than the expected money supply. To show that this is feasible and will result in informational efficiency consider the policy which sets  $R_t$  so that  $E(P_t) = \bar{P}$  and results in the equilibrium nominal price and money solutions

$$(11) \quad P_t = \Pi_{10} + \Pi_{12}N_t$$

$$(12) \quad M_t = \Pi_{20} + \Pi_{21}N_{t-1} + \Pi_{22}N_t + \Pi_{23}\theta_t$$

$R_t$  must be set to satisfy

$$(13) \quad R_t = \frac{1}{m_1} (-E(M_t) + E(P_t) + m_1 E(C_t) + E(\theta_t))$$

Substituting  $E(M_t) = \Pi_{20} + \Pi_{21}N_{t-1} + \Pi_{23}\lambda\theta_{t-1}E(C_t) = \frac{1}{1-\sigma\alpha} N_{t-1}$ ,  $E(\theta_t) = \lambda\theta_{t-1}$  into (13) and combining with equation (4) yields

$$(14) \quad \frac{1}{m_1} (-(\Pi_{20} + \Pi_{21}N_{t-1} + \Pi_{23}\lambda\theta_{t-1}) + \Pi_{10} + \frac{m_1}{1-\sigma\alpha} N_{t-1} + \lambda\theta_{t-1}) \\ = \frac{\alpha-1}{1-\sigma\alpha} N_{t-1} - (\Pi_{10} + \Pi_{12}N_t) + \frac{1-\alpha}{1-\sigma\alpha} N_t + \Pi_{10}$$

which can hold only if  $\Pi_{23} = 1$ ; money demand shocks, to the extent anticipated, should be accommodated. The reduced form equation for interest rates is given by  $R_t = \frac{\alpha-1}{1-\sigma\alpha} N_{t-1}$ , and for prices  $P_t = \bar{P} + \frac{1-\alpha}{1-\sigma\alpha} N_t$ . Interest rate targets should respond negatively to unanticipated past price changes and should be independent of past changes in money growth to implement the policy which holds constant the expected price level.

However, there are some instances in which it is desirable for interest rate target to respond to past money growth rates. Suppose that, instead of considering money demand shocks to be intrinsically irrelevant to any real variables, an increase in money demand in period  $t$  is associated with an increase in aggregate demand in period  $t+1$ .<sup>7</sup> The term aggregate demand is taken to be the relative preference for current goods in terms of future goods. Analytically, this can be represented by random components in  $\beta$ ,<sup>8</sup> the rate of subjective time preference. Suppose that  $\beta_t = -\theta_{t-1}$ . This means that a rise in period  $t$  money demand is followed by an increase in the rate the future is discounted, which translates into a relative preference for current over future consumption. If the intertemporal supply of goods is fixed, such a demand shift requires a rise in the expected real rate appropriate for consumption decisions made at  $t$ . If the authority sets interest rates without regard to this type of disturbance, the burden of interest rate adjustment will be left on nominal prices. Particularly, prices will rise so that the prospect of subsequent deflation will raise the expected real rate. Under this policy, agents will be differentially informed about expected future prices so that complete information transmission about current productivity shocks will not occur.

In this case nominal interest rate targets should rise in response to expected demand increases. As before, it is optimal to set the interest rate so that the expected price level is a constant, say  $\bar{P}$ . To show that this is feasible, consider the equilibrium equations 3-6, with the modification that  $\beta_t = -\theta_{t-1}$ . Posit a solution of the form

$$(15) \quad P_t = \bar{P} + \Pi_{13} N_t$$

$$(16) \quad M_t = \Pi_{20} + \Pi_{21} \theta_t + \Pi_{32} N_{t-1} + \Pi_{23} N_t + \Pi_{24} \theta_t$$

As before, set consumption equal to its full informational value

$$C_t = \frac{1}{1-\sigma\alpha} N_{t-1}. \quad \text{The policy rule sets } R_t \text{ so } E(P_t) = \bar{P}.$$

$$(17) \quad R_t = \frac{1}{m_2} (\bar{P} - E(M_t) + m_1 E(C_t) + E(\theta_t))$$

combining (17) into (8)

$$\begin{aligned} & \frac{1}{m_2} (\bar{P} - (\Pi_{20} + \Pi_{21} \theta_t + \Pi_{23} N_{t-1}) + \frac{m_1}{1-\sigma\alpha} N_{t-1}) \\ & = -\beta_t - \left( \frac{1-\alpha}{1-\sigma\alpha} N_{t-1} + \Pi_{10} + \Pi_{13} N_t \right) \\ & \quad + \left( \frac{1-\alpha}{1-\sigma\alpha} N_t + \Pi_{10} \right) \end{aligned}$$

which holds as an identity for

$$\Pi_{20} = \bar{P}$$

$$- \frac{\Pi_{21}}{m_2} = -1$$

$$0 = -\Pi_{13} + \frac{1-\alpha}{1-\sigma\alpha}$$



so that

$$\begin{aligned} R_t &= -\beta_t - \frac{1-\alpha}{1-\sigma\alpha} N_{t-1} \\ &= \theta_{t-1} - \frac{1-\alpha}{1-\sigma\alpha} N_{t-1} \end{aligned}$$

