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by

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In a model incorporating "rational" expectations and the "natural rate" hypothesis, Sargent and Wallace (1975) demonstrated three familiar propositions: (I) There is no stabilization role for monetary policy since fluctuations in output are not affected by systematic policy rules. (II) There is no growth role for monetary policy since the real rate of interest is not affected by systematic policy rules either. (III) Pegging the interest rate is destabilizing in the sense that it results in an indeterminant price level. So Poole's (1970) results do not carry over to this new generation of models. The implication of these three propositions would seem to be that the monetary authorities should only be concerned with controlling inflation.

These propositions are not new. They were much discussed within the framework of the old fashioned non-stochastic neoclassical models, and they were all valid as long as wealth effects on consumption were ignored. As is well known, wealth effects invalidate propositions (II) and (III), and "sticky" nominal wages invalidate all three.

In the new stochastic framework, proposition (I) has been questioned by some because of the existence of long-term labor contracts. Fischer (1977) and others have argued that these contracts imply a temporary stickiness in wages that allows monetary policy to work in the familiar way. But propositions (II) and (III) seem to be have been generally accepted, even by proponents of the contracting models.[1]

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[1] Taylor (1979), for example, reports that "interest rate targeting generally leads to instability in rational expectations models, whether prices are flexible or temporarily rigid."

The purpose of the present paper is to show that propositions (II) and (III) are not valid if there are wealth effects in consumption,[1] and to demonstrate that Poole's results carry over to this new class of models in a very robust manner. Interest rate policies are better than money supply policies if monetary disturbances are "large" relative to real disturbances, and this is true in contracting models, where there is scope for lagged feedback policies, and in the Sargent-Wallace model, where there is not.

It is interesting to note that, as Taylor (1979) has asserted, the very existence of long-term contracts is not sufficient to invalidate proposition (III). The wage stickiness these contracts imply allows monetary policy to influence real wages and employment, but it does not result in a determinant price level if the monetary authorities peg the rate of interest. In this respect the new stochastic models are at odds with their non-stochastic counterparts.

Contracting models will be discussed in an appendix. The main focus of the paper will be upon wealth effects in a model quite similar to the one analyzed by Sargent and Wallace.

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[1]Sargent and Wallace themselves noted (in footnote 5) that proposition (III) resulted from their exclusion of wealth from the aggregate demand schedule.

I. The Model and Its Solution

The model is, for the most part, a familiar one:

(1) $y_t = \bar{y} + s(p_t - p_{t|t-1})$

(2) $a = \log (M_t + B_t) = 0$

(3) $y_t = \bar{y} - d_1[r_t - (p_{t+1|t-1} - p_t)] + d_2(a - p_t) + u_t$

(4) $m_t - p_t = -(1/\ell_1)\, r_t + \ell_2(y_t - \bar{y}) + (1 - \ell_2)(a - p_t) + v_t$

where y is the log of aggregate output, p is the log of the price level, M + B is the total nominal indebtedness of the government to the private sector, r is the nominal rate of interest, and m is the log of the money supply. u and v are stochastic disturbances, and $p_{t|t-1}$ and $p_{t+1|t-1}$ are predictions of p_t and p_{t+1} based upon information available at the end of period t-1; these predictions are assumed to be "rational" in the sense of Muth (1961).

Equation (1) is an aggregate supply schedule incorporating the "natural rate" hypothesis; price prediction errors cause output to fluctuate about its natural rate, $\bar{y}$. This hypothesis has been motivated in several ways. Under the "signal extraction" interpretation, individual suppliers of goods and labor observe price changes in their own markets, but they are unable to immediately decompose them into relative price changes and movements in a general price index. Consequently, an unexpected increase in the price index will be confused at the local level with an increase in relative prices, and suppliers will provide more goods and services than they would have had they known the true relative prices. Lucas (1973) used this argument to explain the observed correlation between rates of economic activity and rates of inflation. Under the "long-term contracts" interpretation, suppliers of, say, labor lock themselves into nominal wage contracts for a specified length of time. The nominal wage settings are based upon cost of living predictions; the goal is to set a real wage consistent with a desired or "natural" rate of employment. If prices turn out to be higher than anticipated, the real wage will be lower than intended, and employment and production will exceed their natural rates. Equation (1) can be explained in this way if the length of a period is defined by the length of labor contracts.[1]

