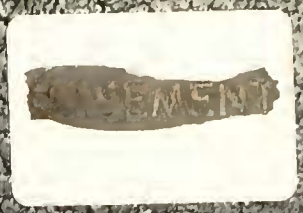

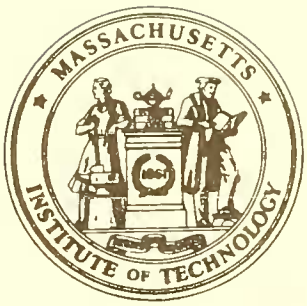

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LONG-TERM CONTRACTS, RATIONAL EXPECTATIONS AND THE OPTIMAL MONEY SUPPLY RULE

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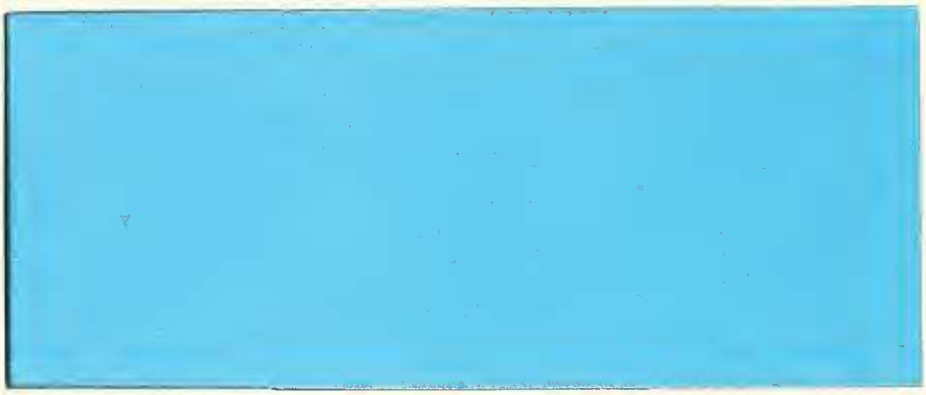

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LONG-TERM CONTRACTS, RATIONAL EXPECTATIONS AND THE OPTIMAL MONEY SUPPLY RULE*

Stanley Fischer

M.I.T.

This paper is concerned with the role of monetary policy in affecting the behavior of real output and argues the case for monetary activism, rational expectations notwithstanding. Recent contributions[1] have suggested that the behavior of real output is invariant to the money supply rule chosen by the monetary authority if expectations are formed rationally. The argument to the contrary advanced below turns on the existence of long-term contracts in the economy and makes the reasonable assumption that economic agents contract for periods longer than the time it takes the monetary authority to react to changing economic circumstances -- in this paper the relevant contracts are labor contracts.

The paper makes two separate arguments about long-term contracts and monetary policy. The first argument, contained in Sections I - III, shows that if there are long term contracts that set nominal wages for more than one period, then monetary policy can affect the behavior of real output, even when that policy is preannounced and its consequences

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*I am indebted to Rudiger Dornbusch for extensive discussions, to Edmund Phelps for a suggestive discussion some years ago and for his comments on the first draft of this paper, and to Benjamin Friedman and Thomas Sargent for comments. An argument similar to the thesis of this paper is contained in an independent paper by Phelps and Taylor (1975); the details are sufficiently different that the two papers should be regarded as complementary. Research support from the National Science Foundation is gratefully acknowledged.

recognized in the setting of wages. The second, contained in Section IV, argues that an active and stabilizing monetary policy reduces the need for frequent renegotiation of contracts and/or wage and price setting, and it is accordingly suggested that such an active policy is desirable.

The literature on the policy implications of rational expectations is relatively technical. It is therefore worthwhile setting the issue in recent historical perspective. Since the discovery of the Phillips' curve in 1958[2], the logic of the evolution of professional views on the ability of monetary policy to affect real output has tended towards a position similar to the empirically based early postwar Keynesian view -- that monetary policy can play no significant role in determining the behavior of output.

The Phillips' curve was originally seen as a stable long run relationship providing those combinations of unemployment and inflation rates among which policymakers could choose in accord with their preferences. The theoretical rationalization due to Lipsey (1960), based on the "law of supply and demand" in the labor market, did not affect that particular view of the curve.[3]

The famous "Phillips' loops" around the long run relationship, discussed in the original Phillips article, suggested that the short run tradeoff differed from the long run relationship. The distinction between the short and long run tradeoffs formed the basis for the originally startling natural rate hypothesis of Friedman (1968) and Phelps (1967) which argued that while there was a short run Phillips tradeoff, there was in the long run a natural unemployment rate, independent of the steady state rate of inflation. More dramatically, the natural rate hypothesis

implies that the long run Phillips curve is vertical.