Thus  $R_t$  should rise with past rates of money growth so as to make the expected price level a constant.

The general message of this section is that it is desirable to set the interest rate target so that the expected price level is unaffected by past period events. In equilibrium, the price level will adjust in response to new information about real factors. This is desirable because such information is useful for current period supply decisions.

#### IV) Conclusion

The model presented in Section I is, of course, too artificial and specific to draw any robust conclusions about how policy ought to be conducted in actual economies. Nevertheless, it illustrates that interest rate policies can be desirable even when one accepts the major assumptions of rational expectations market clearing models of aggregate economic behavior.

The major analytic conclusions of the model have a decidedly "Keynesian" flavor: it is desirable to stabilize the expected price level by means of appropriate policy induced variations in the rate of interest. Particularly, interest rates should rise with past money growth rates to the extent that variations in observed money represent anticipations of future spending decisions, but should be left unaltered if they merely represent portfolio changes (LM shocks). As emphasized in the model, such policy has benefits by improving the quality of information in earlier periods.

Footnotes

- 1) The assumptions are designed to capture the idea that price information is more easily available than the quantity data. The assumption that aggregate consumption is directly observable is not crucial to the results, but simplifies the exposition.
- 2) Constant terms will, in general, depend on conditional variances which are dependent upon the policy regime.
- 3) This result was proven in Weiss (1980b) in the class of equilibrium price functions which are linear in the underlying disturbances. I do not know if there are other equilibria which do not share this property.
- 4) It may be shown that the reduced form equation for aggregate labor supply is for  $\delta$  small,  $L_t = \frac{\alpha}{1-\sigma\alpha} N_t + \frac{\delta y(\alpha-1)}{(1-\alpha-m_1)(1-\sigma\alpha)(1+y)} \theta_{t+1}$ , where  $y = \text{VAR}(\rho^j) / \text{VAR}(\theta)$ . Available price data reflect the full information value  $((1-\alpha)C_{t+1} + P_{t+1})$  which, for  $\delta$  small, is equal to  $\frac{1}{1-\sigma\alpha} N_t + \frac{\delta(2\sigma y\alpha - 1 - y)}{(1-\alpha-m_1)(1-\sigma\alpha)(1+y)} \theta_{t+1}$ . Thus, for  $\delta \neq 0$ , both  $\theta_{t+1}$  and  $N_t$  may be inferred.
- 5) The inability to find a "best" policy was a result of Weiss (1980b).
- 6) Perhaps a more realistic constraint on policy would be to assume that lagged labor input is observable only with an error. In this case, the policy authority would not know the exact value of  $\theta_{t+1}$  prior to period  $t$ . Under this assumption there would exist a best policy of the form  $M_t = (1-\delta)E(\theta_t)$ .

7) Such a formulation is suggested by the assumption in Clower (1965) that money must be accumulated prior to spending.

8) This shock would affect the supply of goods in the model presented in Section I. I will ignore that channel by which time preference affects the supply of commodities.

References

- Clower, R. 1965. "The Keynesian Counterrevolution: A Theoretical Appraisal," in F. Han and F. Brechling, eds. The Theory of Interest Rates, Macmillan.
- Grossman, S. and L. Weiss. 1980. "Heterogenous Information and the Theory of the Business Cycle," CFDP #558, Yale University.
- Lucas, R. 1972. "Expectations and the Neutrality of Money," Journal of Economic Theory, pp. 103-24.
- McCallum, B. 1980. "Price Level Determined with an Interest Rate Policy Rule and Rational Expectations," NBER Working Paper #559.
- Sargent, T.J. and N. Wallace, 1975. "'Rational' Expectations, the Optimal Monetary Instrument and the Optimal Money Supply," Journal of Political Economy 83, pp. 241-54.
- Weiss, L. 1980. "The Role for Active Monetary Policy in a Rational Expectations Model," Journal of Political Economy, April 1980.
- Weiss, L. 1980. "Information Aggregation and Policy," CFDP #492, Yale University.