Equation (2) gives the nominal wealth of the private sector. Since the capital stock has been suppressed (for algebraic simplicity), this consists of money and government bonds. Monetary policy consists of "open market" exchanges of money and bonds. These exchanges leave the nominal value of wealth unchanged; units are chosen so that a, the nominal value of wealth, equals zero.

Equation (3) is an aggregate demand schedule. Demand for output varies inversly with the (expected) real rate of interest and directly

[1] See Fischer (1977) or Canzoneri (1980).

with the real value of wealth.[1] Equation (4) is the equilibrium condition for the asset sector. The fraction of wealth held in real money balances depends upon the nominal rate of interest and the ratio of income to wealth[2]; ℓ_2, the income elasticity of demand for money, is assumed to be less than unity.

The first step in solving this model is to find a reduced form for the price level. The supply and demand equations ((1) and (3)) can be solved for

$$\text{(5r)} \quad p_t = h_1 p_{t+1|t-1} - h_2(p_t - p_{t|t-1}) - h_1 r_t + h_3 u_t$$

where

$$h_1 = d_1 h_3 \qquad h_2 = sh_3 \qquad h_3 = 1/(d_1 + d_2)$$

The expected value of u is zero, and in the main body of the paper, it

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[1]Some explanation of the dating of expected inflation may be in order. Two other dating schemes have been used in the literature: (a) $p_{t+1|t-1} - p_{t|t-1}$ and (b) $p_{t+1|t} - p_t$. Sargent and Wallace (1975) used (a), and indeed (a) is the most popular specification in the closed economy literature. It can be argued, however, that purchasers should at least know the price of what they are buying. Specification (b), which is popular in the international finance literature, assumes full knowledge of all current information. The choice among these specifications does note affect the qualitative conclusions of the present paper; some minor differences will be pointed out in footnotes.

[2]Equation (4) is a log linearization of

$$\frac{M}{p} = \alpha \frac{A}{p} \quad \text{where } \alpha = f(r, \frac{y}{A/p})$$

will be assumed that u is serially uncorrelated. Equation (5r) determines the path of prices if the nominal rate of interest is the instrument of monetary policy. Using (4) to eliminate r_t in (5r), one obtains

$$(5m)\quad p_t = f_1\, p_{t+1|t-1} - f_2(p_t - p_{t|t-1}) + f_3\, m_t + w_t$$

where

$$f_1 = h_1/(1 + h_1\ell_1\ell_2) \qquad f_2 = (h_2 + h_1\ell_1\ell_2 s)/(1 + h_1\ell_1\ell_2)$$

$$f_3 = h_1\ell_1\ /(1 + h_1\ell_1\ell_2) \qquad w_t = (h_3 u_t - h_1\ell_1 v_t)/(1 + h_1\ell_1\ell_2)$$

which determines the path of prices if the money supply is the instrument of monetary policy. w is a combination of real and monetary disturbances; it too will be assumed to be serially uncorrelated and to have a zero mean.

Suppose first that the interest rate is the instrument of monetary policy. Forwarding (5r) j periods and taking the expectation based upon information available at the end of period t-1,

$$p_{t+j|t-1} = h_1 p_{t+j+1|t-1} - h_1 r_{t+j|t-1}$$

This difference equation can be solved forward to obtain an expression for $p_{t+1|t-1}$; that is,[1]

[1] (6r) is obtained by repeated forward substitutions:

$$\begin{aligned} p_{t+1|t-1} &= h_1 p_{t+2|t-1} + h_1\ r_{t+1|t-1} \\ &= h_1^{\ 2}\ p_{t+3|t-1} + h_1(r_{t+1|t-1} + h_1 r_{t+2|t-1}) \\ &= \ldots \end{aligned}$$

