RATIONAL EXPECTATIONS, NONLINEARITIES, AND THE EFFECTIVENESS OF MONETARY POLICY

Dennis J. SNOWER*)

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*) Assistent der Abteilung Ökonomie am Institut für Höhere Studien, Wien

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Summary

This paper contends that even if the rational-expectations hypothesis and the natural-rate hypothesis both hold, systematic monetary policy may nevertheless be able to influence output and employment, provided that the relation between the money supply and the price level is nonlinear. Such a nonlinear relation is suggested by a variety of theoretical considerations. The paper contains a well-known macroeconomic model in which this nonlinearity occurs. In this context, it is shown how systematic monetary policy is able to manipulate output and employment in accordance with predetermined policy goals.

Zusammenfassung

Dieser Artikel demonstriert, daß systematische Geldpolitik einen Einfluß auf Produktion und Beschäftigung haben kann, sogar wenn die "rational-expectations" und "natural-rate" Hypothesen in Kraft treten. Dieser Einfluß ist zu verzeichnen, wenn die Beziehung zwischen der Geldmenge und dem Preisniveau nichtlinear ist. Solch eine Nichtlinearität lässt sich aus verschiedenen theoretischen Ansätzen ableiten. An Hand eines bekannten makroökonomischen Modells (in der diese Nichtlinearität vorkommt) wird die Steuerung der Produktion und Beschäftigung durch systematische Geldpolitik beschrieben.

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1. Introduction

This paper examines whether systematic monetary policy is able to affect real output and employment if all agents in an economy have rational expectations. "Systematic monetary policy" is meant to denote that policy undertaken in accordance with a given money supply rule (e.g. the change in the money supply is a function of the unemployment rate), which can be anticipated perfectly if expectations are formed rationally. A number of recent contributors (Sargent and Wallace (1975, 1976), Lucas (1972), Barro (1976) and others) to the policy-effectiveness debate have suggested that systematic monetary policy could influence real output and employment only if it could change actual and expected price levels by different amounts, but that systematic monetary policy cannot do so in the presence of rational expectations. This paper, however, argues that even if expectations are rational and output and employment are manipulatable only via the discrepancy between actual and expected prices, systematic monetary policy may nevertheless be effective, provided that the relation between the money supply and the actual price level is nonlinear.

The nonneutrality of systematic monetary policy will be illustrated in the context of a simple macroeconomic model which contains a nonlinear relation between the money supply and the actual price level. It will be shown that, for a given point in time, an increase in the systematic money supply may have an expansionary or contractionary effect on production and employment. The economic conditions determining the sign of this effect have an interesting policy implication. Furthermore, it will be shown that the effect of an increase in the systematic money supply on production and employment over the short run may differ (in magnitude and sign) from that over the long run. For example, an increase in the systematic money supply may have an expansionary effect in the short run and a contractionary effect in the long run. The economic determinants of these effects also have significant implications for the monetary policy manipulation of production and employment.

The policy-ineffectiveness argument implies that systematic monetary policy can be formulated without regard to the government's output and employment goals and may therefore be devoted entirely to other goals, such as the attainment of the optimal rate of inflation. In view of these radical policy implications, it is important to examine the structure of this argument rather closely. The argument rests on two basic hypotheses: the "natural rate hypothesis" and the "rational expectations hypothesis". The natural rate hypothesis asserts that, given the microeconomic structure of the economy (e.g. firms' production functions and households' utility functions), correct price expectations are associated with unique level of output and employment (viz. the "natural" levels). Thus, aside from "structural policies" (which alter the positions of labor demand and labor supply curves relative to the corresponding perceived real wages), government policies which affect actual and expected prices by equal amounts cannot affect production and employment. Real variables are influenced only by policies which drive a wedge between actual and expected prices. The rational expectations hypothesis, as applied to economic models, asserts that the expectations of economic agents "are the predictions implied by the model itself, contingent on the information economic agents are assumed to have" (Fischer (1977, p. 193)). Given that all relevant economic data are available to the public and the government at virtually the same time, then economic agents with rational expectations can (and do) figure out all the systematic policy rules which the government devises and identify the probable effects of these rules on all relevant economic variables.

If the natural rate hypothesis and the rational expectations hypothesis are accepted conjointly, then it appears -- at first glance -- that the policy-ineffectiveness argument must follow inevitably. If expectations are formed rationally, then the content and effect of systematic monetary policies are entirely anticipated. Hence, these policies must (apparently) affect actual and expected prices by the identical amounts. Yet, if the natural rate hypothesis obtains, then output and employment react only to changes in the relation between actual and expected prices. Therefore, systematic monetary policies must be ineffective.

On the other hand, unsystematic monetary policies -- e.g. increments to the money supply chosen at random (with a mean of zero) by the monetary authority -- are able to affect output and employment. These policies are unpredictable and thus cannot be taken into account in the formation of expectations. Hence, they influence actual prices but leave expected prices unchanged. In other words, the monetary authority can influence real variables only if it acts unpredictably.

This paper does not question the two assumptions which underlie the policy-ineffectiveness argument. It does not inquire whether government policy can influence production and employment through avenues other than the discrepancy between expected and actual prices. For example, it bypasses the question of whether production and employment may be affected directly, through spill-over effects à la Barro-Grossman (1971, 1976), when product and labor markets exhibit price rigidities -- due possibly to risk-shifting arrangements (as treated by Azariadis (1975, 1978), Bailey (1974), Grossman (1977, 1978), Gordon (1974) and others) or administrative costs of price change (as treated by Barro (1972), Sheshinski and Weiss (1977), Carlton (1978) and others) -- and institutional constraints prevent production and employment contracts of the sort outlined by Barro (1977). The paper also does not ask whether it is realistic to assume that economic agents always formulate their expectations rationally. For example, it ignors the question whether economic agents learn about new systematic monetary policies only gradually -- by relating new information to old information -- and whether expectations are rational during this learning process. See, for example, Taylor (1975). Here the natural rate hypothesis and the rational expectations hypothesis are accepted without argument and it is shown that systematic monetary policy may affect real variables despite these two hypotheses.

The recent policy-effectiveness debate has witnessed two major demonstrations of the effectiveness of monetary policy under these conditions. First, it has been shown (by Sargent and Wallace (1975) and others) that if the monetary authority is better informed than the public about the movement of some economic variables, systematic monetary policy remains potent. If the money supply rule depends (at least in part) on these variables, then the money supply reacts to events which are treated as random by the public and these reactions affect actual prices without affecting expected prices. Second, Fischer (1977a, b) has shown that if (a) economic agents make labor contracts which fix the money wage for a period of time longer than it takes the monetary authority to make a systematic change in the money supply and (b) employment is determined unilaterally by the employers, then it is possible for systematic monetary policy to affect production and employment.

Although both of these demonstrations are logically correct, they have been criticized either on account of their limited relevance and realism or because their underlying assumptions remain unjustified. With regard to the former demonstration, it has been argued that differential access to economic data is an unrealistic assumption for most mature, capitalist economies. "... differential access to information is an implausibly weak reed upon which to rest a counterattack against [the policy-ineffectiveneess argument] in an economy like the U.S. in which government statistics are publicized in newspapers only a few days after they are compiled; there would be too great a payoff to close study by economic agents of the monetary authority's procedures" (Gordon (1976, p.201)).

If we leave aside the question whether the public has sufficient incentive to pay as close attention to economic data as the monetary authority (for acceptance of the rational expectations hypothesis implies an affirmative answer), this criticism appears to be sound with regard to most types of data relevant to the implementation of monetary policy. Money supply rules usually relate the money supply to economic variables which both the monetary authority and the public may be expected to know in an equally intimate (or remote) way. If the systematic component of the money supply were to depend on the number of eggs I scramble in the course of each week, then I could be expected to have better information about systematic monetary policy than that gleaned by the government (from, say, press conferences in which I disclose the extent of my egg-scrambling activities). On the other hand, if the systematic component of the money supply were to depend on the unsystematic policy "surprises" engineered by the monetary authority, then the monetary authority would presumably be better informed. However, the common money supply rules relate the money supply neither to my scrambled eggs nor to unpredictable monetary surprises, but rather to such variables as GNP, the unemployment rate, or the inflation rate. Neither the public nor the monetary authority has a significant, innate advantage in acquiring information abour these variables; both are dependent on the same data collecting and processing agencies for guidance. When seen in this light, the first demonstration of the effectiveness of monetary policy looses much of its bite. However -- with a view to one of the arguments of Sections 3 and 4 of this paper -- it is important to emphasize that this demonstration cannot be dismissed so easily if systematic monetary policy depends on economic variables to which the government is more intimately related than the public.

