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On macroeconomics: comparative statics

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Abstract

In this chapter the authors formulate a meta-model of a national economy, whose variety of solutions can yield classical, Keynesian or monetarist outcomes. Variety is achieved by adding, to the conventional set of macro-economic relationships, a stockmarket, in which aggregate investment is financed; a labour market, in which trade unions and firms negotiate over wages; and a government, whose discretionary expenditures respond to changes in GNP and unemployment.

After formulation, the model is reduced to six non-linear equations, with fourteen parameters, for which solutions are assumed to exist. The system is then linearized around the solution points, in the form of total differentials of the variables; the total differentials are then expressed with respect to each other and to the policy parameters.

These expressions can conveniently be summarized in terms of the reaction of the price level to a change in the government's deficit, and in terms of three marginal response ratios (relating, on the one hand, real activity, to, on the other hand, either the stock of money, or the price level, or the interest rate). Depending on the values that the reaction coefficient and the three response ratios take, a classical, Keynesian, or monetarist outcome emerges.

Knowledge of these four phenomena is so limited, the authors argue, that research into their values in different economies is necessary, if any estimates of the likelihood of different outcomes are to be made.

1. Introduction

A cursory inspection of the historical development of macroeconomic theory might uncharitably conclude that the only progress was in the complication of the models. Indeed, the development of the subject could be thought of as an exercise in increasing the number of

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equations. The classical quantity theory of money concerned a single equation, $MV = PT$, i.e.

$$M/P = T/V,$$

where M is the quantity of money oustanding in the economy, V is the velocity of circulation of money, P is the general price level, and T is a variable standing for transactions taking place with this money supply. The classical theory held that the velocity of money was approximately constant and that the transactions in the economy were a function of the gross national product Y. Hence for a given level of real activity represented by Y, the price level and the money supply would move together. The theory held that the competitive behaviour of the banking system would act so as to keep the price level constant at a level of real activity consistent with full employment. Lord Keynes, in his famous *General Theory*, showed the theoretical fallacy in this argument in a world where its practical irrelevance was obvious. Central to the classical argument was the assumption that sufficient demand for money could always be generated by a low enough interest charge by the banking system. Keynes detailed the process whereby the demand for investment funds from the banking system in a situation of high uncertainty and low confidence would be insufficient to generate full employment—the famous 'liquidity trap'. The only institution able to generate this deficient demand would be the central government, whose expenditure could regulate real activity through the division of product between consumption and private and public investment.

In the hands of Hicks and Hansen this became the famous two-equation model of elementary macroeconomic textbooks. Since its inception in the late 1930s and widespread acceptance in the early 1950s, the equilibrium behaviour of the model enshrined in the *IS–LM* curve and the liquidity trap has been taught to countless undergraduates.

The textbook version of Keynesian theory concerns the two equations

$$\begin{aligned} Y &= C(Y) + I(r, Y) \\ M/P &= L(r, Y) = T(Y) + l(r). \end{aligned}$$

Here Keynes introduced the interest rate r in the equation determining real money balances. The right hand side of this equation is thought of as the demand for money split into two components: the original transaction demand for money depending on the real gross national product Y and the liquidity preference function l expressing the

demand for bank balances as a function of the interest rate. This demand was said to move inversely with the interest rate as the opportunity cost of real return in the economy expressed by r varied.

In more recent times, Professor Friedman has revived a sophisticated version of the original quantity theory of money which holds that the only effective policy instrument in the hands of the government is the control of the money supply. Although there has been much debate between the neo-Keynesian and monetarist schools of macroeconomic theorists, the current popular conclusion is that neither addresses the problems of the modern economy (see Heller 1975). Neither explains the current conjunction of inflation and recession. Recent papers by Blinder and Solow (1973, 1974) and Brunner and Meltzer (1974) have put, respectively, the eclectic Keynesian and monetarist positions (see also the Symposium on Friedman's Theoretical Framework 1972). Although both of these classes of models have interesting features, the difficulty with the Keynesian versions is that the price level is taken as fixed, so that inflation cannot be explained within the model; while the monetarist models take the stock of real capital, population and effective labour force as constant, so that questions of unemployment and real investment cannot be treated within the model.

The time has evidently come for a shift in prevailing paradigms. When economists are continually surprised, when they cannot fit current behaviour into prevailing theories, it is not the world, but the theories through which they attempt to deal with the world, that must change. Since our knowledge of economic behaviour is evidently too gross to fit current circumstances, it is desirable to go beneath conventional constructs. A prime target is the production side of the economy. As things stand now, investment and employment are usually treated theoretically as unspecified functions of gross national product and interest rates. Little consistent evidence exists for, and much controversy centres on, their specific functional forms. We therefore think it advisable to make use of an explicit model of production that does away with the necessity of investment and employment appearing untouched, as it were, by human hands. Of particular interest here are the investment financing arrangements of firms and the bargaining ability of labour unions. For given conditions in the capital markets, production levels that might have been achieved at an 'economic wage' may be considerably reduced as unions perform their function of raising wages beyond what they would be in the absence of collective bargaining processes.