The arguments rested on the point that the short run tradeoff was the result of expectational errors by economic agents. In Friedman's version, suppliers of labor at the beginning of an inflationary period underestimate the price level that will prevail over the period of the work contract, accordingly overestimate the real wage, and offer a greater supply of labor at the prevailing nominal wage than they would if expectations were correct. The result is employment in excess of the equilibrium level and a tradeoff between output and unanticipated inflation[4]. However, the expectational errors cannot persist so that employment returns to its equilibrium level -- and unemployment returns to its natural rate -- as expectations adjust to reality. Subsequent work by Phelps and others (1969) provided a better worked out theoretical foundation for the short run tradeoff[5].

The dependence of the short run tradeoff on expectational errors did not by itself preclude any effects of monetary policy on output provided the monetary authority could produce a rate of inflation that was not anticipated. Indeed the widespread use of adaptive expectations suggested that an ever-accelerating rate of inflation could maintain an unemployment rate below the natural rate -- hence adherents of the natural rate hypothesis were for a time known as accelerationists. The accelerationist version of the natural rate hypothesis had two important consequences. First, by making the short run tradeoff depend on expectational errors it brought to the fore the question of the optimality of the natural rate[6].

Second, the accelerationist hypothesis' reliance on expectational errors made it possible that some expectations mechanism other than adaptive expectations would imply that there is no tradeoff usable by policy-

makers. Rational expectations is that hypothesis[7].

Briefly, rational expectations as applied in the context of economic models is the hypothesis that expectations are the predictions implied by the model itself, contingent on the information economic agents are assumed to have[8]. In particular, if economic agents are assumed to know the policy rule being followed by the monetary authority, that rule itself will affect expectations. For instance, consider the consequences for expectations of a current price level that is higher than had been expected. Adaptive expectations implies that the expected price level will increase. Under rational expectations, the expected price level will change in a manner dependent on the money supply rule: if monetary policy accommodates inflationary shocks, the expected price level will rise; if monetary policy counteracts inflationary shocks, the expected price level may be lower than the current level.

Now consider the implications of the rational expectations hypothesis for the effects on output of alternative preannounced monetary rules in an economy that has an expectational Phillips curve of the Lucas form[9]:

$$(1) \quad Y_t = \alpha + \beta(P_t - {}_{t-1}P_t) + u_t \qquad \beta > 0$$

where α and β are constant parameters, Y_t the level of output, P_t the logarithm of the price level, and ${}_{t-1}P_t$ the expectation taken at the end of period (t-1) of P_t, and u_t is a stochastic disturbance term.

The only way in which monetary policy can affect output, given (1), is by creating a difference between the actual price level and the expected price level. However, if the money supply rule is known to economic agents and is based on the same information as those agents have (for example, the money supply may be adjusted on the basis of lagged values

of prices and output), then the predictable effects of the money supply on prices are embodied in $_{t-1}P_t$ and monetary policy can affect output only by doing the unexpected. Alternatively, if the monetary authority has superior information to private economic agents, say because it receives data more rapidly than they do, it can affect the behavior of output[10]. Superior information is, however, a weak reed on which to base the argument for the effectiveness of monetary policy both because one has to ask why the information is kept secret and also because useful information has a habit of becoming available.

The argument made in this paper for the effectiveness of monetary policy depends instead on the existence of long-term contracts in the economy. The aggregate supply equation (1) implies that the only expectation relevant to the behavior of output is the expectation formed one period earlier. The length of the period is not specified, but for the result to be interesting one supposes that it is a year or less. Since there are contracts that are made for more than a year, expectations of P_t made in periods earlier than (t-1) are likely to be relevant to the behavior of output.

In this paper I construct a model similar in spirit to the simple rational expectations models such as that of Sargent and Wallace (1975) -- henceforth SW -- and assume that expectations are formed rationally. If all contracts in the model economy are made for one period, the SW result on the irrelevance of the money supply rule for the behavior of output obtains; if there are some longer term nominal contracts, then even fully anticipated monetary policy affects the behavior of output and there is room for a stabilizing monetary policy. The use of longer-term contracts puts an element of stickiness into the nominal wage which is responsible

for the effectiveness of monetary policy. The paper does not inquire into the reasons for the existence of long-term contracts though the transaction costs of frequent price setting and wage negotiations must be part of the explanation.

Section I introduces the model and demonstrates the fundamental rational expectations result on the irrelevance of monetary policy in a world where all contracts are made for only one period. Section II presents a model with overlapping labor contracts it which all labor contracts are made for two periods and in which at any one time half the firms are operating in the first year of a two-year contract and the other half in the second year of a contract. In this model monetary policy can affect the behavior of output. Section III considers various indexed labor contracts.

