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"Anticipated Counter-Cyclical Monetary Policy"

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5th draft

Anticipated Counter-Cyclical Monetary Policy

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Section I. Introduction

One of the major developments in macroeconomics in the 1970's was the elaboration of the hypothesis that expectations are formed rationally. Theoretical and empirical work in this area by Lucas [1972], Sargent [1973, 1975, 1976], Wallace, Barro [1976, 1977, 1978] and others has had significant effect in questioning the appropriate role of monetary policy. Indeed, the distinction is often made in this literature between anticipated and unanticipated monetary policy, and it is sometimes argued that only unanticipated policy has effects on real variables such as output, consumption, employment and unemployment. In this view, anticipated monetary policy does not "work", and unanticipated policy "works" only by fooling people and leading to undesirable results; hence countercylcical monetary policy is useless at best, likely harmful, and on a normative level should perhaps be abandoned.

Some papers have suggested that anticipated monetary policy does have real, systematic effects (Lucas [1975], Fischer [1979]) by modelling the demand function for capital goods as depending not only on the expected real rate of return on capital goods, but also (positively) on the expected inflation rate--the "Tobin effect", as Fischer calls it. Anticipated countercyclical monetary policy is feasible in these models just in case steady-state inflation affects real variables.

McCallum [1980] argues that monetary policy is ineffective in such models; while it may affect capacity and actual output, it does not affect deviations of actual from capacity output. However, it might be plausibly argued that society desires to reduce anticipated fluctuations in actual output by generating offsetting capital stock changes through potent, anticipated monetary policy.

In the model developed here, the steady-state inflation rate has no effect on any real variable save real balances. However, if real balances enter the representative individual's utility function and this function is non-separable, ups and downs in money supply growth will affect real variables; this offers the potential for using monetary policy to offset cyclical disturbances to real variables. However, optimum policy does not attempt to stabilize any real variables (or combination), but aims at maintaining (a perhaps changing) optimum quantity of real money, for which an "X%" money supply growth rule is not generally adequate.

Section 2 develops a simple, perfect foresight micro model (similar to Brock [1974, 1975] and Turnovsky and Brock [1980]; see also Sidrauski [1966]) that demonstrates the above. Section 3 argues this corresponds to the macro case of a real balance effect in the consumption function. The investment decision in this model depends only on considerations of capital productivity and the market-determined real rate of interest. Thus, for counter-cyclical monetary policy to work, it is sufficient for real balances to affect aggregate demand, and it is not necessary either for inflation to have steady-state effects on real variables or for the inflation rate to enter the capital stock demand function as a separate argument (as in Lucas and Fischer).[1] Indeed, there seems no reason for inflation to enter as a separate argument in the certainty case; with uncertainty, inflation will enter only indirectly and with a coefficient that varies with changes in the variance-covariance structure of disturbances to the economy. Section 4 offers a summary and conclusions.

Section 2. A Simple Micro Model

This section builds a simple, perfect foresight micro model of a monetary economy, where government's only role is to finance transfer payments through issuing money.[2] Optimum monetary policy sets the marginal utility of real balances, U_m, equal to zero at all times. If the utility function is separable, monetary policy cannot affect any real variable, save real balances; however, fluctuations in say real output (y) require variation in monetary policy to keep $U_m = 0$. If the utility function is non-separable, steady-state monetary policy cannot affect long run values of capital, output, etc.; nevertheless, fluctuations in money supply growth--counter cyclical policy--can cause fluctuations in these variables. However, optimum policy is still to set $U_m = 0$, though economic disturbances require variations in policy to keep $U_m = 0$.

Assume the economy consists of identical representative individuals, each of whose intertemporal welfare function is

$$(1) \qquad \sum_{t=1}^{\infty} [1/(1+\delta)]^t U(c_t, m_t),$$

where the concave instantaneous utility function $U(\cdot)$ is the same in all periods, the discount rate δ is constant, and c_t and m_t are the individual's real consumption and real balances respectively in period t.[3] Each individual produces real output with capital K_t and the production function

$$(2) \qquad y_t = f(K_t); \quad f' > 0, \quad f'' < 0.$$

The other source of personal income is net nominal government transfer payments, TR. The budget constraint in t is

$$P_t c_t + M_t + P_t K_{t+1} - P_t y_t - TR_t - M_{t-1} - P_t K_t \leq 0,$$

where P_t is the price level, M_t nominal balances, and K_{t+1} the stock of (non-depreciating) capital acquired in t and available for production in period t+1. In real terms,

$$(3) \qquad c_t + m_t + (K_{t+1} - K_t) - y_t - \frac{TR_t}{P_t} - m_{t-1}\frac{P_{t-1}}{P_t} \leq 0.$$