The second demonstration of monetary policy effectiveness assumes that long-term contracts (justified by risk-shifting considerations, see Azariadis (1975, 1978), Bailey (1974), etc.) are responsible for stickiness of the money wage and thus systematic monetary policy, by altering the price level, can change the real wage. If firms are responsible for determining employment, the labor demand function translates the change in the real wage into a change in employment. Hence, a rise in the systematic component of the money supply lowers the real wage and thereby raises employment and production; a fall in the systematic component has the opposite effect.

This demonstration has been criticized (by Barro (1977)) on account of its employment determination mechanism. If monetary policy can affect employment without changing the positions of the labor demand and labor supply curves and without altering the relation between the actual price and the expected price (i.e. the expectation formulated in the previous period), then this policy is capable of causing a discrepancy between the demand for and the supply of labor. In other words, monetary policy drives a wedge between the marginal product of labor and the marginal value of time. Under these circumstances, however, employers and employees face unexploited mutual gains from trade, i.e. the employment contract is suboptimal for both parties. Unless an adequate reason can be found for why these gains from trade remain unexploited, the assumption that employers determine employment must be adandonned. Only those employment contracts which clear the labor market are Pareto optimal. Yet given such contracts, the effect of systematic monetary policy on the real wage (when the money wage is sticky) does not imply any effect on employment. Employment is determined through the intersection of the labor demand and labor supply curves and these curves remain impervious to systematic monetary policy. In reply to this argument, Fischer (1977b) suggested that, as a fact of life, Pareto optimal employment contracts are not undertaken. "Firms will be left to determine labor input because firms specialize in organizing production, and it is expensive for workers to monitor the reasons for changing output levels" (Fischer (1977b, p.321-2). Nevertheless, the precise reasons for the existence of unexploited gains from trade remain unexplored. At the present stage of the controversy, we must conclude that if systematic monetary policy can affect employment, it is by no means transparent why it can do so.

This paper provides a different rationale for the effectiveness of systematic monetary policy. It is suggested here that systematic changes in the money supply can affect output and employment if the relation between the money suply and the price level is nonlinear. To derive such a nonlinear relation, a standard Keynesian IS-LM model of aggregate product demand is coupled with a natural rate hypothesis explanation of aggregate product supply. A major source of the nonlinearty is to be found in the liquidity preference schedule and possibly also the aggregate product supply schedule.

In this context, two arguments will be made for the effectiveness of systematic monetary policy. According to both arguments, the nonlinear relation above implies that the public will inevitably be fooled with regard to the relation between the systematic money supply and the price level -- rational expectations notwithstanding -- and therefore changes in the systematic money supply can affect production and employment. The first argument may be sketched (very roughly) as follows.

(A) The money supply is assumed to be composed of a systematic and an unsystematic component. Let the unsystematic component be a random variable which is normally distributed about a mean of zero. (For simplicity, suppose that this is the only random variable in our model.) Since the relation between the money supply and the price level is nonlinear, the effect of the systematic component on the price level depends on the magnitude of the unsystematic component. Thus, the effect of the systematic component on the price level is a random variable.

(B) According to the natural rate hypothesis, the levels of output and employment depend on the discrepancy between the actual price level and a point expectation of the price level. By implication, the effect of the systematic money supply on output and employment depends on the discrepancy between the actual effect of the systematic money supply on the price level and a point expectation of the effect of the systematic money supply on the price level.

(C) According to the rational expectations hypothesis, the public knows the distribution of the unsystematic component of the money supply and the corresponding distribution of the systematic monetary effect on the price level (since the public recognizes how the unsystematic compnent influences this systematic monetary effect). The public's point expectation of the systematic monetary effect on the price level is a point on the distribution of this effect, associated with a particular value of the unsystematic component.

(D) Let this value of the unsystematic component be "A", where A is any real number (which may or may not be zero). Whenever the unsystematic component is not equal to A, the actual effect of the systematic money supply on the price level differs from the expected effect. Under these circumstances, systematic monetary policy can drive a wedge between the actual and the expected price level and therefore can influence output and employment.

Whether the monetary authority can use systematic monetary policy to manipulate output and employment is another matter. If the unsystematic component of the money supply may be accounted for by unpredictable monetary "surprises" which are willfully engineered by the monetary authority, then it may be presumed that the monetary authority has more intimate knowledge of the unsystematic component than the public has. Under these conditions, the monetary authority may be able to influence output and employment in accordance with preconceived policy goals.

The second argument for the effectiveness of monetary policy is independent of the first, although it, too, turns on the assumption that the relation between the money supply and the price level is nonlinear. This argument may be sketched (very, very roughly) as follows.

(A') If systematic monetary policy is to have no consistent effect on output and employment in the short run (viz. the time period between two occurences of the unsystematic component of the money supply) and the long run (viz. a sequence of time periods long enough for the sample mean of the unsystematic component to be a "good" approximation of the theoretical mean), then systematic monetary policy must be unable to cause consistent expectational errors with regard to the effect of the systematic money supply on the price level for both the short run and the long run.

(B') If the effect of the systematic money supply on the price level is to be derived by means of the natural rate hypothesis, then (as noted in step (B) of argument 1) we must assume that the public formulates its anticipation of this effect in terms of a point expectation.

(C') The public is not subject to consistent expectational errors in the short run if its point expectation of the effect of the systematic money supply on the price level has a higher chance of being correct than any other point expectation. In other words, the public is not consistently fooled in the short run if its point expectation is equal to the mode of the distribution of the systematic monetary effect on the price level.

(D') The public is not subject to consistent expectational errors in the long run if its point expectation of the systematic monetary effect on the price level is equal to the average value of this effect through time. In other words, the public is not consistently fooled in the long run if its point expectation is equal to the mean of the distribution of the systematic monetary effect on the price level.

(E') For the model identified above, there is a concave relation between the unsystematic component of the money supply and the effect of the systematic component on the price level. Thus, if the unsystematic conponent is normally distributed, then the distribution of the systematic monetary effect on the price level is skewed.

(F') If the distribution of the systematic monetary effect on the price level is skewed, then the mode of this distribution is not equal to the mean. Thus, it is inevitable that the public be subject to consistent expectational errors in the short run or the long run or both. Consequently, systematic monetary policy may drive a wedge between the actual and the expected price level in the short run or the long run or both and thereby influence the levels of output and employment.

The flesh and blood of these two arguments is provided below. Before that, however, a particularly simple, but rigorous, version of the policy-ineffectiveness argument is presented in Section 2, in order for the distinctive features of my two policy-effectiveness arguments to fall into sharp relief. Section 3 is devoted to the first of these arguments; Section 4 to the second. Finally, Section 5 contains a brief overview and some concluding remarks.

2. A Policy-Ineffectiveness Argument

The present section provides a simple economic model by means of which it may be shown that systematic monetary policy cannot affect the levels of output and employment. This model contains an aggregate product supply curve which embodies the natural rate hypothesis and an aggregate product demand curve which embodies the quantity theory of money. The natural rate hypothesis is derived in a manner akin to the contribution of Friedman (1968), Lucas (1973, 1975), and Sargent (1973).

The product market is assumed to clear always. The level of output may be shown to depend on the discrepancy between the actual and the expected product price. In turn, the actual and the expected price depend (among other things) on the actual and the expected money supply, respectively. It will be shown that, if expectations are rational, the level of output depends on the unsystematic component of the money supply, but not on the systematic component. This formulation of the policy-ineffectiveness argument belongs to the same family as that offered by Gordon (1976, pp.199-201), Santomero and Seater (1978, pp.529-30), and others.

Let a Cobb-Douglas production function describe how a homogeneous output, Q, is produced by means of labor, L (and possibly other factors of production, which are held in fixed supply):

(1) $Q^S = \beta \cdot (L^D)^\alpha$

where α and β are constants and the superscripts "S" and "D" denote quantities supplied and demanded, respectively. Suppose that the "representative firm" is able to observe the actual product price, P, and the actual money wage, W, and that its demand for labor is determined through an equation of the marginal product of labor to the real wage, (W/P):

$$(2)\ \ln(L^D) = (\frac{1}{1-\alpha})\cdot\ln(\alpha\cdot\beta) - (\frac{1}{1-\alpha})\cdot\ln(\frac{W}{P}) \quad .$$

Moreover, suppose that the "representative household" is able ot observe its actual money wage, but not the actual product price, before making its labor supply decision and that the labor supply function is given by

$$(3)\ \ln(L^S) = a + b\cdot\ln(\frac{W}{P_\varepsilon}) \quad ,$$

where a and b are constants and P_ε is the household's point expectation of P.