In Sections I - III it is assumed that the monetary authority's objective is to stabilize real output while wage contracts are made with the aim of maintaining stability of the real wage. There is thus a conflict between the objectives of wage setting and the monetary authority. Section IV examines instead a co-operative situation in which both wage-setting and the monetary authority have the objective of stable real income. In that context the variance of real income can be minimized either by a very complicated labor contract contingent on an arbitrary monetary policy or by having a stable nominal wage and a particular active monetary stabilization policy. The argument for an active monetary policy in that case is that it makes private contracts simple to write and reduces the frequency of adjustment of wages and prices.

I. The Model with One-Period Contracts

The model used to study monetary policy in this paper has three elements: wage setting behavior; an output supply equation; and an aggregate demand equation. The economy is stationary in that the analysis abstracts from growth in the capital stock and an increasing price level though the latter is easily included. A potential role for stabilization policy is created by the assumption that the economy is subjected to random disturbances -- real supply disturbances and nominal demand disturbances -- that affect output and the price level in each period. Depending on the details of wage setting, monetary policy may be able to offset some of the effects of these disturbances on real output.

First we consider wage setting behavior. The nominal wage is treated as predetermined throughout the paper in that it is known at the beginning of the period while output and the price level adjust during the period. The assumption that the wage is predetermined is based on the empirical observation that wages are usually set in advance of employment.

In Sections I - III it is assumed that the nominal wage is set to try to maintain constancy of the real wage, which is equivalent in this model to maintaining constancy of employment and/or labor income; this assumption is based on recent work on the labor contract[11]. In Section IV we will assume that the nominal wage is set to maintain constancy of real income. If labor contracts are made every period, and assuming the goal of nominal wage setting is to maintain constancy of the real wage:

$$(2) \qquad {}_{t-1}W_t = \gamma + {}_{t-1}P_t$$

where ${}_{t-1}W_t$ is the logarithm of the wage set at the end of period t-1 for

period t; γ is a scale factor in the determination of the real wage and will be set at zero for convenience.

Second, the supply of output is assumed to be a decreasing function of the real wage:

$$(3) \quad Y_t^s = \alpha + (P_t - W_t) + u_t$$

where, again, the coefficient β of (1) has been set equal to unity for convenience, and where α will be taken to be zero. P_t is the logarithm of the price level and Y_t the level of output. It is assumed that firms operate on their demand curves for labor, i.e. that the level of employment is determined by demand. Substituting from (2) into (3)[12]:

$$(4) \quad Y_t^s = (P_t - {}_{t-1}P_t) + u_t.$$

This is similar to the standard rational expectations supply function (1). The term u_t is a stochastic "real" disturbance that impinges on production in each period; its properties will be specified below.

It remains now to close the model by taking demand considerations into account, and the simplest way of doing so is to specify a velocity equation

$$(5) \quad Y_t = M_t - P_t - v_t$$

where M_t is the logarithm of the money stock in period t and v_t is a disturbance term[13].

Disturbances aside, this very simple macro model would be assumed in equilibrium to have the real wage set at its full employment level, would imply the neutrality of money, and would obviously have no role for monetary policy in affecting the level of output. Note again that (2) implies that all wages are set each period -- there are only one-period labor contracts. A potential role for monetary policy is created by the

presence of the disturbances, u_t and v_t that are assumed to affect the level of output each period. Each of the disturbances is assumed to follow a first order autoregressive scheme:

$$(6) \quad u_t = \rho_1 u_{t-1} + \varepsilon_t \qquad |\rho_1| < 1$$

$$(7) \quad v_t = \rho_2 v_{t-1} + \eta_t \qquad |\rho_2| < 1$$

where ε_t and η_t are mutually and serially uncorrelated stochastic terms with expectation zero and finite variances σ_ε^2 and σ_η^2 respectively.

We shall assume that expectations are formed rationally. Eliminating Y_t between (4) and (5) -- which is equivalent to assuming the price level adjusts each period to equate aggregate supply and demand:

$$(8) \quad 2P_t = M_t + {}_{t-1}P_t - (u_t + v_t).$$

Now, taking expectations as of the end of (t-1) in (8), and noting that $E_{t-1}\,[{}_{t-1}P_t] = {}_{t-1}P_t$:

$$(9) \quad {}_{t-1}P_t = {}_{t-1}M_t - {}_{t-1}(u_t + v_t)$$

where ${}_{t-1}X_t$ is the expectation of X_t conditional on information available at the end of (t-1).