The individual maximizes the welfare function (1) subject to the production function (2) and the budget constraint (3), or equivalently

$$(4) \qquad \sum_{t=1}^{\infty}\left[\frac{1}{1+\delta}\right]^t \left\{U(c_t, m_t) - \lambda_t\left[c_t + m_t + (K_{t+1} - K_t) - f(K_t) - \frac{TR_t}{P_t} - m_{t-1}\frac{P_{t-1}}{P_t}\right]\right\},$$

where λ_t is a sequence of Lagrangean multipliers. Necessary conditions for an interior maximum are

$$(5) \qquad U_c - \lambda_t = 0, \quad \lambda_t > 0,$$

$$(6) \qquad U_m - \lambda_t + \lambda_{t+1}\frac{P_t}{P_{t+1}}\;\frac{1}{1+\delta} = 0,$$

$$(7) \qquad f'(K_t) - ((1+\delta)\lambda_{t-1}/\lambda_t - 1) = 0,$$

and the budget constraint (3) as an equality.

With government expenditures zero, goods market equilibrium requires

$$(8) \qquad c_t + (K_{t+1} - K_t) = y_t.$$

If u(t) is the percent rate of growth of the money stock, then TR_t =

$$(9) \qquad M_t - M_{t-1} = u(t)M_{t-1}$$

and dividing through by P_t,

(10) $$m_t - m_{t-1}\frac{P_{t-1}}{P_t} = u(t)m_{t-1}\frac{P_{t-1}}{P_t},$$

or

(11) $$\frac{P_{t-1}}{P_t} = \frac{m_t}{m_{t-1}[1 + u(t)]} .$$

Thus, the marginal condition (6) for real balances becomes

(12) $$U_m - \lambda_t + \lambda_{t+1}\frac{m_{t+1}}{m_t(1+\delta)\ [1 + u(t+1)]} = 0.$$

Equations (2), (5), (12), (7) and (8) are to be solved with initial values for K_0 and M_{-1} for the time paths of c_t, m_t, K_t, λ_t and y_t. Obtaining exact solutions for particular functional forms is not the object here; the purpose is to see how variations in the time path of u affect the paths of c_t, K_t, y_t and m_t.[4]

2.a Interpretation of the Model. From the marginal condition for consumption (5), λ_t equals the marginal utility of consumption in period t. In the condition for capital investment (7), interpret the term $\frac{\lambda_{t-1}}{\lambda_t}(1+\delta) - 1$ as the real rate of interest r, so the marginal physical product of capital is set equal to the real rate of interest.[5] Since λ_t depends on c_t, (7) says that the real rate of interest and the consumption and capital investment decisions interact over time. In steady state, with c and m constant, λ_t

is constant and $f'(K_{-}) = \delta$; thus, δ is the (parametric) long run real rate of interest,[6] the familiar result (Brock [1974], Sidrauski [1966]).

In the marginal condition for real balances (6), using one unit more real balances this period gives the marginal utility U_m, to be balanced against the marginal utility of consumption lost (λ_t) by not consuming an extra unit in this period, adjusted for the $\frac{1}{1+\Delta P/P}$ units that can be consumed next period with discounted marginal utility $\frac{\lambda_{t+1}}{(1+\delta)}$. Interpret the term $(1 + \frac{\Delta P}{P})(1+\delta)$ as $(1+i)$, where i is the nominal rate of interest; thus equilibrium requires $U_{m_t} = U_{c_t} - U_{c_{t+1}} \frac{1}{1+i}$. In steady state, c and m are constant and thus $U_{c_t} = U_{c_{t+1}}$, so

$$U_{m_t} = U_{c_t} \left[1 - \frac{1}{1+i}\right] = U_{c_t} \frac{i}{1+i}$$

and the marginal rate of substitution $(-U_c/U_m)$ is set equal to $-(1+i)/i$.

In the steady state, inflation equals the rate of monetary growth, or $\frac{\Delta P}{P} = u(t)$. The nominal interest rate i is (approximately) $i = r + \Delta P/P = \delta + \Delta P/P$. Goods market equilibrium requires $c_t = y_t$ since there is no government spending or, in the steady state, investment; $y_t = y^*$, where y^* is the level of y consistent with the steady-state discount rate δ. Thus, the representative individual is somewhere on the vertical y^* line in Figure 1. The level of real balances varies inversely with i (and hence $\Delta P/P$ and u(t)), assuming c,m are complements and thus the indifference curves become steeper with movements up the y^* curve. Changes in $\Delta P/P$ (or u(t)) have no effect, then, on the long run values of the real variables c, y, or K. The relevant questions are whether the time path of u(t) affects the paths of these real variables to their steady state, and whether cylical behavior of u(t) can induce cycles in them. This depends on whether U(·) is separable or not.

2.b Utility Function Separable. If U(·) is separable, U_c depends only on c_t, not m_t. Clearly, given K_1, the system (2), (5), (7), and (8) can be solved for c_t, y_t, K_t and λ_t, independent of both m_t and u(t). (Section 2.e shows this is not true if U is non-separable).

From (12), variations in the time path of u(t) must be met by changes in the time path of m_t, since the sequence of λ_t is already given as described above.