(6r) $$p_{t+1|t-1} = \lim_{T\to\infty} h_1^{T-1} p_{t+T|t-1} - h_1 \sum_{i=0}^{\infty} h_1^i r_{t+i+1|t-1}$$

To obtain a unique solution, one must specify a terminal condition for the first term in (6r). Since $h_1 < 1$, it is plausible to assume that

(7r) $$\lim_{T\to\infty} h_1^{T-1} p_{t+T|t-1} = 0$$

If, for example, the price level is not expected to blow up (that is, if $p_{t+T|t-1}$ is bounded for all T), then (7r) will be satisfied. Sargent (1973) calls this a "no speculative bubbles" assumption. Suppose the interest rate is simply pegged at $\bar{r}$; then substituting (7r) into (6r), and (6r) into (5r), one obtains a reduced form for the price level <u>under a fixed interest rate policy:</u>

(8r) $$p_t = -h_1(1-h_1)^{-1}\bar{r} - h_2(p_t - p_{t|t-1}) + h_4 u_t$$

The reasoning used to derive (8r) does require the presence of wealth in the aggregate demand schedule, (3). If $d_2 = 0$, then $h_1 = 1$ and (7r) is not the only plausible terminal condition. In particular,

(7r)' $$\lim_{T\to\infty} h_1^{T-1} p_{t+T|t-1} = p_{t+\infty|t-1}$$

and simply asserting that the price level is not expected to blow up is not sufficient to pin down the terminal condition. Any finite $p_{t+\infty|t-1}$ yields a particular solution for $p_{t+1|t-1}$ in (6r) and a new solution for p_t. Unless some cogent argument can be given for a particular value of

[1]If dating scheme (a) in footnote is used, one also needs $d_2 > d_1$ to ensure that the equivalanet of h_1 is less than unity.

$p_{t+\infty|t-1}$, the price level is indeterminent.[1]

The same procedure can be used to solve (5m) for a reduced form under a fixed money supply policy:

$$(8m) \quad p_t = f_4 (1 - f_1)^{-1} \bar{m} - f_2(p_t - p_{t|t-1}) + w_t$$

Here wealth effects are not necessary for the argument; $f_1 < 1$, even if $d_2 = 0$.

These reduced forms can be used to calculate price prediction errors under the two regimes, and then substitution into (1) gives reduced forms for output. With a fixed interest rate policy,

$$(9r) \quad y_t = \bar{y} + s(1 + h_2)^{-1} h_3 u_t$$

and with a fixed money supply policy,

$$(9m) \quad y_t = \bar{y} + s(1 + h_2 + \phi)^{-1} (h_3 u_t - h_1 \ell_1 v_t)$$

where

$$\phi = j_1 \ell_1 \ell_2 (1 + s) > 0$$

The values of $\bar{r}$ and $\bar{m}$ do not appear in these reduced forms, but the choice of an instrument clearly makes a difference in the stochastic structure of the fluctuations in output.

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[1] And the problems do not end here. Unless the $r_{t+i+1|t-1}$ converge quickly to zero, the infinite sum is (6r) will not be finite. If the interest rate is pegged at zero, Taylor's (1977) condition can be imposed to achieve uniqueness.

II. The Real Rate of Interest and Monetary Policy

The values of $\bar{r}$ and $\bar{m}$ do affect the real rate of interest in this model. It can be shown that[1]

$$(10r)\quad E[r_t - (p_{t+1|t-1} - p_t)] = \bar{r}$$

under a fixed interest rate policy, and

$$(10m)\quad E[r_t - (p_{t+1|t-1} - p_t)] = -\ell_1(1-h_1)(1-h_1 + h_1\ell_1\ell_2)^{-1}\ \bar{m}$$

under a fixed money supply policy. (Here, $E[\cdot]$ is the unconditioned expectation operator.) In either case, monetary policy is not neutral; the choice of $\bar{r}$ or $\bar{m}$ affects the real rate of interest.