Assume the monetary rule is set on the basis of disturbances which have occurred up to and including period (t-1):

$$(10) \quad M_t = \sum_{i=1}^{\infty} a_i u_{t-i} + \sum_{i=1}^{\infty} b_i v_{t-i}.$$

The disturbances can be indentified ex post so that there is no difficulty for the monetary authority in following a rule such as (10) or for the public in calculating the next period's money supply. From (10) it follows that

$$(11) \quad {}_{t-1}M_t = M_t$$

and thus:

$$(12)\quad P_t - {}_{t-1}P_t = \frac{M_t}{2} - \frac{{}_{t-1}P_t}{2} - \frac{u_t + v_t}{2}$$

$$= \frac{{}_{t-1}(u_t + v_t)}{2} - \frac{u_t + v_t}{2}$$

$$= \frac{1}{2}\,[\rho_1 u_{t-1} + \rho_2 v_{t-1} - (\rho_1 u_{t-1} + \varepsilon_t + \rho_2 v_{t-1} + \eta_t)]$$

$$= -\frac{1}{2}\,(\varepsilon_t + \eta_t)$$

The disturbances in (12) are current shocks that can be predicted by neither the monetary authority nor the public and thus cannot be offset by monetary policy.

Substituting (12) into (4) it is clear that the parameters a_i and b_i of (10) have no effect on the behavior of output. Of course, as SW note, the monetary rule does affect the behavior of the price level, but since that is not at issue, there is no point in exploring the relationship further. The explanation for the irrelevance of the money supply rule for the behavior of output in this model is simple: money is neutral, and economic agents know each period what next period's money supply will be. In their wage setting they aim only to obtain a specified real wage and the nominal wage is accordingly adjusted to reflect the expected price level.

Thus, the model with only one period contracts confirms the SW result of the irrelevance of the monetary rule for the behavior of output.

II. The Model with Two Period Non-Indexed Labor Contracts

We now proceed to inject an element of stickiness into the behavior of the nominal wage. Suppose that all labor contracts run for two periods and that the contract drawn up at the end of period t specifies nominal wages for periods (t+1) and (t+2). Assuming again that contracts are drawn up to maintain constancy of the real wage, we specify:

$$(15) \quad {}_{t-i}W_t = {}_{t-i}P_t \qquad , \quad i = 1, 2$$

where ${}_{t-i}W_t$ is the wage to be paid in period t as specified in contracts drawn up at (t-i), and ${}_{t-i}P_t$ is the expectation of P_t evaluated at the end of (t-i). To prevent misunderstanding it should be noted that the use of a one-period, and not a two-period, labor contract is optimal from the viewpoint of minimizing the variance of the real wage; there must be reasons other than stability of the real wage, such as the costs of frequent contract negotiations and/or wage-setting, for the existence of longer-term contracts.

In period t, half the firms are operating in the first year of a labor contract drawn up at the end of (t-1) and the other half in the second year of a contract drawn up at the end of (t-2). There is only a single price for output. Given that the wage is predetermined for each firm, the aggregate supply of output is taken to be given by:

$$(14) \quad Y_t^s = \frac{1}{2} \sum_{i=1}^{2} (P_t - {}_{t-i}W_t) + u_t.$$

$$(14') \quad Y_t^s = \frac{1}{2} \sum_{i=1}^{2} (P_t - {}_{t-i}P_t) + u_t.$$

Now, using rational expectations again, by combining (14') and (5), and

noting that $E_{t-2}\,[{}_{t-1}P_t] = {}_{t-2}P_t$:

$$(15)\quad {}_{t-2}P_t = {}_{t-2}M_t - {}_{t-2}(u_t + v_t)$$

$$(16)\quad {}_{t-1}P_t = \frac{2}{3}\,{}_{t-1}M_t + \frac{1}{3}\,{}_{t-2}M_t - \frac{1}{3}\,{}_{t-2}(u_t + v_t) - \frac{2}{3}\,{}_{t-1}(u_t + v_t)$$

Not that since, by assumption, M_t is a function only of information available up to the end of period (t-1), ${}_{t-1}M_t = M_t$.

Accordingly,

$$(17)\quad 2P_t = \frac{4}{3}\,M_t + \frac{2}{3}\,{}_{t-2}M_t - (u_t + v_t) - \frac{1}{3}\,{}_{t-1}(u_t + v_t) - \frac{2}{3}\,{}_{t-2}(u_t + v_t)$$

and

$$(18)\quad Y_t = \frac{M_t - {}_{t-2}M_t}{3} + \frac{1}{2}\,(u_t - v_t) + \frac{1}{6}\,{}_{t-1}(u_t + v_t) + \frac{1}{3}\,{}_{t-2}(u_t + v_t).$$