In this separable utility case, u can affect only m and not c, and can affect U (and hence $\Sigma[1/(1+\delta)]^t U$) only through m . Thus, welfare is maximized here when u(t) is chosen so that for all t $U_m = 0$ (assuming that $U_m = 0$ for finite m exists). From the real balances marginal condition (6), setting $U_m = 0$ implies

$$\frac{1}{1+\frac{\Delta P}{P}} = \frac{\lambda_{t-1}}{\lambda_t}(1+\delta)$$

With the capital investment condition (7), $U_m = 0$ then requires

$$(1 + \frac{\Delta P}{P}) = \frac{1}{f'(K_{t+1}) + 1} \qquad \text{or} \qquad \frac{\Delta P}{P} = \frac{-f'}{1+f'} \cong - f'.$$

Thus, setting $U_m = 0$ requires deflation on each period (approximately) equal to the marginal physical product of capital, the "optimum quantity of money" result (Friedman [1969]).

2.c Variations in Real Output -- The Separable Utility Case. If (2) is replaced by

$$(13) \qquad y_t = f(K_t) + \theta \cos(t), \qquad \theta > 0,$$

then the system (13), (5), (7) and (8) can still be solved for the equilibrium time paths of c_t, K_t, y_t and λ_t.[7] All fluctuate over time, but are still independent of m_t and u(t); hence, counter-cyclical monetary policy would not affect these real variables, and by (sometimes) setting $U_m \neq 0$, would be inoptimal. $\Sigma\left[\frac{1}{1+\delta}\right]^t U$ is maximized by choosing u(t) to continuously set $U_m = 0$, as before. Since variations in y_t cause c_t to vary over time, and thus λ_t, both the inflation rate $\frac{\Delta P}{P}$ and the rate of monetary growth u(t) must also change over time in response to the disturbance to y to keep m at that constant value m* where $U_m(m^*) = 0$. The time path of u(t) can be found from (12) as a function of λ_{t+1}/λ_t, with $U_m = 0$ and $m = m^*$.

The exact relationship between changes in income and in consumption will depend on the disturbance term to y_t. Thus, if Δc and Δy vary together over the cycle, the optimal $\frac{\Delta M}{M}$ will display counter-cyclical behavior regarding y. With more complicated relations between Δy and Δc, monetary policy may bear complex lead-lag relations to Δy. The variations in $\frac{\Delta M}{M}$ only keep $U_m = 0$, and are not in any way designed to affect fluctuations in c_t or y_t.

2.d Optimum Monetary Policy With a Non-Separable Utility Function. With $U(\cdot)$ non-separable, optimum policy is still to set $U_m = 0$ for all t.

Suppose the government can arbitrarily pick m_t for each individual, and can also choose c_t subject to $c_t + (K_{t+1} - K_t) - y_t = 0$. Then, the government's problem is to maximize

$$\sum_{t=1}^{\infty}\left[\frac{1}{1+\delta}\right]^t U[f(K_t) - (K_{t+1} - K_t), m_t].$$

Necessary conditions for an interior maximum are

$$(14) \qquad U_c[f(K_t) - (K_{t+1} - K_t), m_t] \cdot (f' + 1)$$

$$- U_c[f(K_{t-1}) - (K_t - K_{t-1}), m_{t-1}](1+\delta) = 0,$$

$$(15) \qquad U_m = 0.$$

(14) is equivalent to (2), (5), (7) and (8). Thus, the optimum consumption condition (14) is met by the private economy. The optimum monetary condition (15) will be met by the private economy <u>if</u> the government picks u(t) to set $U_m = 0$ for all <u>t</u>. In a more complex model such as Turnovsky and Brock [1980], monetary policy has a role beyond setting $U_m = 0$, for example financing part of government expenditures; nevertheless, it remains true that stabilizing fluctuations due to (13) are not part of optimum monetary policy.

<u>2.e Non-Separable Utility</u>. Suppose $\frac{\partial^2 U}{\partial c \partial m} \neq 0$ in general. The system corresponding to (2), (5), (7) and (8) now has U_c dependent on m_t. The time paths of c_t, y_t, K_t and λ_t are no longer independent of m_t and u(t). However, a once-and-for-all decrease in u(t) and hence $\Delta P/P$ would have no effect on steady-state values of real variables, but would raise <u>m</u> as shown, for example, by the move in Figure 1 from IC_1 to IC_2 along the y* curve.

Nevertheless, a pattern of cyclical changes in u(t) would have real effects beyond $\underline{m}$[8] and could in principle be used to stabilize $\underline{c}$, $\underline{y}$ or K (or some function of them) under, say, the cyclical disturbance in (13). To see this, suppose first that fluctuations in u(t) have no effect on $\underline{m}$, λ, $\underline{c}$, $\underline{y}$, or K. Then, clearly the marginal condition for real balances (12) would be violated, so this supposition must be wrong. Next, suppose that cyclical variations in u(t) affect $\underline{m}$ and λ, but not $\underline{c}$, $\underline{y}$ or K; for convenience, start with the steady state at the $IC_1 - y^*$ intersection. To keep K constant, from the capital stock condition (7), the ratio λ_t/λ_{t-1} does not vary. But from the consumption marginal condition (5), with $\underline{c}$ constant U_c will vary systematically with $\underline{m}$ and hence $\lambda_t/\lambda_{t+1} = U_{c_t}/U_{c_{t+1}}$ must be varying, thus proving a contradiction and showing $\underline{c}$, $\underline{y}$ and K cannot be independent of u(t) in this non-separable case.