This non-neutrality depends crucially upon the presence of wealth in the aggregate demand schedules. (If $d_2 = 0$, then the interest rate policy is infeasible and $h_1 = 1$, so $\bar{m}$ dissapears in (10m).) This result is essentially Metzler's (1951).

III. The $\bar{r}$ Policy versus the $\bar{m}$ Policy

If the goal of monetary policy is to minimize the fluctuations in output, then (9r) and (9m) can be used to choose between pegging the interest rate at $\bar{r}$ and setting the money supply at $\bar{m}$. With a fixed

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[1] It is clear from (8r) and (8m) that $E[p_{t+1|t-1} - p_t] = 0$, no matter which instrument is chosen. (10r) follows immediately. Using (4) to calculate $E(r_t)$ and (8m) to evaluate $E(p_t)$, one obtains (10m).

interest rate policy,

$$\sigma_{y,\,\bar{r}}^{2} = s^{2}(1 + h_{1})^{-2}\, h_{3}^{2}\, \sigma_{u}^{2}$$

and with a fixed money supply policy (assuming that u and v are not correlated),

$$\sigma_{y,\,\bar{m}}^{2} = s^{2}(1 + h_{2} + \phi)^{-2}\, (h_{3}^{2}\, \sigma_{u}^{2} + h_{1}^{2} \ell_{1}^{2}\, \sigma_{v}^{2})$$

The ratio of these variances

$$(11) \quad \sigma_{y}^{2},_{\bar{m}} / \sigma_{y}^{2},_{\bar{r}} = \Theta[1 + (h_{1}\ell_{1}/h_{3})^{2}\, R]$$

where

$$R = \sigma_{v}^{2} \,/\, \sigma_{u}^{2} \qquad \Theta = (1 + h_{2})^{2}(1 + h_{2} + \phi)^{-2} < 1$$

depends upon the relative sizes of real and monetary disturbances. Equation (11) is graphed in figure 1. If monetary disturbances are "small" in comparison with real disturbances (that is, if $R < R^{*}$), then the $\bar{m}$ policy is better than the $\bar{r}$ policy. If monetary disturbances are "large" ($R > R^{*}$), the $\bar{r}$ policy is better.

The reason for this is clear. The interest rate policy does not allow a monetary disturbance to affect the goods market. On the other hand, a flexible interest rate allows financial markets to absorb some of the effects of a real disturbance. This result is essentially Poole's (1970).

IV. A Better Interest Rate Policy

The instrument selection problem, as posed in the last section, probably presents too stark a contrast. The FED has rarely, if ever, pegged an interest rate. Instead, we have witnessed a variety of interest rate policies, each characterized by a degree of interest rate flexibility.[1] This continuum of policies might be represented by[2]

$$(12) \quad m_t = \bar{m} + g(r_t - \bar{r}) \qquad g \geq 0$$

Larger values of g correspond to more vigorous stabilization efforts. (In fact, it will be seen below that $g = \infty$ corresponds to an $\bar{r}$ policy, while $g = 0$ corresponds to an $\bar{m}$ policy.)

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[1] It is not even clear that the goal of these policies was to fix an interest rate per se. The idea may have been to create a demand for money consistent with a money supply target.

[2] The reader might wonder why policy rules of the form

$$(12)' \quad m_t = \bar{m} - g\,(y_t - \bar{y})$$

are not discussed, since the ultimate goal is to stabilize output. The motivation for the present discussion is that "current" information on interest rates is available to the monetary authorities while information about real variables comes with a lag. It is well known that rules of the form

$$(12)'' \quad m_t = \bar{m} - g(y_{t-1} - \bar{y})$$

have no effect on $y_t - \bar{y}$ in the present model.

Clearly, $\bar{r}$ and $\bar{m}$ can not be chosen independently.[1] The choice of $\bar{r}$ and $\bar{m}$ will affect the real rate of interest, but it will not affect the fluctuation of output about its natural rate. So without loss of generality, $\bar{r}$ and $\bar{m}$ can be set equal to zero; this combination works, and it results in simple algebraic expressions.