Let the money supply again be determined by the rule:

$$(10)\quad M_t = \sum_{i=1}^{\infty} a_i u_{t-i} + \sum_{i=1}^{\infty} b_i v_{t-i}$$

so that

$$(19)\quad {}_{t-2}M_t = a_1\rho_1 u_{t-2} + \sum_{i=2}^{\infty} a_i u_{t-1} + b_1\rho_2 v_{t-2} + \sum_{i=2}^{\infty} b_i v_{t-i}$$

and

$$(20)\quad M_t - {}_{t-2}M_t = a_1(u_{t-1} - \rho_1 u_{t-2}) + b_1(v_{t-1} - \rho_2 v_{t-2}) = a_1\varepsilon_{t-1} + b_1\eta_{t-1}$$

The difference between the actual money stock in period t and that stock as

predicted two periods earlier arises from the reactions of the monetary authority to the distrubances ε_{t-1} and η_{t-1} occurring in the interim. It is precisely these disturbances that cannot influence the nominal wage for the second period of wage contracts entered into at (t-2).

Substituting (20) and (10) into (18) it is clear that the parameters a_i and b_i of the money supply rule, for $i \geq 2$, have no effect on the behavior of output, and for purposes of this paper can be set at zero[14]. Thus:

$$(21) \quad Y_t = \frac{1}{3}\left[a_1(\varepsilon_{t-1} - \rho_1 u_{t-2}) + b_1(v_{t-1} - \rho_2 v_{t-2})\right] + \frac{1}{2}(u_t - v_t) + \frac{1}{6}{}_{t-1}(u_t + v_t) + \frac{1}{3}{}_{t-2}(u_t + v_t)$$

$$= \frac{1}{2}[\varepsilon_t - \eta_t] + \frac{1}{3}\left[\varepsilon_{t-1}(a_1 + 2\rho_1) + \eta_{t-1}(b_1 - \rho_2)\right] + \rho_1^{\,2}\, u_{t-2}$$

Before we examine the variance of output as a function of the parameters a_1 and b_1, it is worth explaining why the values of those parameters affect the behavior of output, even when the parameters are fully known. The essential reason is that between the time the two year contract is drawn up and the last year of operation of that contract, there is time for the monetary authority to react to new information about recent economic disturbances. Given the negotiated second period nominal wage, the way the monetary authority reacts to disturbances will affect the real wage for the second period of the contract and thus output.

Calculating the asymptotic variance of Y from (21) we obtain:

$$(22)\quad \sigma_Y^2 = \sigma_\varepsilon^2 \left[\frac{1}{4} + \frac{4}{9}\rho_1^2 + \frac{\rho_1^4}{1-\rho_1^2} + \frac{a_1(4\rho_1 + a_1)}{9}\right]$$

$$+ \sigma_\eta^2 \left[\frac{1}{4} + \frac{1}{9}\rho_2^2 - \frac{b_1}{9}(2\rho_2 - b_1)\right]$$

The variance minimizing values of a_1 and b_1 are accordingly:

$$(23)\quad a_1 = -2\rho_1$$

$$b_1 = \rho_2$$

which yield output variance of

$$(24)\quad \sigma_y^2 = \sigma_\varepsilon^2 \left[\frac{1}{4} + \frac{\rho_1^4}{1-\rho_1^2}\right] + \frac{1}{4}\sigma_\eta^2$$

To interpret the monetary rule, examine the second equality in (21). It can be seen there that the level of output is affected by current disturbances ($\varepsilon_t - \eta_t$) that cannot be offset by monetary policy, by disturbances (ε_{t-1} and η_{t-1}) that have occurred since the signing of the older of the existing labor contracts, and by a lagged real disturbance (u_{t-2}). The disturbances ε_{t-1} and η_{t-1} can be wholly offset by monetary policy and that is precisely what (23) indicates. The u_{t-2} disturbance, on the other hand, was known when the older labor contract was drawn up and cannot be offset by monetary policy because it is taken into account in wage-setting. Note, however, that the stabilization is achieved by affecting the real wage of those in the second year of labor contracts and thus should not be expected to be available to attain arbitrary levels of output -- the use of too active a policy would lead to a change in the structure of contracts.

For a more general interpretation of the monetary rule, note from (17) that u -- the real disturbance -- and v -- the nominal disturbance -- both tend to reduce the price level. The rule accordingly is to accommodate real disturbances that tend to increase the price level and to counteract nominal disturbances which tend to increase the price level. Such an argument has been made by Gordon (1975).

The monetary rule can alternately be expressed in terms of observable variables as

$$(25) \quad M_t = \rho_2 M_{t-1} + (2\rho_1 - \rho_2) P_{t-1} - (2\rho_1 + \rho_2) Y_{t-1} - \rho_1 ({}_{t-2}W_{t-1} + {}_{t-3}W_{t-1})$$

and it is also possible to substitute out for the wage rates in (25) to obtain a money supply rule solely in terms of lagged values of the money stock, prices and income.