Thus, monetary policy can be used to offset cyclical real disturbances. Optimum monetary policy is not, however, used in this way.

To summarize the results of this section: In the model discussed, monetary policy has short-run real effects (on $\underline{c}$, $\underline{y}$, K) if and only if the utility function is non-separable.[9] In <u>all</u> cases, optimum policy is to choose the time path of the money supply to set the marginal utility of real balances equal to zero, and not to try to affect $\underline{c}$, $\underline{y}$, etc., beyond this.

Section 3. When Does (Anticipated) Money Matter?

The above model shows that if the utility function is non-separable, counter-cyclical monetary policy has systematic effects on real income, consumption and the capital stock. There is no real balance effect in the separable case, but there is in the non-separable case.[10] It is the existence of the real balance effect on consumption, then, that allows counter-cyclical monetary policy to have real effects (beyond m).

The role of the real balance effect is somewhat hard to follow in recent literature. Sargent [1973] and Sargent and Wallace [1975] obtain some of their most powerful results about the impotence of anticipated counter-cyclical policy by assuming there is no real balance effect. McCallum [1980] acknowledges that monetary policy has real effects if steady state changes in inflation cause steady state changes in real balances that affect aggregate demand and hence affect other real variables; call this a long-run real balance effect. In contrast, the above model found steady state inflation or real balances had no effect on the long run level of real variables, or there was no long-run real balance effect. However, there was a short-run real balance effect due to inflation-induced fluctuations in m that caused cycles in c, y and K around their unaltered steady state values. The models of Lucas [1975] and Fischer [1979] have no real balance effects, but simply assume inflation enters the capital stock demand function as a separate argument. Thus, in these models cyclical fluctuations in inflation have real effects just in case long run inflation has steady state effects. However, this approach is not necessary for cyclical monetary policy to have real effects; further, inflation as a separate argument in the capital stock demand function is seemingly invalid under certainty, and under uncertainty the coefficient on the inflation rate is itself a function of the covariance structure of shocks to the model and varies with changes in this structure. This section develops these points.

3.a The Importance of the Real Balance Effect. Sargent [1973] demonstrated that anticipated monetary policy has no effects on real output if (a) output is produced with a Lucas supply function, and (b) expectations are formed rationally. The Lucas supply function has deviations of output from its trend natural rate depend only on forecast errors regarding the price level, or

$$(16) \qquad y_t = y_n + g(p_t - p_t^*),$$

where y_t is output in t, y_n in its given trend natural rate, p_t^* is the natural log of the price level expected for period t as of the end of t-1, p_t the log of the actual price level, and g a constant > 0. If expectations are formed rationally, p_t^* is the mathematical expectation of p_t, conditional on all information available to the public at its time of formation, or $p_t^* = E_{t-1}p_t$, where E_{t-1} is the mathematical expectations operator and the expectation is taken as of time t-1. Since all available information is by hypothesis used in the forecast, the forecast error $(p_t - p_t^*)$ must be a purely random variable that can't be forecast. To the extent that anticipated policy affects p_t, this will be foreseen and affect p_t^*, and hence will not affect $(p_t - p_t^*)$ and, from (16), will not affect y_t (or $y - y_n$, or unemployment).

Thus, Sargent [1973] argued he could test for real effects of anticipated monetary policy by looking at the relationship between the systematic (anticipated) part of money stock growth and y.

He also shows that anticipated policy will not affect the expected real rate of interest if (a) and (b) hold and additionally, (c) there is no real balance effect in the aggregate demand function. Thus, if he maintained (c), he could use tests for no real effects of anticipated monetary policy on _y_ to infer whether there was a relationship between the systematic part of money stock growth and _r_.

However, at this point a slip occurs. Sargent says his results follow in much more general models than the one he uses. For example, he replaces the Lucas supply function in (a) with one where (a') current output depends on a distributed lag on past values of the expected real rate of interest, as found in many neo-classical models where the desired capital stock depends on the expected real rate of interest (as in Section 2 above). (a') and (b) do not give the same results as (a) and (b), i.e., that anticipated monetary policy is impotent for _y_. For anticipated policy to have no effects, (a'), (b) and also (c) are required. Thus, the subsidiary hypothesis (c) becomes a major assumption once the Lucas supply function is abandoned.