Substituting the policy rule (12) into (4), one obtains

$$(13)\qquad r_t - \bar{r} = r_t = (1+\ell_1 g)^{-1}\ell_1[\ell_2 p_t + \ell_2 s(p_t - p_{t|t-1}) + v_t]$$

As $g\to\infty$, the interest rate is pegged at $\bar{r}$. As g is decreased, interest rate fluctuations become larger. Substituting into (5r), one obtains

$$(14)\qquad p_t = h_1 p_{t+1|t-1} - h_2(p_t - p_{t|t-1})$$
$$-(1+\ell_1 g)^{-1}h_1\ell_1[\ell_2\, p_t + \ell_2 s(p_t - p_{t|t-1}) + v_t] + h_3 u_t$$

which reduces to (5r) as $g\to\infty$ and (5m) as $g\to 0$. Equation (14) can be solved in the same way for the reduced[2]

$$(15)\qquad p_t = [1 + h_2 + (1 + \ell_1 g)^{-1}\,\phi]^{-1}\,[h_3 u_t - (1 + \ell_1 g)^{-1}\, h_1\ell_1 v_t]$$

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[1] Taking the (unconditional) expected value of (3) and (4), $\bar{m} = -\ell_1^{-1}\,\bar{r} + \ell_2\bar{p}$ and $\bar{p} = -d_1 d_2^{-1}\,\bar{r}$. So $\bar{m} = -(\ell_1^{-1} + \ell_2 d_1 d_2^{-1})\bar{r}$.

[2] A quicker way of deriving (15) is to note that (14) is identical to (5m) with ℓ_1 replaced by $(1+\ell_1 g)^{-1}\ell_1$; (15) can then be inferred from (8m).

So with policy rule (12),

(16) $$\sigma^2_{y,g} = s^2[1+h_2 + (1+\ell_1 g)^{-1}\phi]^{-2}\,[h_3^{\,2}\,\sigma_u^2 + (1+\ell_1 g)^{-2}\,h_1^2\,\ell_1^2\,\sigma_v^2]$$

The best policy can be found by differentiating (16) with respect to g; it turns out that the variance minimizing g is

(17) $$g^* = (\beta\ell_1)^{-1}\,(R-\beta)$$

where

$$\beta = h_3^{\,2}\,\ell_2(1+s)/h_1\ell_1(1+h_2)$$

As shown in figure 2, the $\bar{m}$ policy (or $g=0$) is best if monetary disturbances are "small" relative to real disturbances (that is, if $R < \beta$).[1] The "larger" are monetary disturbances relative to real disturbances, the less flexible should be the interest rate policy. However, it should be noted that the $\bar{r}$ policy ($g = \infty$) is never best. Pegging the interest rate is a feasible policy, but it is always dominated by a more flexible policy. The reason for this should be clear. The interest rate provides some information about the unobserved disturbances if it is allowed to fluctuate in response to them; pegging the interest rate is tantamount to throwing this information away.[2]

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[1] This discussion assumes that interest rate destabilizing policies ($g < 0$) are not even considered.

[2] Finally, it may be interesting to note that $R^* > \beta$. The analysis of section II leads one to turn away from interest rate policies at too low a value for R. The reason for this is again the $\bar{r}$ policy is not the best interest rate policy.

V. Conclusion

Even in models without long-term labor contracts, there are policy choices facing the monetary authority that affect real variables. The choice of a monetary instrument (or a "combination" policy) has implications for stability in the goods market, and these implications are basically those identified by Poole (1970) in a much simpler context. In addition, monetary policy can affect the real rate of interest and thus capital formation. These conclusions, which differ substantially from those of Sargent and Wallace (1975), are directly attributable to wealth effects in consumption.