If the labor market, like the product market, always clears, then $L^D = L^S$ and (2) may be substituted into (3) to obtain

$$(4)\ \ln(W) = \frac{\ln(\alpha\cdot\beta)-a\cdot(1-\alpha)}{1+b\cdot(1-\alpha)} \quad (\frac{1}{1+b\cdot(1-\alpha)})\cdot\ln(P) + (\frac{b\cdot(1-\alpha)}{1+b\cdot(1-\alpha)})\ \ln(P_\varepsilon)$$

Substituting (4) into (3), we find (after some algebraic manipulations)

$$(5)\ \ln(L^S) = (\frac{a+b\cdot\ln(a.\beta)}{1+b\cdot(1-\alpha)}) + (\frac{b}{1+b\ (1-\alpha)}).\ [\ln(P) - \ln(P_\varepsilon)]$$

Finally, substituting (5) into the production function, we obtain a Lucas variant (1973) of the expectational Phillips curve:

$$(6)\ \ln(Q^s) = (\frac{\alpha\cdot a + (1+b)\cdot\ln(\beta) + \alpha\cdot b\cdot\ln(\alpha)}{1+b\cdot(1-\alpha)}) + (\frac{\alpha\cdot b}{1+b\cdot(1-\alpha)}).\ [\ln(P) - \ln(P_\varepsilon)]$$

which may be rewritten more simply as

$$(6')\ \ln(Q^S) = A + B\cdot(\ln(P) - \ln(P_\varepsilon)) \ ,$$

where $B > 0$. Equation (6') is our aggregate product supply schedule, embodying the natural rate hypothesis.

The aggregate output transacted in the economy may be simply described in terms of the velocity equation

(7) $\ln(P) = \ln(M) + \ln(v) - \ln(Q)$,

where v, the income velocity of money, may be assumed constant for convenience. Given that the money market clears, M represents both the demand for and the supply of money. If households' expectations are rational, then the logarithm of the anticipated price must be

(8) $\ln(P_\varepsilon) = \ln(M_\varepsilon) + \ln(v_\varepsilon) - \ln(Q^D)$,

where the subscript "ε" denotes an anticipated value. Equation (8) may serve as our aggregate product demand schedule. Since v is a constant, $v_\varepsilon = v$. Inserting the above expressions for ln(P) and $\ln(P_\varepsilon)$ into equation (6'),

(9) $\ln(Q^S) = A + B \cdot [\ln(M) - \ln(Q) - \ln(M_\varepsilon) + \ln(Q^D)]$.

The money supply is composed of a systematic and an unsystematic component. Let the logarithm of the systematic component be a function, h, of a variety of variables (such as production and employment) which will be denoted by the vector $\underline{X}$. Let the logarithm of the unsystematic component, γ, be a random variable which is normally distributed about a mean of zero.

(10) $\ln(M) = h(\underline{X}) + \gamma$

Applying the rational expectations hypothesis, the loarithm of the expected money supply must be

(11) $\ln(M_\varepsilon) = h(\underline{X})$.

Rational expectations also explain why aggregate product demand is equal to the anticipated product supply, Q^S_ε, which is given by

(12) $\ln(Q^S_\varepsilon) = A + B \cdot [\ln(P_\varepsilon) - \ln(P_\varepsilon)] = A$.

Substituting equation (10), (11), and (12) into equation (9),

(13) $\ln(Q^S) = A + B \cdot [\gamma - \ln(Q) + A]$.

Since the product market clears, equation (13) may be written as

(14) $\ln(Q) = A + \left(\frac{B}{1+B}\right) \cdot \gamma.$

Equation (14) shows that output (and therefore also employment) depends on the unsystematic component of the money supply, but not on the systematic component. One prominent reason for this result is that we have assumed the relation between M and P to be linear, which implies that the systematic monetary effect on the price level is separable from the unsystematic monetary effect on the price level. Consequently, the rational expectations hypothesis does not only ensure that the systematic monetary component be perfectly anticipated, but that the effect of this component on the price level be perfectly anticipated as well. Under these circumstances, the systematic monetary component must influence the actual price level in the same way as the expected price level, and therefore (by the natural rate hypothesis) output and employment remain unaffected.

The linear relation between M and P is a characteristic which the model above shares with the various other macro models which have been marshalled in support of the policy-ineffectiveness argument. The validity of the policy-ineffectiveness argument depends on this linearity in a crucial way. For if the relation between M and P were nonlinear, the effects of the systematic and unsystematic monetary components on P would be inseparable. Then the public's imperfect knowledge of the unsystematic component would be reflected in the imperfect predictability of the effect of the systematic component on the money supply. Thus, the perfect foresight which rational expectations provide with regard to the magnitude of the systematic component would not guarantee perfect foresight with regard to the effect of this component on the price level. What this possibility implies for the impact of systematic monetary policy on output and employment is explored in the following two sections.

3. The First Policy-Effectiveness Argument

The arguments for the effectiveness of systematic monetary policy in this and the following section are based on the same macroeconomic model. As noted above, the vital feature of this model -- for the purpose of deriving our policy-effectiveness conclusions -- lies in the nonlinear relation between the money supply and the price level. Thus, although the model is quite standard in macroeconomic theory, it is merely illustrative of a broad class of models which contain such a nonlinear relation. Whereas the precise manner in which systematic monetary policy affects output and employment depends on the particular nonlinearity specified, the general conclusion that systematic monetary policy does have an impact on real economic variables holds for all of these models.

In order to facilitate an easy comparison between the present analysis and that underlying the most popular presentations of the policy-ineffectiveness argument, I have chosen a macroeconomic model which is very similar to that of Sargent and Wallace (1975). In both models, aggregate product supply is a function of the discrepancy between actual and expected product prices, and aggregate product demand is given by the standard Keynesian IS-LM curves.[1] The major difference between the two models is that the Sargent-Wallace model contains log linear product supply and demand functions (the demand function implying a linear relation between the money supply and the price level), whereas my model comprises product supply and demand functions which have not been linearized in this way.

In the latter model, the money supply is assumed (as in Section 2) to be composed of a systematic and an unsystematic component, the latter being a unimodal, symmetrically distributed random variable with a mean of zero and a constant variance.[2] (For convenience, suppose that it is normally distributed.) In accordance with the rational expectations hypothesis, the public expects the value of the unsystematic component to be zero. For the sake of expositional simplicity (but without loss of generality), the money supply function appears as the only stochastic relation in my model. All other relations are deterministic and the public rationally expects them to be what they are.

The aggregate product supply schedule is formulated quite generally as

(15) $Q^S = \emptyset\ (P, P_\varepsilon)$,

where $\emptyset_P = (\partial\emptyset/\partial P) = -(\partial\emptyset/\partial P_\varepsilon) > 0.$[3]

The aggregate product demand schedule is determined from the intersection of the IS and LM curves. The IS curve is given by

(16) $Q^D = C\ (Q^S) + I(r) + G, \quad C' > 0, \ I' < 0,$

where r is the real rate of interest and C, I, and G are consumption, investment, and government product demands, respectively. The LM curve is given by

(17) $\frac{M^D}{P} = L\ (Q^D, r + \rho), \qquad L_Q > 0, \ L_r < 0,$

where ρ is the expected rate of inflation. For simplicity, ρ may be set equal to zero throughout this analysis. Inverting the LM curve,

(17') $r = R\ (Q^D, m^D),$

where $m^D = (M^D/P)$ and the first derivatives are

$$R_Q = -(L_Q/L_r) > 0 \quad \text{and} \quad R_m = (1/L_r) < 0.$$

Substituting (17') into (16),

(18) $Q^D = C(Q^S) + I\ [R(Q^D, m^D)] + G.$

The money supply is

(19) $M = \bar{M} + \gamma,$

where $\bar{M}$ is the systematic component and γ is the unsystematic component. For simplicity, but without loss of generality, $\bar{M}$ is assumed to be a constant. Since the money market clears, equations (18) and (19) may be combined to yield the aggregate product demand schedule:

(20) $Q^D = C(Q^s) + I[R(Q^D, \frac{\overline{M}}{P} + \frac{Y}{P})] + G.$

Since the product market also clears, the excess product supply function, Ψ, may be written as

(21) $\Psi = \emptyset(P,P_\varepsilon) - C[\emptyset(P,P_\varepsilon)] - I[R(\emptyset(P,P_\varepsilon), \frac{\overline{M}}{P} + \frac{Y}{P})] - G = 0.$

This equation describes the relation between the money supply and the price level for given values of P_ε. It is apparent that this relation is nonlinear.

Given the natural rate hypothesis as formulated in the aggregate product supply schedule (15), the systematic monetary effect on production depends on the systematic monetary effect on the actual and expected price levels:

(22) $\frac{dQ^s}{d\overline{M}} = \emptyset_P \cdot [\frac{dP}{d\overline{M}} - \frac{dP_\varepsilon}{d\overline{M}}]$.

