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Source: *The Journal of Political Economy*, Vol. 85, No. 1 (Feb., 1977), pp. 191-205
Published by: The University of Chicago Press
Stable URL: http://www.jstor.org/stable/1828335
Accessed: 24/09/2009 09:56

Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule

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The paper is concerned with the role of monetary policy and argues that activist monetary policy can affect the behavior of real output, rational expectations notwithstanding. A rational expectations model with overlapping labor contracts is constructed, with each labor contract being made for two periods. These contracts inject an element of short-run wage stickiness into the model. Because the money stock is changed by the monetary authority more frequently than labor contracts are renegotiated, and, given the assumed form of the labor contracts, monetary policy has the ability to affect the short-run behavior of output, though it has no effects on long-run output behavior.

This paper is concerned with the role of monetary policy in affecting real output and argues that activist monetary policy can affect the short-run behavior of real output, 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 empirically reasonable assumption that economic agents contract in nominal terms 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.

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 Robert Barro, 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 (1977); the details are sufficiently different that the two papers should be regarded as complementary. Note 19 below discusses the relationship between the two papers. Research support from the National Science Foundation is gratefully acknowledged.

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

[*Journal of Political Economy*, 1977, vol. 85, no. 1]

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 toward 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 trade-off differed from the long-run relationship. The distinction between the short- and long-run trade-offs 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 trade-off, 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 trade-off 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 trade-off 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 (1970) provided a better worked out theoretical foundation for the short-run trade-off.[5]

The dependence of the short-run trade-off on expectational errors did not by itself preclude any effects of monetary policy on output provided

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

[3] However, Harry Johnson (1969) in his inflation survey expressed doubts as to the ability of policymakers to exploit the Phillips tradeoff (see pp. 132–33).

[4] The level of employment and the rate of unemployment move inversely in Friedman's exposition.

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

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 trade-off depend on expectational errors it brought to the fore the question of the optimality of the natural rate.[6]

Second, the reliance of the accelerationist hypothesis on expectational errors made it possible that some expectations mechanism other than adaptive expectations would imply that there is no trade-off usable by policymakers. 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 the expected price level of a current price level that is higher than had been expected. Adaptive expectations implies that the price level currently expected for next period will be higher than the price level that was expected last period to prevail in this period. 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 level expected for this period.

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]

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

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

[6] This issue, among others, was analyzed by Tobin (1972); it is taken up by Prescott (1975).

[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).

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 because useful information has a habit of becoming available, perhaps through inference based on the actions of the monetary authority.

The argument made in this paper for the effectiveness of monetary policy depends instead on the existence of nominal 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) (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 nominal contracts puts an element of stickiness into the nominal wage which is responsible for the effectiveness of monetary policy.

The paper does not provide a microeconomic basis for the existence of long-term nominal contracts, though the transaction costs of frequent price setting and wage negotiations must be part of the explanation. It will be seen below that the essential element needed for the effectiveness of monetary policy in this paper is that long-term contracts not be written in such a way as to duplicate the effects of a succession of single-period contracts, or the use of spot markets. It is reasonable to conjecture that the costs of wage setting lead to the use of long-term contracts and that the difficulties of contract writing prevent the emergence of contracts that are equivalent to the use of spot markets.

Section I introduces the model and demonstrates the fundamental rational expectations result on the irrelevance of monetary policy in a

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

world where all contracts are made for only one period. Section II presents a model with overlapping labor contracts in 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 2-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. Conclusions and further discussion are contained in Section IV.

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 readily 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.

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] However, it should be emphasized that no substantive results of the paper would be affected if a nominal wage *schedule* (e.g., specifying overtime payments) were to be negotiated, rather than simply a nominal wage *rate*.[12]

If labor contracts are made every period, and assuming the goal of nominal wage setting is to maintain constancy of the real wage:

$$ {}_{t-1}W_t = \gamma + {}_{t-1}P_t, \tag{2} $$

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.

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

[12] The derivation of the aggregate supply function (4) below for the case of a nominal wage schedule is available from the author on request. The function has the same form as (4) but with different coefficients; no subsequent argument is affected by those differences.