III. Indexed Contracts

The only way in which monetary policy can lose its effectiveness when there are long-term labor contracts is for the wage to be indexed in a way which duplicates the effects of one period contracts. However, it will be seen (in (28) below) that such indexing is not of the type generally encountered. Other types of indexing do allow monetary policy that can affect output.

If the wage is set such that

$$(26) \quad {}_{t-i}W_t = {}_{t-1}P_t \qquad i = 1, 2, \ldots$$

then the results of Section I above obtain, and, in particular, output is given by

$$(27) \quad Y_t = \frac{1}{2}(\varepsilon_t - \eta_t) + \rho_1 u_{t-1}.$$

However, the indexing formula implied by (26) is unlike anything seen in practice. It is:

$$(28) \quad W_t = -\rho_2 M + (\rho_1 + \rho_2) P_{t-1} + (\rho_2 - \rho_1) Y_{t-1} - \rho_1 W_{t-1}$$

where M_t is assumed constant at M since the monetary rule is of no consequence for the behavior of output. For $\rho_1 < 0$ -- negative serial correlation of real disturbances -- and $\rho_1 + \rho_2 > 0$ the above formula could be similar to a wage contract which specifies both indexation to the price level and profit sharing, but it is certainly not in general the type of contract which is found.

The variance of output obtaining with the general indexing formula (28) for wage-determination is

$$(29) \quad \sigma_Y^2 = \sigma_\varepsilon^2 \left[\frac{1}{4} + \frac{\rho_1^2}{1 - \rho_1^2}\right] + \frac{1}{4}\sigma_\eta^2$$

This exceeds the variance of output with optimal monetary policy in the non-indexed economy with two period contracts; this is because the criterion for wage-setting, attempting to maintain constancy of the real wage, is not equivalent to the criterion of minimizing the variance of output. This result may be part of the explanation for the continued hostility of stabilization authorities to indexation.

If any indexation formula for wages other than (28) is used, and there are contracts which last more than one period, there is again room for stabilizing monetary policy. For instance, consider a wage indexed to the price level such that

$$(30) \quad {}_{t-i}W_t = {}_{t-i}W_{t-i+1} + P_{t-1} - P_{t-i}$$

in which the wage paid in period t on a contract made at the end of (t-1) is the wage specified for the first year of the contract adjusted for inflation over the intervening period. We also specify that

$$(31) \quad {}_{t-i}W_{t-i+1} = {}_{t-i}P_{t-i+1}$$

i.e. that the wage for the first year of the contract minimizes the variance of the real wage in that period.

Assuming two year contracts, the supply equation (14), the velocity equation (5) and rational expectations in determining the expected price level in (31), one obtains, using the lag operator L:

$$(32) \quad Y_t [6 - 4L + 2L^2] = 2M_t [1 - L]^2 + u_t [3 - (1 - \rho_1)L + \rho_1 L^2] - v_t [3 - (3 + \rho_2)L + (2 - \rho_2)L^2]$$

where use has been made of the fact that

$$M_t = {}_{t-1}M_t \, .$$

Since M_t enters the output equation, it is clear the monetary policy does have an effect on the behavior of output. In this case it is actually possible for monetary policy to offset the effects of all lagged disturbances by using the rule

$$(33)\quad M_t = Lu_t\,[-(1 + 2\rho_1) + (1 + \rho_1)L - \rho_1 L^2][2(1 - L)^2]^{-1} - Lv_t\,[1 - (1 + 3\rho_2)L - \rho_2 L^2][2(1 - L)^2]^{-1}$$

which leaves

$$(34)\quad \sigma_y^2 = \frac{\sigma_\varepsilon^2}{4} + \frac{\sigma_\varepsilon^2}{4}$$

In the face of real disturbances, the monetary rule (33) destabilizes the real wage relative to its behavior under the optimal monetary policy in the non-indexed two-period contract model, and a fortiori relative to its behavior when there are single period contracts. Given that the assumed aim of labor is to have stable real wages, an indexed contract like (30) would be less attractive to labor than the non-indexed contracts of Section II.

IV. Co-Operative Policy

The conclusions thus far can be succinctly summarized. Unless all contracts are made for one period, or contain an elaborate formula (28) that duplicates the effects of one-period contracts, the money supply rule chosen by the monetary authority does affect the behavior of output, even when that rule is preannounced and known to all economic agents, and even if the goals of wage-setting and monetary policy conflict. It should be clear, though, that this conclusion is independent of the assumption of conflicting objectives, but instead requires only the presence of nominal long-term contracts.