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FIGURE 1

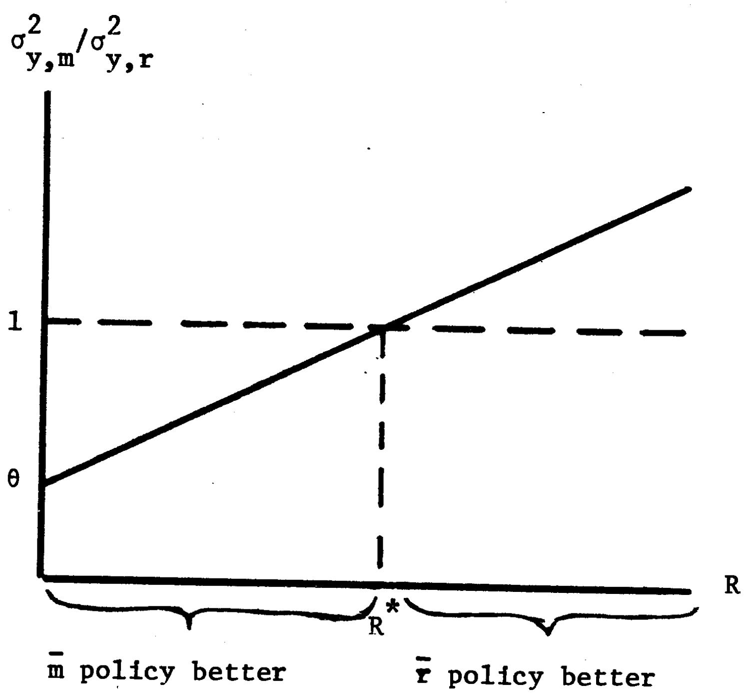
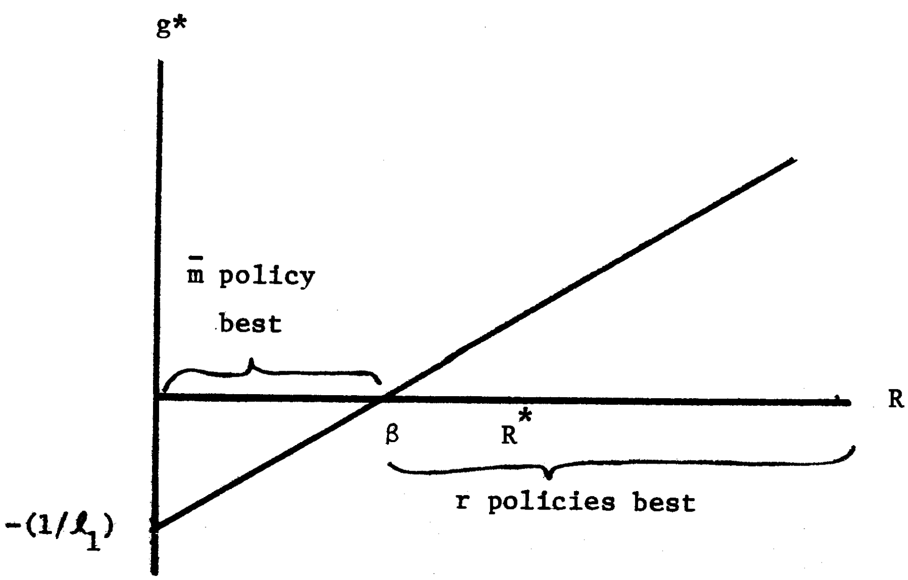


FIGURE 2



Appendix: Wealth Effects in Models with Long-Term Labor Contracts

This purpose of this appendix is two-fold. First, it will be shown that the very existence of such contracts does not allow the FED to peg interest rates; if wealth effects are absent, the price level is once again indeterminent under an $\bar{r}$ policy. Second, it will be shown that the choice of a monetary instrument (or more generally, an interest rate policy) will depend upon much the same considerations as were discussed in sections III and IV; in particular, it depends upon the relative sizes of real and monetary disturbances. The long-term contracts do imply a role for lagged feedback policies, but the instrument selection problem is largely independent of this fact.