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

$$Y_t^s = \alpha + (P_t - W_t) + u_t, \tag{3}$$

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, that is, that the level of employment is determined by demand. Substituting from (2) into (3):[13]

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

This is similar to the standard rational expectations supply function (1). The form of the aggregate supply function is essentially unaffected if the firm faces a nominal wage schedule in which the wage rises as labor input is increased.[14] 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

$$Y_t = M_t - P_t - v_t \tag{5}$$

where M_t is the logarithm of the money stock in period t and v_t is a disturbance term.[15]

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:

$$u_t = \rho_1 u_{t-1} + \varepsilon_t, \qquad |\rho_1| < 1, \tag{6}$$

$$v_t = \rho_2 v_{t-1} + \eta_t, \qquad |\rho_2| < 1, \tag{7}$$

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.

[13] 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.

[14] See n. 12 above.

[15] 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. A model with overlapping labor contracts and separate goods and money markets is presented in the appendix to Fischer (forthcoming).

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—we get:

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

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

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

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 $(t - 1)$:

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

The disturbances can be identified 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

$${}_{t-1}M_t = M_t \tag{11}$$

and thus:

$$\begin{aligned} P_t - {}_{t-1}P_t &= \frac{M_t}{2} - \frac{{}_{t-1}P_t}{2} - \frac{u_t + v_t}{2} \\ &= \frac{{}_{t-1}(u_t + v_t)}{2} - \frac{u_t + v_t}{2} \\ &= \tfrac{1}{2}[\rho_1 u_{t-1} + \rho_2 v_{t-1} - (\rho_1 u_{t-1} + \varepsilon_t + \rho_2 v_{t-1} + \eta_t)] \\ &= -\tfrac{1}{2}(\varepsilon_t + \eta_t). \end{aligned} \tag{12}$$

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 Nonindexed 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 $(t + 2)$.[16] Assuming again that contracts are drawn up to maintain constancy of the real wage, we specify:

$$ {}_{t-i}W_t = {}_{t-i}P_t, \qquad i = 1, 2, \tag{13} $$

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; as discussed in the introduction, 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.[17] Given that the wage is predetermined for each firm, the aggregate supply of output is given by:

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

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

Now, using rational expectations again, by combining (14′) and (5), and noting that $E_{t-2}({}_{t-1}P_t) = {}_{t-2}P_t$:

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

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

[16] Akerlof (1969) uses a model with overlapping labor contracts, in which prices charged differ among firms.

[17] The extreme assumption is made here that labor is attached to a particular set of firms and that the state of excess supply or demand for labor in firms operating in mid-contract does not affect the starting wage in the new contracts of the remaining firms. Some labor mobility between firms could be incorporated in the analysis without affecting the results so long as mobility is not sufficiently great to eliminate all wage differentials between the two types of firms in a given period.

Note 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,

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

and

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

Let the money supply again be determined by the rule of equation (10) so that

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

and

$$\begin{aligned} M_t - {}_{t-2}M_t &= a_1(u_{t-1} - \rho_1 u_{t-2}) + b_1(v_{t-1} - \rho_2 v_{t-2}) \\ &= a_1\varepsilon_{t-1} + b_1\eta_{t-1}. \end{aligned} \tag{20}$$

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 disturbances 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.[18] Thus:

$$\begin{aligned} Y_t &= \tfrac{1}{3}[a_1(u_{t-1} - \rho_1 u_{t-2}) + b_1(v_{t-1} - \rho_2 v_{t-2})] \\ &\quad + \tfrac{1}{2}(u_t - v_t) + \tfrac{1}{6}{}_{t-1}(u_t + v_t) + \tfrac{1}{3}{}_{t-2}(u_t + v_t) \\ &= \tfrac{1}{2}(\varepsilon_t - \eta_t) + \tfrac{1}{3}[\varepsilon_{t-1}(a_1 + 2\rho_1) + \eta_{t-1}(b_1 - \rho_2)] + \rho_1^2 u_{t-2}. \end{aligned} \tag{21}$$

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.

[18] From the viewpoint of the behavior of the price level it might be desirable to have nonzero values of those parameters, but we are focusing strictly on the behavior of output.

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

$$\begin{aligned}\sigma_Y^2 &= \sigma_\varepsilon^2\left[\tfrac{1}{4} + \tfrac{4}{9}\rho_1^2 + \frac{\rho_1^4}{1-\rho_1^2} + \frac{a_1(4\rho_1 + a_1)}{9}\right] \\ &+ \sigma_\eta^2\left[\tfrac{1}{4} + \tfrac{1}{9}\rho_2^2 - \frac{b_1}{9}(2\rho_2 - b_1)\right].\end{aligned} \tag{22}$$

The variance minimizing values of a_1 and b_1 are accordingly:

$$\begin{aligned} a_1 &= -2\rho_1 \\ b_1 &= \rho_2 \end{aligned} \tag{23}$$

which yield output variance of

$$\sigma_Y^2 = \sigma_\varepsilon^2\left[\frac{1}{4} + \frac{\rho_1^4}{1-\rho_1^2}\right] + \tfrac{1}{4}\sigma_\eta^2. \tag{24}$$

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

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

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

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

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

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

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

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

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. Probably the major reason such contracts are not seen in practice is that calculation of their terms would be difficult since industry and firm specific factors omitted from this simple model are relevant to contracts that duplicate the effects of a full set of spot markets.