To see the results of including a real balance effect in the consumption function, let inflation rise and fall in a cyclical pattern. The initial rise in inflation drives up the nominal interest rate _i_ and if there is any interest sensitivity of money demand, real balances fall. This in turn reduces consumption and thus aggregate demand. To make aggregate demand again equal real output, the expected real rate of interest must fall (_i_ rises less than $\Delta P/P$) to cause investment demand to rise. In the next period, then, the capital stock is larger than otherwise and hence so is potential real output. Note that this chain in no way required that the capital stock demand function (or the investment function) depend directly on the rate of inflation itself. Rather, since monetary policy can always affect inflation, the result required that, first, inflation affects real balances and, second, real balances affect aggregate demand. Note also that counter-cyclical monetary policy here requires only a short-run real balance effect, with no presumption that a change in the steady-state inflation rate necessarily affects real variables in the long run.

In the comments on Sargent's [1973] piece, Tobin [1973] argued that Sargent's results were very restricted since a higher steady-state inflation rate would reduce the return on real balances and lead to a larger (per capita) capital stock. The mechanism for such an effect was spelled out in Tobin's [1965] full employment growth model. In the present model, however, an increase in the steady-state rate of inflation reduces real balances, but has no effect on long-run $\underline{y}$ or K. Thus, there is no necessary relationship between the efficacy of counter-cyclical monetary policy and steady-state influence of inflation on the capital stock and other real variables. In other words, it is quite possible that counter-cyclical monetary policy has real effects, while long run monetary policy is impotent.

McCallum [1980, section 6] argues that anticipated monetary policy is irrelevant in models where its real effects are on "the level of productive capacity or full-employment output." He gives the (incorrect) impression [p. 726] that such non-neutralities occur because of a long run real balance effect in the IS curve (he cites Fischer [1979] where the non-neutrality arises from including the inflation rate as a separate variable in the capital stock demand function). McCallum argues that anticipated policy then affects both actual and capacity $\underline{y}$, but not the difference of the two. Hence such policy is "ineffective," and any deterministic policy rule is as good as another, and hence an "X%" rule is (weakly) optimal. However, first, it is not apparent that flucatuations in actual y as in (13) should be ignored by policy-makers who can in principle mitigate them; rather, this must be shown, as was done above. Second, it was also shown that optimal anticipated policy cannot be arbitrarily selected, and "X%" money supply growth can only be optimal in a steady state (where $-x \cong \delta$).

3.b Inflation as a Separate Argument in Asset Demand Functions. Lucas [1975] develops a business cycle model where the stock demand for capital depends positively on both the expected real rate of return of capital and the expected inflation rate. Lucas shows that anticipated monetary policy does have real effects in this case, both in the short and long run. Lucas (n. 7, p. 1119) argues

> "this non-neutrality of inflation did not appear in Lucas (1972) or Sargent (1973), since both papers excluded capital information. This led Tobin (1973), and perhaps others, to wonder how *monetary distortions present in models with certainty and perfect foresight* can disappear when uncertainty is introduced. The point of Lucas (1972) and Sargent (1973b) is not that the introduction of uncertainty removes long-familiar neo-classical non-neutralities but, rather, that it does not in itself introduce new ones." (Italics added.)

Earlier in this paper (p. 1117), he had decided to "neglect [the] 'real balance effect' [in the asset demand functions] in order to focus on the effects of monetary changes on the [expected real rate of return on capital and the inflation rate]." The reader may then be left with the impression that anticipated monetary policy has real effects just because inflation enters the capital stock demand functions as a separate argument; that the Lucas [1972] and Sargent [1973] results differed from Tobin's [1965] results that the inflation rate mattered because the Lucas and Sargent pieces did not include capital accumulation; that when such accumulation is included "in models with certainty and perfect foresight," inflation separately does enter the capital demand function and produce "long-familiar neoclassical non-neutralities"; that the real balance effect plays no essential role; and that the possibility of counter-cyclical monetary policy depends on the fact of a steady-state influence of inflation on real variables.

Such impressions, however, are somewhat misleading and conflict with Section 2's model. First, as shown earlier in this section, Sargent [1973] did consider capital accumulation and failed to find a real effect of anticipated monetary policy precisely because the real balance effect was excluded from aggregate demand. (This also happened in Sargent and Wallace [1975] where there is capital accumulation.)

Second, it is true that including the inflation rate as a separate argument in the capital stock (and hence the aggregate) demand function will allow anticipated monetary policy to have both short- and long-run real effects, as Lucas [1975] and Fischer [1979] argue. It is not true that introducing capital accumulation necessarily means the introduction of such an argument, and it is certainly not true that it is required (or made more likely) if the model is one "with certainty and perfect foresight". Indeed, the model of Section 2 has certainty and perfect foresight, but the inflation rate does not enter the capital stock demand function. Instead, this demand depends only on a single discount factor (the equivalent of the real rate of return on bonds)[11] to which the marginal physical product of capital is equated; inflation "works" counter-cyclically by affecting real balances and these in turn cause a change in the equilibrium value of this discount rate <u>if</u> there is a real balance effect in the goods market .