If labor contracts span two periods, the supply schedule (1) becomes[1]

$$\text{(I)} \qquad y_t = \bar{y} + s(p_t - p_{t|t-1}) + s(p_t - p_{t|t-2})$$

the rest of the model remains unchanged. Equations (I) and (3) imply

$$\text{(IIr)} \quad p_t = h_1\, p_{t+1|t-1} - h_2(p_t - p_{t|t-1}) - h_2(p_t - p_{t|t-2}) - h_1 r_t + h_3 u_t$$

and using (4) to eliminate r_t,

$$\text{(IIm)} \quad p_t = f_1\, p_{t+1|t-1} - f_2(p_t - p_{t|t-1}) - f_2(p_t - p_{t|t-2}) + f_3 m_t + w_t$$

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[1] See Fischer (1977) or Canzoneri (1980) for a derivation of (I). The length of a period is determined by the length of the lag in policy feedback rules, and this in turn is usually identified with the data lag for real variables. (In section IV, it was assumed that there is no lag for financial data.) The present author usually thinks in terms of quarters. It is clear that most labor contracts span more than two quarters; however, the results presented here are easily generalized to models with n-period contracts.

These equations correspond to (5r) and (5m) in the main text, and they can be solved in exactly the same way for the reduced forms

$$\text{(IIIr)}\quad p_t = -h_1(1 - h_1)^{-1}\,\bar{r} - h_2(p_t - p_{t|t-1}) - h_2\,(p_t - p_{t|t-2}) + h_3 u_t$$

and

$$\text{(IIIm)}\quad p_t = f_4(1 - f_1)^{-1}\,\bar{m} - f_2\,(p_t - p_{t|t-1}) - f_2(p_t - p_{t|t-2}) + w_t$$

which correspond to (8r) and (8m). The reduced form (IIIr) is only valid if $d_2 \neq 0$ (so that $h_1 \neq 1$). The discussion in the main text carrys over word for word. The price level is indeterminent without wealth effects in the aggregate demand schedule.

Now if the disturbances are serially correlated the reduced forms will be more complicated.[1] However, it is well known that in this case the price prediction error $p_t - p_{t|t-2}$ will depend upon both current and lagged innovations in the disturbances.[2] This will cause output to "cycle" about its natural rate. It is also well known that lagged feedback rules for monetary policy can completely offset this cyclical component in output.[3]

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[1] The expressions for $p_{t+j|t-1}$ will include $u_{t+j|t-1}$ or $w_{t+j|t-1}$.

[2] See, for example, Fischer (1977) or Canzoneri (1980).

[3] Ibid.

In the present context, those rules take the form

$$(\text{IIIr}) \quad r_t = \bar{r} + (h_3/h_1)u_{t|t-1}$$

or

$$(\text{IIIm}) \quad m_t = \bar{m} - (1/f_3)w_{t|t-1}$$

depending upon which instrument is selected. It should be clear what these rules do. Noting that $h_3/h_1 = 1/d_1$,(IIIr) simply moves the interest rate to offset the predictable part of the demand disturbance in (3); (IIIm) has to offset the predictable effects of both monetary and real disturbances. With (IIIr) and (IIIm), (IIr) and (IIm) become

$$(\text{IVr}) \quad p_t = h_1 p_{t+1|t-1} - h_2(p_t - p_{t|t-1}) - h_2(p_t - p_{t|t-2}) - h_1\bar{r} + h_3(u_t - u_{t|t-1}$$

$$(\text{IVm}) \quad p_t = f_1 p_{t+1|t-1} - f_2(p_t - p_{t|t-1}) - f_2(p_t - p_{t|t-2}) + f_3\bar{m} + (w_t - w_{t|t-1})$$

Now (IVr) and (IVm) are exactly analygeous to (5r) and (5m) in the main text (since it will turn out that $p_t - p_{t|t-1} = p_t - p_{t|t-2}$). So in models with long-term contracts, one should add the feedback terms described in (IIIr) and (IIIm), but then the analysis proceeds as before. It is clear from (9r) and (9m) that the cyclical component has been eliminated.