Thus far we have been arguing for the effectiveness of monetary policy in affecting output, resting the case on the existence of long-term contracts. We have explicitly avoided any discussion of price stability. We want now to argue that the revealed preference of economic agents for long-term contracts makes a policy that also pays attention to the stability of wages and prices desirable. We shall assume that the more complicated contracts have to be to achieve a given end, the more likely is it that relatively short-term contracts with room for renegotiation in the light of changing circumstances will be used.

Consider now a situation in which both monetary policy and wage-setting have the same goal. We assume that the goal is stability of real income, though that is not essential. It will be seen that the policy objective can be achieved either by maintaining the money supply constant and adjusting the wage each period or by maintaining a stable nominal wage and conducting an active monetary policy[15]. Since the money supply can fundamentally be controlled by a single agency and wages are set in many firms and other institutions, there is a strong case for using an active

monetary policy and letting the nominal wage remain stable.

Consider now equations (3) and (5), reproduced here for convenience;

$$(3) \quad Y_t = P_t - W_t + u_t$$

$$(5) \quad Y_t = M_t - P_t - v_t.$$

These imply:

$$(35) \quad 2Y_t = M_t - W_t + u_t - v_t.$$

Use (3) and (5) lagged one period and (6) and (7) above to obtain

$$(36) \quad 2Y_t = M_t - W_t + (\rho_1 - \rho_2)Y_{t-1} + (\rho_1 + \rho_2)P_{t-1} + \rho_1 W_{t-1} + \varepsilon_t + \eta_t .$$

Using the certainty equivalence principle, the variance of output is minimized by setting:

$$(37) \quad M_t - W_t = (\rho_2 - \rho_1)Y_{t-1} - (\rho_1 + \rho_2)P_{t-1} - \rho_1 W_{t-1} .$$

It is accordingly clear that either an active monetary rule combined with a passive wage policy such that $W_t = W$ for all t, i.e.

$$(38) \quad M_t = (\rho_2 - \rho_1)Y_{t-1} - (\rho_1 + \rho_2)P_{t-1} + (1 - \rho_1)W$$

or an active rule for wage-setting with passive monetary policy ($M_t = M$ for all t), i.e.

$$(39) \quad W_t = M + (\rho_1 - \rho_2)Y_{t-1} + (\rho_1 + \rho_2)P_{t-1} + \rho_1 W_{t-1}$$

can achieve the minimum variance of output[16].

In this co-operative setting, then, the case for an active monetary policy is simply that such a policy reduces the need for frequent and costly renegotiating of contracts and wage setting or alternatively that the form of the wage contract can be much simpler with an active than with a passive monetary policy.

V. Conclusions

Fundamentally, the paper makes two arguments about active monetary policy, both turning on the revealed preference of economic agents for long-term contracts. The first argument, contained in Sections I - III, is that in the presence on long-term contracts, monetary policy can in general affect the behavior of real output. In this paper the only long-term contracts are labor contracts, and they generally provide a Keynesian-like element of temporary wage rigidity that provides a stabilizing role for monetary policy even when that policy is fully anticipated. Monetary policy loses its effectiveness only if long-term contracts are indexed in an elaborate way that duplicates the effects of single period contracts, as indicated at the beginning of Section III -- and it should not be doubted that the labor contract of equation (28) is a very simplified version of the long-term contract that would in practice be needed to duplicate the effects of contracts negotiated each period.

The second argument, contained in Section IV, is that an appropriate active monetary policy allows the use of simple and long-term private contracts whereas a passive policy would require elaborate long-term contracts or else frequent renegotiation of contracts to attain the same desired behavior of output.

The effectiveness of monetary policy does not require anyone to be fooled. In the model of Section II, with two period contracts, monetary policy is fully anticipated but because it is based on information which becomes available after the labor contract is made, it can affect output. If the monetary authority wants to stabilize output, it can do so; in the model of Section II its optimal policy from the viewpoint of output stabilization is to accommodate real disturbances that tend to increase

the price level and counteract nominal disturbances that tend to increase the price level. Stabilization of output in the face of real disturbances implies a less stable real wage than would obtain with one period contracts while output stabilization in the face of nominal disturbances implies a real wage as stable as that obtained with one period contracts.

While the paper argues that an active monetary policy can affect the behavior of output if there are long-term contracts, and is desirable in order to foster long-term contracts, one of the important lessons of the rational expectations literature should not be overlooked:[17] the structure of the economy adjusts as policy changes. An attempt by the monetary authority to exploit the existing structure of contracts to produce behavior far different from that envisaged when contracts were signed would likely lead to the reopening of the contracts and, if the new behavior of the monetary authority were persisted in, a new structure of contracts. But given a structure of contracts, there is some room for manouevre by the monetary authorities -- which is to say that their policies can, though will not necessarily, be stabilizing.