Lucas and Sargent [1978] appear to neglect Lucas's [1975] paper when they write that the new classical business cycle theory

> "predicts that there is no way that the monetary authority can follow a systematic activist policy and achieve a rate of output that is on average higher over the business cycle than would occur if it simply adopted a no-feedback, x-percent rule of the kind Friedman...and Simon...recommended. For the theory predicts that aggregate output is a function of current and past *unexpected* changes in the money supply. Output will be high *only* when the money supply is and has been higher *than* it had been expected to be, that is, higher than average." (Italics added.)

This discussion is not correct in the models of Tobin [1965], Fischer [1979], or Lucas [1975] himself, where inflation affects the long run equilibrium capital stock, or in the model developed above where the long run capital stock is independent of the inflation rate.

It is possible some micro models, with certainty and perfect foresight, reasonably have inflation as a separate argument in the capital stock demand function, and the real balance effect irrelevant. Section 2's model does not.[12] Indeed, the best current rationale for including the inflation rate depends on uncertainty.

3.c Choice of Discount Rate. One strand of modern finance theory emphasizes choice amongst assets as depending on their expected rates of return and on the covariance structure of these rates. Out of this analysis comes a discount rate that the individual firm can use to evaluate risky projects on a net present value basis. This discount rate equals the "risk-free" real rate of return plus a risk factor that depends on an array of covariances weighted by the share of various assets in total real wealth.

Real balances are a part of this real wealth and will tend to fall with an increase in the inflation rate. Looked at this way, it is possible to think of the discount rate as functionally dependent on the inflation rate, but it is then also necessary to realize that this dependence will change with changes in the covariance structure of yields.

This line of argument suggests the following. First, there is no reason for the inflation rate to affect directly the real discount rate used in the investment decision <u>if</u> there is perfect foresight and certainty. Thus, the parts of the Fischer [1979] and Lucas [1975] discussions that make use of certainty and perfect foresight seem to have no rationale for including the expected inflation rate in the capital stock demand function. Second, when uncertainty is introduced, the coefficients on expected yields change when the structure and magnitudes of shocks change. Thus, altering the covariance structure of shocks while holding constant the coefficient on the inflation rates is not really legitimate, as can be seen from the consideration that as the variances of all disturbances approach zero, the coefficient on the inflation rate in the capital stock demand function must also go to zero. (This example also serves to show that while it is possible that there are cases where it is harmless to ignore the dependence of the coefficient of the inflation rate on the covariance structure of shocks, there are cases where recognizing the dependence is crucial.)[13]

Section 4. Summary and Conclusions.

If there is a real balance effect on aggregate demand, anticipated countercyclical monetary policy will affect real output, consumption, investment, etc., in the model developed here. For this effect, variations in steady-state inflation need not affect real variables, and the inflation rate need not enter the capital goods demand function as a separate variable, as in Lucas [1975], Fischer [1979]. Indeed, under conditions of certainty and perfect foresight, inclusion of the inflation rate appears to be illegitimate; while the inflation rate might be included in stochastic models, its coefficient would depend on the covariance structure of shocks, and hence it would be illegitimate to hold constant the coefficient while altering the covariance structure.

In the model developed above, optimum monetary policy sets a deflation rate (approximately) equal to the evolving marginal physical product of capital. If there are cycles in consumption and output, optimum monetary policy could well appear counter-cyclical. However, while optimum monetary policy is necessarily active (save in steady state), it is aimed only at choosing a money stock growth rate that keeps the marginal utility of real balances equal to zero at all times.

It is logically possible to maintain the position that anticipated monetary policy doesn't matter, by adopting the testable hypothesis that there is no real balance effect on aggregate demand. However, it seems very likely that the relevant question is not if anticipated monetary policy matters, but when and for what goals it should be used.[14]

In a less restrictive model than developed here, monetary stabilization policy may be called for on normative grounds. This could not be dismissed on ground that the real balance effect may be small or bounded; because a policy cannot do everything is no reason for having it do nothing. However, it appears that the case for stabilization policy will have to depend crucially on characteristics of worlds where either the vector of prices is costly to adjust (Fischer [1977], Phelps and Taylor [1977]), actors make choices on the basis of costly, incomplete (and possibly differential) information (Howitt [1981], Weiss [1980]), or do not make decisions within the economic paradigm of rationality.

FOOTNOTES

[1]The discussion neglects the possibility that inflation can affect labor supply and thus other real variables, as in Brock [1974], Turnovsky and Brock [1980]. See footnote 12.

[2]No main point is altered by including government spending and taxation; these are excluded for convenience.

[3]The assumption of a representative individual makes the analysis more tractable; no major point depends on it. Approaching the problem by including real balances in the utility function is a less satisfactory simplifying assumption but one frequently used (Brock [1975], Sidrauski [1966]). Further, it is possible that a set of conditions might be developed that would allow analysis of money based on behavior "as if" maximizing a function with $\underline{m}$ included; see Brock [1974, 1975].