This effect on production may be examined with respect to the "short run" and the "long run". The short run coincides with the discrete time period of analysis; it corresponds to a single time period in the rational-expectations models of Lucas (1972, 1975) and Sargent and Wallace (1975). It is the length of time between two manifestations of the unsystematic component of the money supply. The short run is short enough for it to be reasonable to assume that the public's expectation of the money supply is equal to the mathematical expectation of the money supply; in other words, it is short enough for variations in the unsystematic component of the money supply to play no role in the formation of expectations. Yet the short run is long enough for systematic changes in the money supply to be undertaken and production and employment decisions to be made. The long run is a sequence of discrete time periods of analysis. The long run is long enough for the sample mean of the unsystematic component of the money supply to be a "close" approximation of the actual, theoretical mean of this component. Thus, over the long run the "average" effect of systematic monetary policy on production and employment is synonymous with the mathematical expectation of this effect.

The first policy-effectiveness argument is concerned only with the short run. The argument hinges on a demonstration that the systematic monetary effect on the actual price level, $(dP/d\bar{M})$, depends on the value of the unsystematic component of the money supply, γ. Once this has been shown, it follows that there is a distribution of $(dP/d\bar{M})$ corresponding to the distribution of γ. The effect which the public expects a systematic monetary change to have on the price level , $(dP_\varepsilon/d\bar{M})$, is simply a point on the latter distribution. This point corresponds to a particular value of γ. Whenever the actual value of γ differs from this value, $(dP/d\bar{M})$ is not equal to $(dP_\varepsilon/d\bar{M})$ and then systematic monetary policy can affect production and employment.

The systematic monetary effect on the actual price level may be derived from equation (21):

$$(23) \quad \frac{dP}{d\bar{M}} = -\frac{(\partial\psi/\partial\bar{M}) + (\partial\psi/\partial P_\varepsilon)\cdot(\partial P_\varepsilon/\partial\bar{M})}{(\partial\psi/\partial P)}$$

$$= \frac{I'\cdot R_m\cdot(1/P) + \phi_P\cdot(1-C'-I'\cdot R_Q)\cdot(dP_\varepsilon/d\bar{M})}{\phi_P\cdot(1-C'-I'\cdot R_Q) + I'\cdot R_m\cdot(M/P^2)} .$$

The effect of an incremental change in γ on $(dP/d\bar{M})$ follows immediately from this equation. Since variations in γ do not influence the public's point expectation of the product price, they cannot affect $(dP_\varepsilon/d\bar{M})$ or $(d\psi/dP)$. Thus,

$$(24) \quad \frac{d^2P}{d\bar{M}d\gamma} = -\frac{(\partial^2\psi/\partial\bar{M}\partial\gamma)}{(\partial\psi/\partial P)} + \frac{[(\partial\psi/\partial\bar{M}) + (\partial\psi/\partial P_\varepsilon)\cdot(\partial P_\varepsilon/\partial\bar{M})]}{(\partial\psi/\partial P)^2}\cdot\frac{\partial^2\psi}{\partial P\partial\gamma}$$

$$= \frac{I'\cdot R_{mm}\cdot(1/P^2)}{\phi_P\cdot(1-C'-I'\cdot R_Q) + I'\cdot R_m\cdot(M/P^2)}$$

$$- \frac{[I'\cdot R_m\cdot(1/P) + \phi_P\cdot(1-C'-I'\cdot R_Q)\cdot(dP_\varepsilon/d\bar{M})}{[\phi_P\cdot(1-C'-I'\cdot R_Q)+I'\cdot R_m\cdot(M/P^2)]^2}\cdot I'R_{mm}\cdot\frac{M}{P^3}$$

$$- \frac{[I' R_m\cdot(1/P)+\phi_P\cdot(1-C'-I'\cdot R_Q)\cdot(dP_\varepsilon/d\bar{M})]}{[\phi_P\cdot(1-C'-I'\cdot R_Q)+I'\cdot R_m\cdot(M/P^2)]^2}\cdot I'\cdot R_m\cdot\frac{1}{P^2}$$

From this equation it is clear that a marginal increase in γ influences $(dP/d\bar{M})$ via three channels (corresponding to the three term above):

(i) Under the standard assumption that the demand for money is a convex function of the interest rate (i.e. $R_{mm} > 0$), an increase in γ has a dampening effect on $(dP/d\bar{M})$. Due to this convexity, the greater the value of γ, the smaller the decline in the interest rate caused by a given increase in the systematic money supply. Consequently, the smaller is the expansionary effect of an increase in the systematic money supply on aggregate product demand and the smaller the amount by which the actual price level must rise to clear the product market.

(ii) Once the price level rises to clear the product market, the value of (M/P) falls, which brings the money market out of equilibrium. Thus, the interest rate must rise which, in turn, implies that the aggregate product demand and the price level must fall. This is the well-known negative feedback effect in the Keynesian system. The greater the value of γ, the larger is the decline in (M/P) caused by a given increase in P:

$$\frac{d(M/P)}{dP} = -\frac{M + \gamma}{P^2} \quad \text{and} \quad \frac{d^2(M/P)}{dP d\gamma} = -\frac{1}{P^2} .$$

Thus, an increase in γ amplifies the negative feedback effect on aggregate product demand, $I' \cdot R_m \cdot (1/P^2)$, and on the price level and thereby the increase in γ has a dampening effect on $(dP/d\bar{M})$.

(iii) The greater the value of γ, the smaller is the decline in the interest rate caused by the fall in (M/P), which characterizes the negative feedback effect. In this manner, an increase in γ dampens the negative feedback effect on aggregate demand, $I' \cdot R_{mm} \cdot (M/P^3)$, and on the price level and thereby the increase in γ has an amplifying effect on $(dP/d\bar{M})$.

Channels (i) and (ii) imply that a marginal increase in γ lowers the value of $(dP/d\bar{M})$, whereas channel (iii) implies an effect in the opposite direction. These two sets of influences may be of equal magnitude only by accident. For the sake of expositional simplicity, suppose that the former influences outweigh the latter. A sufficient condition for this result may be formulated as follows. R_m is the interest sensitivity to a change in real money balances. Let σ^{R}_{mm} be the elasticity of this interest sensitivity with respect to real money balances:

$$\sigma^{R}_{mm} = \frac{R_{mm}}{R_m} \cdot \frac{M}{P} < 0.$$

If $\sigma^{R}_{mm} > -1$, then the influence of channel (ii) dominates that of channel (iii) and therefore a marginal increase in γ has a dampening effect on $(dP/d\bar{M})$:[4]

$$(24') \quad \frac{d^2P}{d\bar{M}d\gamma} < 0.$$

In accordance with the rational expectations hypothesis, the public knows the distribution of γ as well as the effect which γ has on $(dP/d\bar{M})$. In other words, the public knows the distribution of $(dP/d\bar{M})$ which corresponds to the distribution of γ. The public's point expectation of the systematic monetary effect on the price level is a point on the distribution of $(dP/d\bar{M})$. This point is associated with a particular value of γ, say $\gamma = \hat{\gamma}$.

Whenever the actual (realized) value of γ is equal to $\hat{\gamma}$, then a marginal increment to the systematic component of the money supply has the same effect on the actual price level as on the expected price level. Under these circumstances, $(dP/d\bar{M}) = (dP_{\varepsilon}/d\bar{M})$ and systematic monetary policy can have no influence on production and employment (as indicated by equation (22)). However, if the actual value of γ is greater than $\hat{\gamma}$, then an increase in the systematic component causes the actual price level to rise by less than the expected price level. Under these circumstances, $(dP/d\bar{M}) < (dP_{\varepsilon}/d\bar{M})$ and therefore an increase in the systematic money supply causes production and employment to both contract. Conversely, if the actual value of γ is less than $\hat{\gamma}$, then an increase in the systematic component causes the actual price level to rise by more than the expected price level and hence production and employment both expand.

To recapitulate:

Proposition 1: In the context of the standard model described in this section, let $\hat{\gamma}$ be the value of the unsystematic

monetary component which corresponds to the public's point expectation of the systematic monetary effect on the price level. Assume that $\sigma^R_{mm} \gtrless 1$. Under these conditions, an increase in the systematic component of the money supply
(a) lowers production and employment if $\gamma > \hat{\gamma}$,
(b) stimulates production and employment if $\gamma < \hat{\gamma}$, and
(c) leaves production and employment unaffected if $\gamma = \hat{\gamma}$.