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

$$ \sigma_Y^2 = \sigma_\varepsilon^2 \left(\frac{1}{4} + \frac{\rho_1^2}{1 - \rho_1^2} \right) + \tfrac{1}{4}\sigma_\eta^2. \tag{29} $$

This exceeds the variance of output with optimal monetary policy in the nonindexed 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

$$ {}_{t-i}W_t = {}_{t-i}W_{t-i+1} + P_{t-1} - P_{t-i} \tag{30} $$

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

$$_{t-i}W_{t-i+1} = {}_{t-i}P_{t-i+1}, \tag{31}$$

that is, that the wage for the first year of the contract minimizes the variance of the real wage in that period.

Assuming 2-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:

$$\begin{aligned} Y_t(6 - 4L + 2L^2) = {} & 2M_t(1 - L)^2 + u_t[3 - (1 - \rho_1)L + \rho_1 L^2] \\ & - v_t[3 - (3 + \rho_2)L + (2 - \rho_2)L^2], \end{aligned} \tag{32}$$

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 that 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

$$\begin{aligned} M_t = {} & Lu_t[-(1 + 4\rho_1) + (1 + \rho_1)L - \rho_1 L^2][2(1 - L)^2]^{-1} \\ & - Lv_t[(1 - 2\rho_2) + (-1 + 3\rho_2)L - \rho_2 L^2][2(1 - L)^2]^{-1} \end{aligned} \tag{33}$$

which leaves

$$\sigma_y^2 = \frac{\sigma_\varepsilon^2}{4} + \frac{\sigma_\eta^2}{4}. \tag{34}$$

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 nonindexed 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 nonindexed contracts of Section II.

IV. Conclusions

The argument of this paper about active monetary policy turns on the revealed preference of economic agents for long-term contracts. The only long-term contracts discussed here are labor contracts, which 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.[19] 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 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.

Despite the different implications of this model from that of SW for the effectiveness of monetary policy in affecting output, the implied aggregate supply functions are only subtly different. An aggregate supply function such as that used by Lucas (1973) in which monetary policy cannot affect the behavior of output can be written

$$Y_t = \sum_{i=0}^{\infty} \gamma_i (P_{t-i} - {}_{t-i-1}P_{t-i}) + u_t. \tag{35}$$

That is, output is determined as a distributed lag on one-period forecast errors of the price level. A general aggregate supply function implying the potential effectiveness of monetary policy would be

$$Y_t = \sum_{i=0}^{\infty} \theta_i (P_t - {}_{t-i}P_t) + u_t. \tag{36}$$

In this case output is determined as a function of one and more period forecast errors of the price level.[20] The two formulations could be difficult to distinguish empirically.

[19] The major difference between this paper and that of Phelps and Taylor (1977) (PT) is that in most of PT it is price, rather than wage, rigidity that provides the element of nominal stickiness from which monetary policy derives its effectiveness. At the end of their paper, PT do present a model with (single-period) price and wage stickiness. Persistence effects in the present paper arise from the overlapping contracts and serial correlation of disturbances while in PT inventory accumulation produces persistence of past disturbances.

[20] Obviously, a more general form of (36) could involve terms like

$$\sum_{j=0}^{\infty} \phi_j \sum_{i=0}^{\infty} \theta_i (P_{t-j} - {}_{t-i-j}P_{t-j}).$$

Before concluding, we should note that there is no dispute that monetary policy can affect price level behavior. To the extent that price changes are costly, it would be desirable to maintain price stability. In the face of autocorrelated disturbances of the sort discussed in this paper, and even if all contracts are one period, an activist monetary policy would be needed to maintain stable prices. Thus an argument for the desirability of an activist monetary policy could be constructed even if there were no potential role for monetary policy in affecting output.

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:[21] 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 maneuver by the monetary authorities—which is to say that their policies can, though will not necessarily, be stabilizing.

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