[4]Existence, uniqueness and convergence to steady state equilibrium are not investigated, but assumed. For excellent discussions of these issues when $U(\cdot)$ is separable, see Brock [1974, 1975].

[5]Risk free bonds could be introduced and the equilibrium real rate of return on them would be $(1+\delta)\lambda_{t-1}/\lambda_{t-1}$; it is only for convenience that $\underline{r}$ is left implicit in this fashion.

[6]δ could be made to depend on, say, the long run value of $\underline{c}$, without changing any substantive point. Optimality in the present model depends on accepting the position that peoples' time preferences are not systematically sub-optimal, such as displaying myopia. Further, it is assumed that current generations take due regard for future generations' welfare.

[7]Existence, uniqueness and convergence to a steady state is assumed, not proven. The point is, any solution will be independent of the sequences m_t and $u(t)$.

[8] The marginal rate of substitution between consumption in t and t+1 is $MRS = -\frac{U_{c_t}}{U_{c_{t+1}}}(1+\delta)$. In steady state, $c_t = c_{t+1}$ and $m_t = m_{t+1}$, so necessarily $MRS = -(1+\delta)$ _whatever_ _m_ (or _c_). In other words, the steady state indifference map between c_t and c_{t+1} is homothetic to the origin and along the 45° line, the slope of indifference curves is $-(1+\delta)$. Variations in m_t/m_{t+1} cause shifts in the indifference map _if_ $U(\cdot)$ is non-separable and thus there are necessarily short run effects on real variables.

[9] The key question of separability has been raised before, though its role in the discussion of feasibility of anticipated counter-cyclical monetary policy has not been made explicit as here. Brock [1974, p. 770] notes

> ". . . the capital holding decision is separate from the holding of real balances decision. This is an artifact of the [separable] form of the utility function. The decision to accumulate capital is made by marginal considerations. But money does not enter into marginal utility of real consumption or marginal product of labor and capital. Therefore, in this model it [money] has no effect on capital accumulation. We hasten to add that this result will break down if [$\partial U/\partial c$] depends on m."

[10] Some confusion may arise from the fact there are (at least) two meanings of "real balance effect" currently in use. The first is an individual experiment and asks if consumption demand will rise with an increase in M if there are no other changes; even in the separable case, the answer is, yes. The second is a market experiment and asks whether an increase in the actual, market-determined value _m_ causes a change in _c_. For example, a cyclical rise and fall in u(t) will cause variations in _m_ and _c_ in the non-separable case, but _c_ is unaffected in the separable case, Thus, one can hope to detect econometrically a real balance effect in the non-separable case, but not in the separable case; however, the real balance effect, as a wealth effect that helps determine an equilibrium price level, exists in both cases.

[11] See footnote 5.

[12] In considering a perfect foresight model, Brock [1974] briefly considers the (possibly non-separable) case where $U = U(c,m,L)$, where L is labor with positive disutility, or $U_L < 0$. He derives an inter-temporal marginal condition

$$\frac{\partial f}{\partial L} = -\frac{U_L}{U_c}$$

12 (continued)

where output explicitly depends on variable L as well as K. He argues [1974, p. 774] that this condition ". . . destroys the long run neutrality of money. If money affects the marginal utility of leisure, then the labor supply curve changes when [the steady state inflation rate] changes." See also Turnofsky and Brock [1980].

If planned L does change, very likely planned c also changes, and this latter could be viewed as a real balance effect in the goods market. Regardless of this point, note that the sequence is that $\Delta P/P$ affects m, m affects planned and actual L, L affects the real wage rate and thus affects K. There is no separate role for $\Delta P/P$ aside from its affect on m.

It might be noted in connection with the above marginal condition that even with U non-separable, there is no presumption that a decrease in m would alter U_L/U_c for given values of L and c, or if the ratio changed, in which direction.

Turnovsky and Brock [1980] argue that when labor decisions are explicitly considered, Friedman's optimum deflation rate result does not hold if m affects the MRS between consumption and labor and there is a non-zero income-tax rate.

[13] Lucas [1975], Fischer [1979] and others find an increase in K and y with a rise in steady-state inflation essentially because they assume an increase in inflation raises the demand for capital. In the present model, the inflation rate has no effect on steady-state K. This is because the long-run real rate of interest is equal to the parametric δ, and K adjusts to set $f'(K) = \delta$. Suppose, however, the introduction of risk leads to a discount rate $\delta + rf$, where rf is a risk factor. Sweeney [1980] argues in effect that $\frac{\partial rf}{\partial \Delta P/P} > 0$, so $\frac{dK}{\partial \Delta P/P} < 0$; an increase in inflation reduces m and hence reduces the diversification possibilities of investors in capital goods, thus increasing the discount factor used in the investment decision and reducing K.

[14] Lack of a real balance effect says people will make do in their transactions with any level of real balances. Alternatively, a fall in real balances may be made up by extra transactions costs, affecting the leisure-labor decision (see fn. 12 above), but not the consumption decision; this is a real balance effect that may cause variations in y, though not through the consumption function.