The reason why systematic monetary policy is able to affect production and employment in this manner is that variations in γ elicit variations in the actual systematic monetary effect on the price level, $(dP/d\bar{M})$, but not in the public's point expectation of the systematic monetary effect on the price level, $(dP_\varepsilon/d\bar{M})$. (The point expectation of this effect -- which must be formulated if the effectiveness of monetary policy is to be evaluated by means of the natural rate hypothesis -- does not depend on variations in γ since these variations cannot be foreseen by the public.) If the unsystematic component of the money supply is not equal to $\hat{\gamma}$, then the relation tween the systematic component and the price level is different from the relation which the public expects. Then changes in the systematic component of the money supply can drive a wedge between the actual and expected price levels and therefore affect production and employment.

At this point, it may be useful to provide a simple illustration of the somewhat paradoxical result (a) of Proposition 1. Consider an economy in an initial equilibrium state described by the intersection of the aggregate product supply schedule AS_I, the product market relation IS_I, and the money market relation LM_I (where the subscript "I" stands for the "initial" state) in Figure 1. Now suppose that the systematic component of the money supply rises by $\Delta\bar{M}$ and that the effect of this change on production is to be derived. The public expects the immediate effect of $\Delta\bar{M}$ to be a rightward shift of the LM curve to LM'_ε. Furthermore, the public expects the positions of the IS and AS curves to remain unchanged. (It realizes that the position of the IS curve does not directly depend on non-real variables and that the AS curve depends on the discrepancy between the expected and actual price levels, which is not expected to change.) The preliminary expected rightward shift of the LM curve elicits an expected excess product demand of $Q_I Q'_\varepsilon$. However, the public knows that the product market always clears and consequently it expects the price level to rise sufficiently for the LM curve to return to its original position LM_I.

If $\gamma > \gamma$, then the rise in the systematic component of the money supply causes the actual LM curve to shift rightwards by a smaller amount than the expected LM curve; say, the actual LM curve shifts to LM'. If the consequent rise of the actual price level were equal to the rise of the expected price level, the LM curve would shift leftwards to LM" and the aggregate supply curve would remain unchanged. In that case, there would be excess product supply in the amount $Q''Q_I$. However, since the product market must always clear, it is evident that the actual price level cannot rise by as much as the expected price level. Therefore, the aggregate product supply curve shifts leftwards until the economy attains its final equalibrium state, which is described by the intersection of the IS_I, LM_F, and AS_F curves (where the subscript "F" stands for the "final"state). Through this mechasnism, an increase in the systematic component of of the money supply causes aggregate production to fall from Q_I to Q_F.

To put this analysis into policy perspective, it is appropriate to distinguish between two questions: (a) whether systematic monetary policy can affect real economic variables and (b) whether the monetary authority can use systematic monetary policy to manipulate real economic variables in accordance with its policy goals. The first question is answered in the affirmative by the line of reasoning sketched

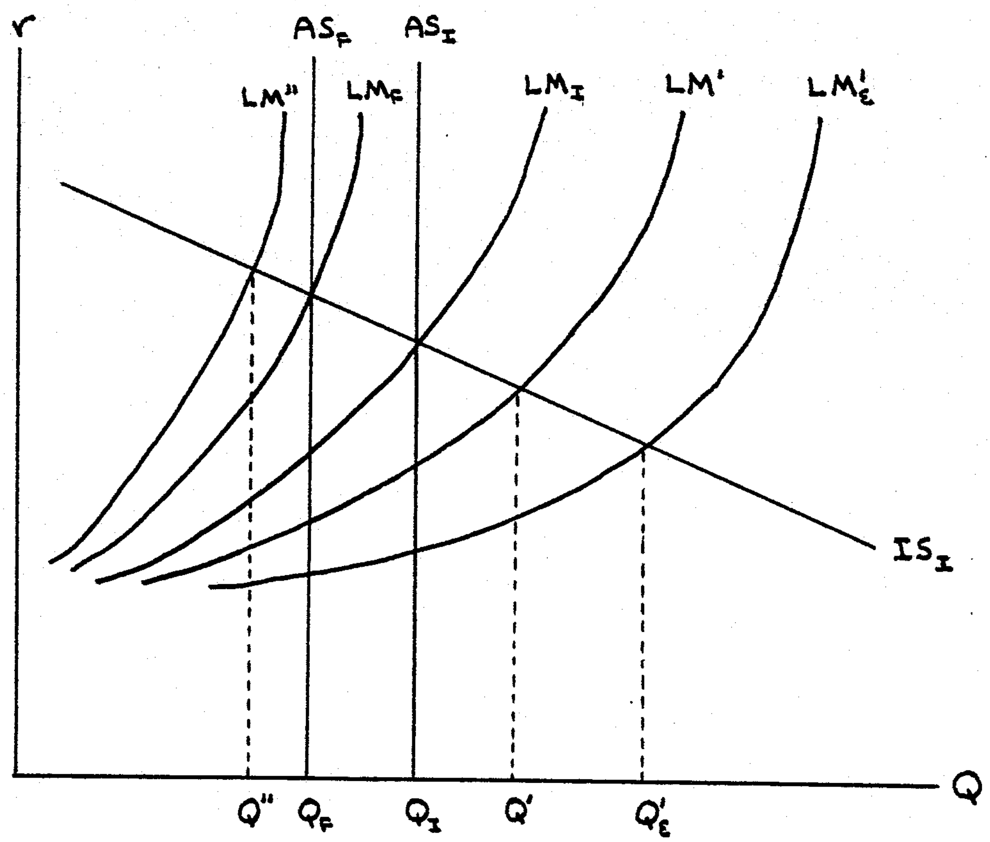


FIGURE 1

above. The answer to the second question depends on whether the monetary authority is better informed than the public about unsystematic variations in the money supply. If these unsystematic variations arise predominantly because the monetary authority cannot control the money supply perfectly (e.g. the Fed's imperfect control over the lending activities of non-member banks), then neither the monetary authority nor the public has a significant, innate advantage in acquiring information about these variations. Under these circumstances, the second question must be answered in the negative. However, if the unsystematic variations are the result of willful policy surprises devised by the monetary authority, we may expect the authority to be better informed than the public about these variations. Then the authority's advance knowledge about the unsystematic component of the money supply permits it to manipulate production and employment through the appropriate adjustment of the systematic component.

4. The Second Policy-Effectiveness Argument

For the model developed in Section 3, the second policy-effectiveness argument is designed to show that (a) if the public is not subject to consistent expectational errors with regard to the effect of the systematic money supply on the price level in the short run, then it must be subject to such errors in the long run and (b) conversely, if the public manages to avoid consistent expectational errors in the long run, then it cannot escape such errors in the short run. Thus, no matter what the public's point expectation of the systematic monetary effect on the price level is, it is inevitable that the public be consistently fooled in the short run or the long run or both. Consequently, systematic monetary policy may be able to affect production and employment in the short run or the long run or both.

By definition, the public is not subject to consistent expectational errors in the short run if its point expectation of the systematic monetary effect on the price level has a higher chance of being correct, at any given point in time, than any other point expectation. The preceeding section showed that there exists a monotonic relation between γ and $(dP/d\bar{M})$. By implication, there is a one-to-one relation between the points on the distribution of γ and the points on the distribution of $(dP/d\bar{M})$. The public's point expectation of the systematic monetary effect on the price level was described as a point on the latter distribution. Since γ takes the value of zero with greater probability than any other value, the associated value of the systematic monetary effect on the price level must also occur with greater probability than any other value. This latter value is the mode of the distribution of $(dP/d\bar{M})$. If the public's point expectation of the systematic monetary effect on the price level is equal to this mode, then the public is not subject to consistent expectational errors in the short run.

By definition, the public is not subject to consistent expectational erreors in the long run if its point expectation of the systematic monetary effect on the price level is equal to the average value of this effect through time. This average value is the mean of the distribution of $(dP/d\bar{M})$.