Footnotes

1. Notably that of Sargent and Wallace (1975); this paper is henceforth referred to as SW.

2. Despite Fisher's (1926) earlier discovery of the unemployment-inflation relationship, it was not until the publication of Phillips' 1958 article that the relationship began to play a central role in policy discussions.

3. Although Harry Johnson (1963) in his inflation survey expressed doubts as to the ability of policymakers to exploit the Phillips tradeoff (see pp. 132-3).

4. The relationship between the level of employment and rate of unemployment is not discussed by Friedman.

5. These developments are summarized by Gordon (1976).

6. This issue, among others, was analyzed by Tobin (1972).

7. The fundamental application of the rational expectations hypothesis in a Phillips curve context is by Lucas (1972); see also Lucas (1973) and SW.

8. See Barro and Fischer (1976) for an extended discussion of rational expectations.

9. This is similar to the aggregate supply function of SW and also Lucas (1973).

10. SW examine a case in which the monetary authority has superior information; see also Barro (1976).

11. See Azariadis (1975), Baily (1974) and Grossman (1975); Gordon (1976) discusses these contributions.

12. By setting α in (3) at zero, we appear to make negative levels of output possible. Any reader worried by that possibility should either set α to a positive value or else view (4) as a relationship that applies to deviations of output from a specified level. Note also that (3) can be viewed as a markup equation with the markup dependent on the level of output.

13. SW are interested in the question of the optimal monetary instrument and thus specify two additional equations: an aggregate demand or IS equation; and a portfolio balance or LM equation. I use the single equation (5) to avoid unnecessary detail.

14. From the viewpoint of the behavior of the price level it might be desirable to have non-zero values of those parameters, but we are focusing strictly on the behavior of output.

15. More precisely, for any specified behavior of the money stock there is a corresponding nominal wage rule that is optimal from the viewpoint of stabilizing real output and vice versa.

16. See footnote 15.

17. Lucas (1976).

Bibliography

Azariadis, Costas. "Implicit Contracts and Underemployment Equilibria", Journal of Political Economy (October 1975).

Baily, Martin N. "Wages and Employment under Uncertain Demand", Review of Economic Studies (January 1974), 37-50.

Barro, Robert J. "Rational Expectations and the Role of Monetary Policy", forthcoming in Journal of Monetary Economics (1976).

_____, _____ and Stanley Fischer. "Recent Developments in Monetary Theory", forthcoming in Journal of Monetary Economics (1976).

Fisher, Irving. "A Statistical Relation Between Unemployment and Price Changes", International Labor Review (June 1926), reprinted in Journal of Political Economy (March/Arpil 1973), 496-502.

Friedman, Milton. "The Role of Monetary POlicy", American Economic Review (March 1968), 1-17.

Gordon, Robert J. "Alternative Responses of Policy to External Supply Shocks", Brookings Papers on Economic Activity (1975, No. 1), 183-206.

_____, _____. "Recent Developments in the Theory of Inflation and Unemployment", forthcoming in Journal of Monetary Economics (1976).

Grossman, Herschel I. "The Nature of Optimal Labor Contracts: Towards a Theory of Wage and Employment Adjustment", unpublished, Brown University (March 1975).

Johnson, Harry G. "A Survey of Theories of Inflation" in H. G. Johnson, Essays in Monetary Economics, Second Edition, Cambridge, Massachusetts, Harvard University Press, 1969.

Lipsey, Richard G. "The Relation Between Unemployment and the Rate of Money Wage Changes in the United Kingdom, 1862-1957: A Further Analysis", Economica (February 1960), 1-31.

Lucas, Robert E. "Expectations and the Neutrality of Money", Journal of Economic Theory (April 1972), 103-24.

_____, _____. "Some International Evidence on Output-Inflation Trade-Offs", American Economic Review (June 1973), 326-334.

_____, _____. "Econometric Policy Evaluation: A Critique", forthcoming in Journal of Monetary Economics (1976).

Phelps, Edmund S. "Phillips Curves, Expectations of Inflation, and Optimal Unemployment Over Time", Economica (August 1967), 254-81.

_____, _____, et. al. Microeconomic Foundations of Employment and Inflation Theory. New York: Norton, 1970.

_____, _____, and John B. Taylor. "Stabilizing Properties of Monetary Policy under Rational Prices Expectations", unpublished, Columbia University (June 1975).

Phillips, A. W. "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957", Economica (November 1958), 283-99.

Sargent, Thomas J. and Neil Wallace. "'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," Journal of Political Economy (April 1975), 241-54.

Tobin, James. "Inflation and Unemployment", American Economic Review (March 1972), 1-18.