However, many people seem to deny that any such real balance effects are "large." This, however, can mean that within the range of historical experience they have never been large, and/or are not worth including in econometric models. Still, as long as (1) monetary policy affects inflation, (2) inflation affects real balances, and (3) these affect the (expected) real rate of interest and thus capital accumulation, then anticipated counter-cyclical monetary policy can have large effects simply by varying widely.

14 (continued)

This does not mean that monetary policy can achieve just any arbitrarily specified result. For example, with fluctuation production in (15) and with a very general but non-separable utility function, monetary policy can keep $y = \bar{y}$, its average value, at all times for some range of θ; the size of this range depends on the forms of $U(\cdot)$ and $f(\cdot)$. Within the feasible range of stabilization, there still remains the question of what stabilization policies to pursue. To say the range is not infinite is not to show that policy within the range can be ignored; indeed, if stabilizing *y* is desirable it will generally be desirable to do it to the extent possible even if it is not *fully* possible.

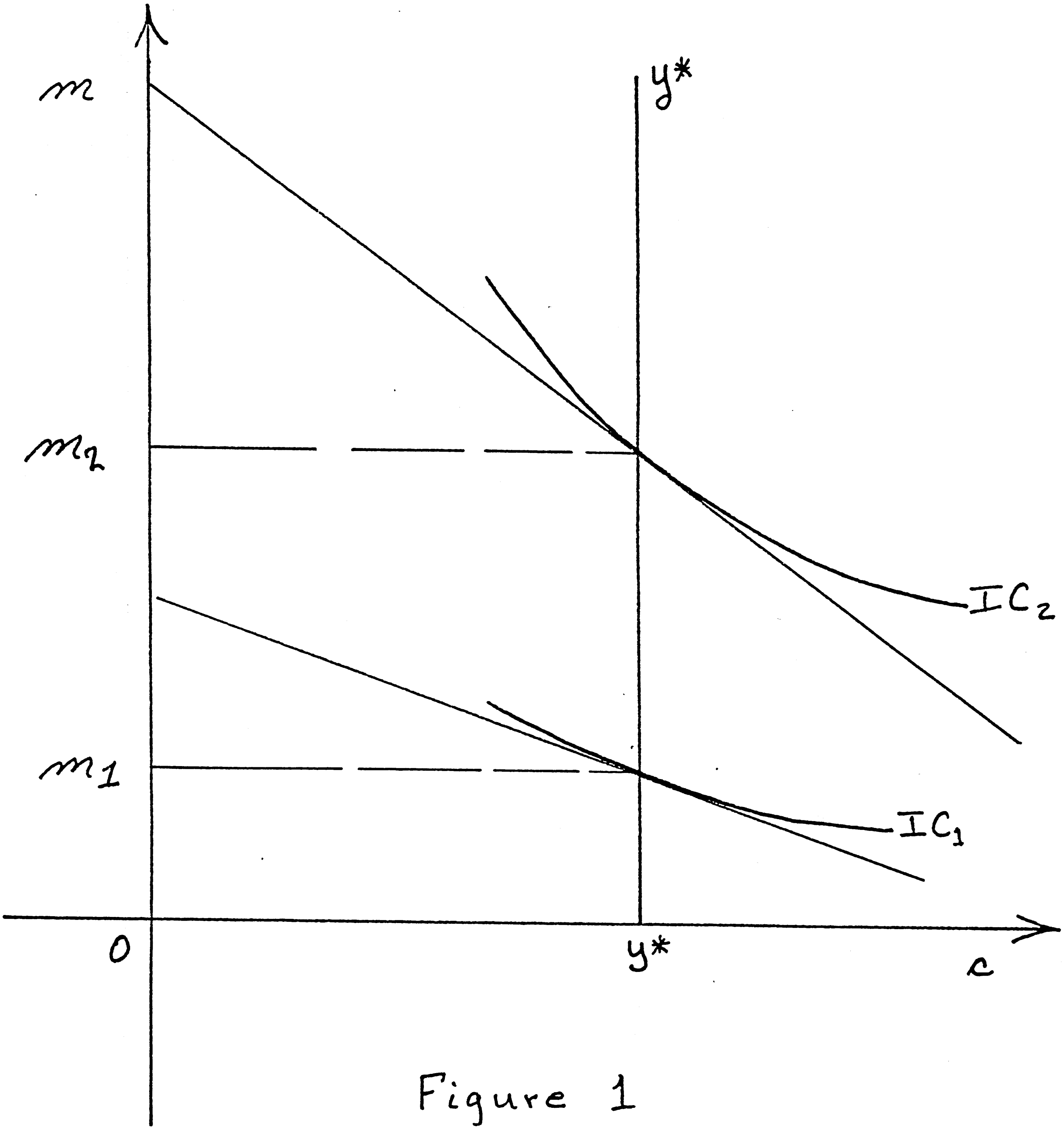

Figure 1