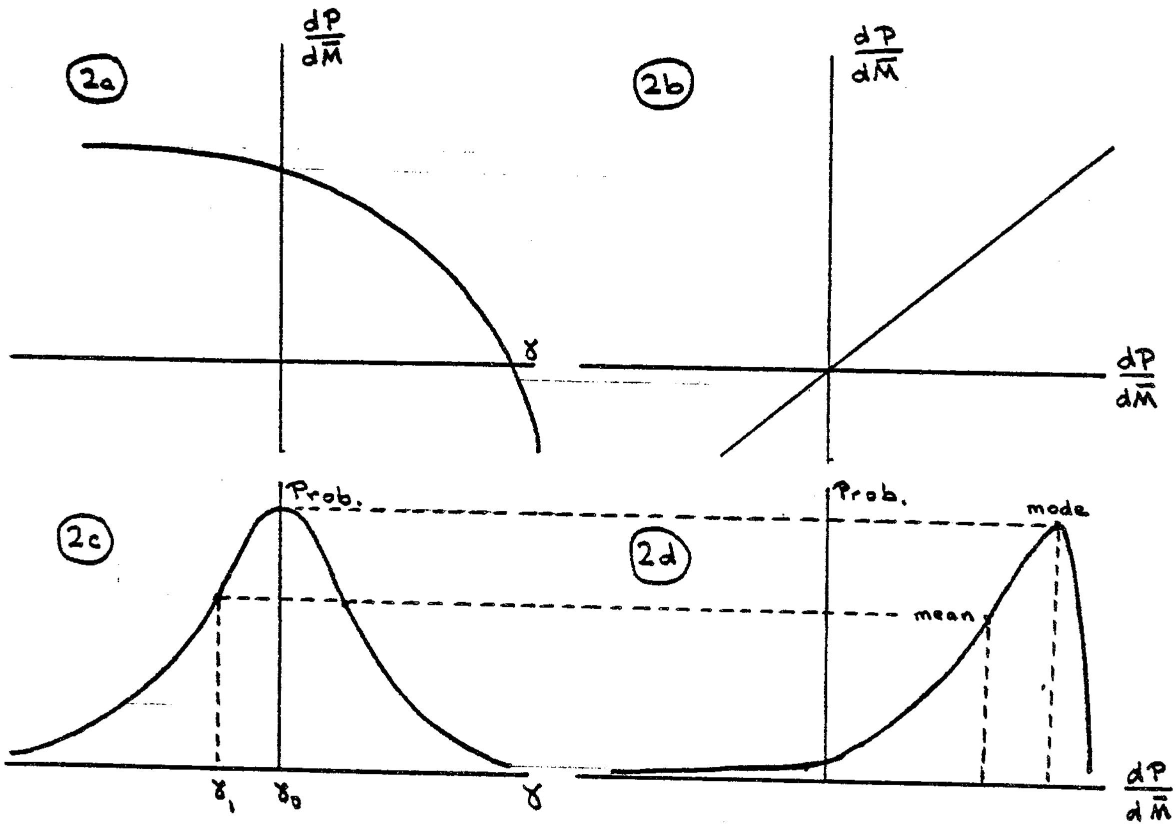
Clearly, it is possible for the public to avoid being consistently fooled in both the short run and the long run only if the mean and the mode of the distribution of $(dP/d\bar{M})$ are identical. However, it will be shown that, for the model outlined in the previous section, the distribution of $(dP/d\bar{M})$ is negatively skewed and thus the mode is greater than the mean.

The crucial step in demonstrating this property of the distribution of $(dP/d\bar{M})$ is to establish that the relation between γ and $(dP/d\bar{M})$ is concave. Differentiating equation (24) with respect to γ,

(25) $$\frac{d^3P}{d\bar{M}d\gamma^2} = -2 \cdot \frac{[(I')^2 \cdot R_{mm} \cdot (1/P^4)}{[\phi_P \cdot (1-C'-I' \cdot R_Q)+I' \cdot R_m \cdot (M/P^2)]^2} \cdot \{ R_{mm} \cdot (\frac{M}{P}) + R_m \}$$
$$+ \frac{[I' \cdot R_m \cdot (1/P)+ \phi_P \cdot (1-C'-I' \cdot R_Q) \cdot g_m}{[\phi_P \cdot (1-C'-I' \cdot R_Q)+ I' \cdot R_m (M/P^2)]^3} \{ I' \cdot R_{mm} \cdot (\frac{M}{P}) + I' \cdot R_m \cdot (\frac{1}{P2}) \}^2$$
$$- 2 \cdot \frac{[I' \cdot R_m \cdot (1/P)+\phi_P \cdot (1-C'-I' \cdot R_Q) \cdot g_m}{\phi_P \cdot (1-C'-I' \cdot R_Q)+I' \cdot R_m \cdot (M/P^2)]^2} \cdot \{I' \cdot R_{mm} \cdot (\frac{1}{P^3}) \}$$
$$< 0.$$

(It is implcitly assumed that R_{mm}=O.)

In section 3 it was shown that there is an inverse relation between the unsystematic component of the money supply (γ) and the systematic monetary effect on the price level ($dP/d\bar{M}$). Equation (25) indicates that the contractionary influence of γ on ($dP/d\bar{M}$) becomes stronger as the value of γ rises. This relation between γ and (dP/dM) is illustrated in Figure 2a. Since we have assumed that γ is normally distributed about a mean of zero (as shown in Figure 2c), it follows that the distribution of ($dP/d\bar{M}$) must be negatively skewed (as shown in Figure 2d).



FIGURES 2

Consequently, the mode exceeds the mean of the distribution of the systematic monetary effect on the price level.

Suppose that the public's point expectation of the systematic monetary effect on the price level is equal to the mode of this distribution. For each instant of time, this point expectation gives the public a bigger chance of correctly guessing the systematic monetary effect on the price level than any other point expectation would have done. In this sense, the public is not subject to consistent expectational errors in the short run.Yet over the long run, this point expectation implies that the public winds up overestimating this effect more than underestimating it. To be more precise, consider two unsystematic components of the money supply which are equal in magnitude but opposite in sign. Let comonent A be positive and component B be negative. If the public's point expectation is equal to the mode of the distribution of $(dP/d\overline{M})$, then the effect of an increase in the systematic money supply on the discrepancy between the actual and expected prices is not the same in absolute value under component A as it is under component B. In particular, for a given increase in the systematic money supply, the amount by which the expected price exceeds the actual price under component A is greater than the amount by which the actual price exceeds the expected price under component B. Since γ is normally distributed about a zero mean, components A and B occur with equal probability. Hence, an average, an increase in the systematic component of the money supply lowers the actual price relative the expected price. In other words, the mathematical expectation of the discrepancy between the actual and expected price caused by an incremental increase in the systematic component of the money supply is negative. In this sense, the public is subject to consistent expectational errors in the long run.

Now suppose that the public's point expectation of the systematic monetary effect on the price level is equal to the mean of the distribution of this effect. In that case, a change in the systematic component of the money supply cannot elicit a discrepancy between the actual and expected price level in the long run. In particular, the mathematical expectation of the discrepancy beween the actual and expected price level caused by a systematic monetary change is zero. Thus, the public makes no consistent expectational errors in the long run. However, for this point expectation of the systematic monetary effect on the price level, it is no longer true that the public's guess has a bigger chance of being correct than any other guess. The negative γ which corresponds to the mean of the $(dP/d\bar{M})$ distribution is associated with a smaller probability than the zero-valued γ which corresponds to the mode of the $(dP/d\bar{M})$ distribution. Thus, the public is consistently fooled in the short run.

Naturally, it is conceivable that the public's point expectation of the systematic monetary effect on the price level be equal to neither the mode nor the mean of the $(dP/d\bar{M})$ distribution. (For example, the public's point expectation may be equal to the median of this distribution.) Under these circumstances, the public is subject to consistent expectational errors in both the short run and the long run.

Thus, no matter how the public sets its point expectation of the systematic monetary effect on the price level, it will be consistently fooled with regard to this effect in the short run or the long run or both. This result does not depend on the validity of Proposition 1. Recall that Proposition 1 presupposes $\sigma^R_{mm} \geq -1$, which ensures that a rise in γ has a contractionary effect on $(dP/d\bar{M})$. However, if $\sigma^R_{mm} < -1$, then it is possible for a rise in γ to have an expansionary effect on $(dP/d\bar{M})$. In that case, the function illustrated in Figure 2a would be upward-sloping rather than downward sloping. Equation (25) indicates that this function is concave, regardless of whether its slope is positive or negative. What makes the distribution of $(dP/d\bar{M})$ negatively skewed is this concavity, not the slope of the function. In other words, the distribution of $(dP/d\bar{M})$ is negatively skewed regardless of whether a rise in γ has a contractionary or an expansionary effect on $(dP/d\bar{M})$. Thus, the inevitability of consistent expectational errors is not contingent on the validity of Proposition 1. In this respect, the first and second policy effectiveness argument are logically independent of one another.

Since the public is unable to avoid systematic expectational errors in the short run or the long run or both, it may be possible for systematic monetary policy to affect production and employment in the short run or the long run or both. To keep the description of this effect as simple as possible, assume for the moment that the aggregate supply schedule is linear in the actual and expected price -- so that, say, a one dollar excess of the actual over the expected price raises output by as much as a one dollar shortfall of the actual under the expected price lowers output. If the public's point expectation of the systematic monetary effect on the price level is equal to the mode of the $(dP/d\bar{M})$ distribution, then there is a sense in which an increase in the systematic money supply has no consistent effect on production and employment in the short run, but has a contractionary effect on production and employment in the long run. There is no consistent short run effect in the following sense. For every instant of time, the most probable value of the unsystematic component of the money supply is zero. If the actual (realized) value of this unsystematic component is zero as well, then an increase in the systematic money supply raises the actual and expected prices by equal amounts and thus cannot influence production and employment. On the other hand, an increase in the systematic money supply may be said to lower production and employment in the long run. This systematic monetary change causes the negative deviations of the actual price from the expected price to exceed, on average, the positive deviations (by equation (25)). These negative deviations, in turn, lower production by more, on average, than the positive deviations expand production (due to the assumption that the aggregate supply schedule is linear in the actual and expected price, i.e. $\phi_{pp} = 0$). Thus, over the long run, an increase in the systematic money supply causes the public to overestimate the price level more than to underestimate it and thus the average levels of production and employment fall.

Similarly, if the public's point expectation of the systematic monetary effect on the price level is equal to the mean of the $(dP/d\bar{M})$ distribution, it may be asserted that an increase in the systematic money supply has an expansionary effect on production and employment in the short run, but has no consistent effect on production and employment in the long run. In this case, the public's point expectation of of the systematic monetary effect on the price level corresponds to a negative value of the unsystematic component of the money supply (viz. γ, in Figure 2c). However, if the actual (realized) value of the unsystematic component is zero -- which is the most probable outcome -- then an increase in the systematic money supply causes the actual price to rise relative to the expected price and thereby causes production and employment to rise as well. It is in this sense that the short run effect of systematic monetary policy is expansionary. On the other hand, the long run effect of systematic monetary policy is nill. The mathematical expectation of the actual price change from a systematic monetary increment is equal to the expected price change from that increment and, whenever $\phi_{pp} = 0$, production and employment remain unaffected on average.

By analogous reasoning, it is evident that if the public's point expectation of an increase in the systematic money supply on the price level is given by a point to the left of the mean on the $(dP/d\bar{M})$ distribution, the public underestimates the price rise in the short run and the long run, and thus an increase in the systematic money supply raises production and employment in both the short and long run. Moreover, if the public's point expectation lies between the mean and the mode on the $(dP/d\bar{M})$ distribution, then it underestimates the price rise in the short run and overestimates the price rise in the long run; and hence, an increase in the systematic money supply raises production and employment in the short run and lowers them in the long run. Finally, if the public's point expectation lies to the right of the mode on the $(dP/d\bar{M})$ distribution, the public overestimaties the price rise in both the short and long run, and thus an increase in the systematic money supply has a contractionary effect on production and employment in both the short and long run.

These results are summarized in Table 1. Note that the signs of the short run results above (i.e. the expansionary

TABLE 1

If the public's point expectation of the systematic monetary effect on the price level is	then an incremental increase in the systematic money supply has a(n)	
	short run	long run
(a) less than the mean	expansionary	expansionary
(b) equal to the mean	expansionary	no
(c) greater than the mean and less than the mode	expansionary	contractionary
(d) equal to the mode	no	contractionary
(e) greater than the mode	contractionary	contractionary
of the (dP/dM) distribution,	effect on production and employment.	

versus the contractionary production effect of an increase in the systematic money supply over the short run) depends on the basic assumption underlying Propositon 1, namely that a rise in γ induces a fall in $(dP/d\bar{M})$. Should the assumption be made that a rise in γ induces a rise in $(dP/d\bar{M})$, then every "expansionary" entry in the "short run" column of Table 1 becomes "contractionary" and vice versa.

Moreover, note that the signs of the long run results above (i.e. the exapnsionary versus contractionary production effect of an increase in the systematic money supply over the long run) depend on the assumption that the aggregate product supply schedule is a linear function of the discrepancy between the actual and expected price (i.e. $\phi_{PP}=0$). By contrast, suppose that the aggregate product supply schedule is a convex function of the discrepancy between the actual and the expected price, i.e. $\phi_{PP}< 0$: the stimulating production effect from a positive deviation of the actual price from the expected price is smaller than the dampening production effect from a negative deviation of equal magnitude. Under these circumstances, an increase in the systematic money supply has no effect on production and employment over the long run long if the public's point expectation of this effect is equal to $(dP_{\varepsilon}/d\bar{M})$, which is <u>less</u> than the mean of the $(dP/d\bar{M})$ distribution. For point expectations above (below) $(dP_{\varepsilon}/d\bar{M})$, the effect of an increase in the systematic money supply on production and employment is contractionary (expansionary). On the other hand, suppose that the aggregate product supply schedule is a concave function of the discrepancy between the actual and the expected price, i.e. $\phi_{PP}>0$. Then an increase in the systematic money supply has no effect on production and employment over the long run only if the public's point expectation of this effect is equal to a $(dP_{\varepsilon}/d\bar{M})$, which is <u>greater</u> than the mean of the $(dP/d\bar{M})$ distribution. Once again, for point expectations above (below) this value of $(dP_{\varepsilon}/d\bar{M})$, an increase in the systematic money supply has an expansionary (contractionary) effect on production and employment.

If ϕ_{PP} is positive and of appropriate magnitude, then it is possible that the long run systematic monetary effect on production and employment is nill when the public's point expectation of the systematic monetary effect on the price level is equal to the mode of the the $(dP/d\bar{M})$ distribution (since the mode is greater than the mean). Recall that the short run systematic monetary effect on production and employment is also nill when the public's point expectation is equal to the mode of the the $(dP/d\bar{M})$ distribution. This is the only set of circumstances in which it is possible for the public to select a point expectation of the systematic monetary effect on the price level such that systematic monetary policy has no influence on real variables over both the short run and the long run. Since a particular value of ϕ_{PP} is required to obtain this result, it appears exceedingly unlikely that monetary policy should have neither short run nor long run influence over production and employment. Clearly, if $\phi_{PP} \leq 0$, this possibility cannot arise at all.

The determinants of ϕ_{PP} may be illustrated by means of the specific aggregate product supply curve derived in Section 2, viz. equation (6'). For this equation,

$$\phi_{PP} = A \cdot B \cdot (B-1) \cdot (P)^{B-2} \cdot (P_{\varepsilon})^{-B}.$$

Since A and B are positive constants, the sign of ϕ_{PP} depends on the sign of (B-1).

$$(B-1) \gtrless 0 \Leftrightarrow \frac{\alpha \cdot \beta}{1+b \cdot (1-\alpha)} \gtrless 1 \Leftrightarrow \alpha \gtrless \frac{1+b}{2 \cdot b} .$$

Recall that α is the elasticity of product supply with respect to L and b is the elasticity of labor supply with respect to the anticipated real wage. If both these elasticities are "small", then $\phi_{PP} \leq 0$; otherwise, $\phi_{PP} > 0$.

The major thrust of the discussion above may be summarized by the following proposition.

Proposition 2: For the standard model described in Section 3, it is inevitable that consistent expectationaly errors arise with regard to the systematic monetary effect on the price level over the short run or the long run or both. If $\phi_{pp} \lessgtr 0$, then a change in the systematic component of the money supply can affect production and emplyment in the short run or the long run or both.

In sum, the rational expectations hypothesis cannot ensure that the public is never consistently fooled in its anticipation of the effect of a change in the systematic money supply on the price level. All that the rational expectations hypothesis can ensure is that the public knows the true distribution of this effect and recognizes all systematic variations in the money supply. This knowledge is not sufficient to avoid consistent expectational errors, given that the public formulates its anticipations of the systematic monetary effect on the price level in terms of a point expectation. Such a formulation is required in order for the effectiveness of monetary policy on real variables to be assessed through the natural rate hypothesis. Since this hypothesis makes aggregate product supply depend on the difference between the actual product price and a point expectation of the product price, the effect of a systematic monetary change on product supply must depend on the difference between the actual effect of a systematic monetary change on the product price and a point expectation of the effect of a systematic monetary change on the product price. As I have shown, the influence of monetary policy on real variables is contingent on how this latter point expectation is chosen. The rational expectations hypothesis provides no guidance for making this choice, aside from implying that the price expectation must, presumably, lie on the $(dP/d\bar{M})$ distribution. Yet regardless of how this choice is made, if $\phi_{pp} \lessgtr 0$, the public is consistently fooled over the short run or the long run or both -- rational expectations notwithstanding.

As in Section 3, it is important to distinguish the question whether systematic monetary policy can affect production and employment from the question whether the monetary authority can use systematic monetary policy to manipulate production and employment in accordance with its policy goals. The first question has been answered affirmatively, apart from the exceptional case discussed above. The answer to the second question depends on (a) whether the monetary authority can accurately evaluate the public's point expectation of the systematic monetary effect on the price level and (b) whether the monetary authority is better informed than the public about variations in the unsystematic component of the money supply. If the public's point expectation remains reasonably stable through time -- in the face of an unchanging economic model and consequently an unchanging $(dP/d\bar{M})$ distribution -- the monetary authority may infer the value of this point expectation by observing the actual effect of variations in the systematic money supply on production and employment. Once this inference has been made, systematic monetary policy can be used to manipulate production and employment over the long run -- unless the public's point expectation is set at precisely the value which implies long-run policy ineffectiveness (e.g. a point expectation equal to the mean of the (dP/dM) distribution when $\phi_{PP} = 0$). Moreoever, if unsystematic variations in the money supply are purposefully engineered by the monetary authority, the authority may be better informed than the public about these variations, and then systematic monetary policy can be used to manipulate production and employment over the short run as well.

5. Concluding Remarks

The first and second policy-effectiveness arguments show that systematic changes in the money supply may affect production and employment even if the rational expectations hypothesis and the natural rate hypothesis hold. The crucial assumption underlying these arguments is that the relation between the aggregate money supply and the product price level is nonlinear. The conventional model developed in Section 3 is merely illustrative of how this assumption can lead to policy-effectiveness conclusions. Such conclusions are derivable from other models containing this assumption, although the magnitude and sign of the monetary effect will vary from one model to another.

If the relation between M and P is nonlinear, then the effect of the systematic component of the money supply on the price level is not separable from the effect of the unsystematic component on the price level. Since the public cannot perfectly foresee the value of the unsystematic component (despite rational expectations), it cannot perfectly foresee the effect of the systematic component on the price level either. Whenever the public is mistaken with regard to this effect, systematic monetary policy can affect production and employment. This, in short, is the message of the first policy-effectiveness argument.

Furthermore, if symmetric variations in the unsystematic component do not elicit symmetric variations in the effect of the systematic component on the price level, then it may be inevitable that the public's anticipation of this effect be mistaken in the long run or the short run or both. To avoid consistent short run mistakes, the public's anticipation must be equal to the mode of the distribution of this effect; whereas to avoid consistent long run mistakes, the public's anticipation must be equal to the mean of this distribution. Yet if the distribution is skewed, then its mean is not equal to its mode, and thus consistent expectational errors become unavoidable. This the message of the second policy-effectiveness argument.

Both policy-effecitiveness arguments hinge on the possibility that the public be "mistaken" in its evaluation of the systematic monetary effect on the price level. Such mistakes can be identified unambiguously since the public formulates its anticipation of this effect in terms of a point expectation. Wherever this point expectation is not equal to the realized value of this effect, the public is manifestly mistaken. As noted above, the reason why the public is assumed to devise a point expectation is to be found in the natural rate hypothesis. The hypothesis asserts that whenever the public's expected price level is equal to the actual price level, unique levels of output and employment (i.e. the "natural" levels) emerge. The hypothesis is commonly extended to imply that whenever the actual price level exceeds the expected price level, output and employment are above their natural levels, and whenever the expected price level exceeds the actual price level, output and employment are below their natural levels. Obviously, it is not meaningful to talk about an expected price being greater than, less than, or equal to the actual price unless the expected price is formulated in terms of a point expectation.

All the major expositions of the natural rate hypothesis incorporate price expectations in this manner. In the "misperceived real wage" paradigm of Friedman (1968), Lucas (1973, 1975) and Sargent (1973), the firms' labor demand depends on the actual real wage (viz. the actual nominal wage divided by the actual price level) whereas households' labor supply depends on the expected real wage (viz. the actual nominal wage divided by the expected price level) and this expectation is a point expectation. If the labor demand curve is downward-sloping and the labor supply curve is upward-sloping, a correct real wage expectation gives rise to a unique level of employment (and also production, provided that labor and output are functionally related). Moreover, if the expected price level adjusts to the actual price level with a lag, an increase in the actual price level (due to an increase in aggregate demand) elicits a rise in employment and production (since the actual real wage falls while the expected real wage rises) and an increase in the actual price level causes a fall in employment and production.

In the "misperceived wage differential" paradigm of Phelps (1970), the firm is assumed to be a wage setter and the rate of change of the money wage depends on the average differential between a firm's wage offer and the wage it expects other firms to offer. Once again, this expectation is a point expectation. If all firms' expectations of the wage differentials are correct, then this differential must be equal to zero and unique levels of production adn employment emerge. Positive differentials are associated with production and employment above their "natural" levels and negative differentials occur when production and employment are below their "natural" levels.

In the "job search" paradigm of Alchian (1970), McCall (1970), Mortensen (1970a, b), Gronau (1971), Parsons (1973), Salop (1973), Lucas and Prescott (1974), and Siven (1974), the worker accepts employment if he receives a wage offer above his "acceptance wage" and continues his job search otherwise. The acceptance wage is chosen so as to equate the marginal costs with the marginal expected benefits of job search. If the actual rate of wage inflation exceeds (falls short of) the expected rate of wage inflation -- a point expectation -- then the worker's marginal expected benefits of job search are unrealistically low (high) and consequently employment and production are above (below) their "natural" levels. These natural levels are attained when the actual and expected rate of wage inflation are equal.[5]

From such paradigms it becomes clear that the natural rate hypothesis -- in its various current theoretical guises -- relies in an essential way on the presumption that economic agents formulate their price anticipations in terms of point expectation. Yet the second policy effectiveness argument shows how the use of these point expectations in evaluating the price effects of systematic monetary policy makes it inevitable that the public be consistently fooled in the short run or long run or both. If the public is to avoid all consistent expectational errors, it must relinquish point expectations and describe its anticipations through probability distributions instead. This would imply a fundamental change in the microeconomic foundations of the paradigms above. For example, in the "misperceived real wage" paradigm, the labor supply schedule could no longer be derived from a deterministic utility-optimization program, but would have to be gleaned from, say, the maximization of a utility function subject to a stochastic budget constraint (in which the product price is a random variable). The utility function would not only depend on consumption and labor, but also represent the household's attitude toward risk. Under these circumstances, it is possible for a household -- operating in the model economy of Sections 3 and 4 -- to anticipate correctly the systematic monetary effect on the price level over the short run and the long run simply by recognizing a negatively skewed distribution of this effect in its optimization program.

It is not clear that the natural rate hypothesis could survive such microeconomic innnovations. Clearly, it would not be meaningful to assert that output and employment attain their unique "natural" levels whenever the actual, ex post price level is equal to the expected price level -- for the actual price level is a scalar, whereas the expected price level would be a distribution. Yet the fate of the natural rate hypothesis in the absence of point expectations lies will beyond the scope of this paper. The purpose of the analysis above is simply to show that if the relation between the money supply and the price level is nonlinear, the conventional formulations of the natural rate hypothesis and the rational expectations hypothesis do not imply that output and employment are unresponsive to systematic monetary policy.

FOOTNOTES

1. These models may be viewed as expansions of the prototype described in Modigliani (1944) and Bailey (1962).

2. It is assumed that changes in the money supply originate through open market operations and leave the magnitude of government expenditures and taxes unaffected.

3. The product supply curve derived in Section 2, equation (6), can be approximated by this supply curve whenever P and P_ε are in the neighborhood of one another. For equation (6'),

$$\frac{\partial \phi}{\partial P} = A \cdot B \cdot (\frac{P}{P_\varepsilon})^B \cdot (\frac{1}{P}).$$

$$\frac{\partial \phi}{\partial P_\varepsilon} = -A \cdot B \cdot (\frac{P}{P_\varepsilon})^B \cdot (\frac{1}{P_\varepsilon}).$$

4. The effects of channels (ii) and (iii) may be rewritten as

$$-\frac{[I' \cdot R_m \cdot (1/P) + \phi_P \cdot (1-C'-I' \cdot R_Q) \cdot (dP_\varepsilon/d\bar{M})}{[\phi_P \cdot (1-C'-I' \cdot R_Q) + I' \cdot R_m \cdot (M/P^2)]^2} \cdot \{ I' \cdot R_m \cdot (\frac{1}{P^2}) \cdot [1 + \sigma_{mm}^R] \} .$$

This expression is negative if $\sigma_{mm}^R > -1$. Furthermore, it is apparent that the first right-hand term of equation (24) is negative. Thus, an increase in γ must lower the value of $(dP/d\bar{M})$.

5. The "misperceived interest rate" paradigm of Lucas (1972), Lucas and Rapping (1970), and Weiss (1972) is frequently mentioned in conjunction with the three paradigms above since it, too, explains the difference between short run and long run Phillips curves in terms of transient misperceptions of real economic variables. Although point expectations play a crucial role in the formulation of this paradigm, it cannot be considered in the present context since it does not support the natural rate

hypothesis. The long run Phillips curve generated by this hypothesis is upward-sloping, not vertical.

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