Following the earlier attempts of Metzler, Patinkin and others, several attempts to synthesize the Keynesian and monetarist positions,

and include the productive sector of the economy, have been made more recently (see Ball and Bodkin 1969; Stein 1974; Gorini 1974). Further, Black (1970, 1972, 1974) has investigated the adequacy of the macro description of the financial system embodied in the variants of the Keynesian money equation utilized in all the studies. He concluded that 'We cannot ignore the mechanism by which monetary policy supposedly influences the price level and other economic variables. We need a detailed microeconomic model of a monetary economy to have any hope of being able to decide which if any of these paths the economy follows.' In a recent paper, Avery (1974) has begun a careful study of the behaviour of the Federal Reserve policy makers; several earlier studies of the monetarist school, see for example Brunner and Meltzer (1963*a*,*b*, 1964, 1972), have detailed the behaviour of the financial system.

A final component in a comprehensive description of the modern macro economy is a model of government behaviour. It is a popular view that government, both local and central, is too large and growing larger (see Simon 1975). Further, both theoretical and practical debate rages on the question of whether the government has any control over the economy through fiscal policy. Recent work of Crecine (1971, 1975) and Davis, Dempster and Wildavsky (1966*a*,*b*, 1971, 1974, 1976) studying the federal budgetary and expenditure processes has led us to the view that, with the possible exception of tax policy, little of textbook fiscal policy is organizationally feasible. The view emerging from these studies is that the overall level of government expenditure must be set so far in advance of actual expenditure that *discretionary* action to control the current economic situation is impossible to plan for. This leaves adjustment to expenditure from current appropriations as the only policy weapon, and there is no doubt that such adjustments are extremely constrained, both bureaucratically and politically. The bureaucratic problem is that expenditures cannot be adjusted at short notice while maintaining the intended direction. Proposed cuts may lead to immediate increases as employees are given severance pay and payments are made for cancelled contracts. The political problems in the face of resistance to reductions in benefits are known to everyone. Less obvious is the fact that when times are good there is little pressure for decreases, but when times are bad there is great pressure for increases. Either way expenditures tend to go up. Government spending is less like an elevator than an escalator—it mostly goes in one direction. The most plausible model of federal government expenditures is therefore a simple reaction to economic variables. These have been modelled by Davis, Dempster and Wildavsky at two levels, Bureaus

and Office of Management and Budget Divisions, where the impact of price and unemployment variables has been found to be particularly significant. The work of Bozeman (1975) is also relevant here.

Two points are worth mentioning concerning the mechanisms by which the government and the (diminishing) remainder of the economy interact. Recent work by Nordhaus (1972) and Tufte (1974) suggests that discretionary appropriation manipulation and expenditure timing by the US Congress and executive induce a politically motivated business cycle through excess government spending in pre-Presidential election years. On the other hand, Gordon (1975) argues that the evidence contradicts the implied cyclical pattern of inflationary periods in the US economy. Instead, he maintains that the natural inertia of politicians in perceiving the need for, and acting to produce, policy changes is the principal culprit—a view which is consistent both with detailed study of the budget process by ourselves and others, and with the behaviour of the model to be developed in this paper. What is probably true is that politically induced pre-election government spending can only have the desired real impact, with or without accompanying inflation, in appropriate regimes of the economy.

The second point concerns the mechanism by which the economic climate affects the government expenditure process through political processes. Our own work shows that, as might be hoped in a democratic society, this influence is stronger on the legislative than on the executive side of the process. Recent work by ourselves (1974), Bozeman (1975) and Niskanen (1975) has begun the long needed examination of these effects through party politics with respect to Congress and the Presidency. A note by Amacher and Tollison (1974) suggests a theoretical public finance explanation, in terms of a (roughly) balanced budget expansionary period of government spending. Our description of the appropriations process above shows why such pressure can only serve to partially mitigate—and then usually temporarily—the *subsequnt* upward course of government expenditure.

This paper sets out the comparative static version of a model of the macro economy which attempts to synthesize and extend recent eclectic Keynesian and monetarist views in light of the Davis–Dempster–Wildavsky/Crecine findings. It explicitly attempts to model at the macro level the productive sector of the economy, the government expenditure process, and the behaviour of the central banking authorities and the private banking sector. Debt financing, open market operations, trade balance and foreign capital transfers influence real activity and inflation through the money and stock markets. The next section of this paper deals with the production sector of the economy

and treats explicitly profit, investment, wages and employment. Section 3 of the paper deals with consumption, government behaviour, trade balance and international capital transfers; while §4 outlines the model of the capital market and the tools of monetary policy. Section 5 contains a comparative static analysis of the model which turns out to be adequate to describe the phenomena of 'stagflation' and hyperinflation as well as including earlier models of the macro economy as special cases. The last section of the paper, §6, contains conclusions and tentative policy recommendations following from the analysis.

The current dissatisfaction with economic management is amply justified. Economists have not been of much help to the economy. Standard models do not work and alternatives are not much better. By the time economic models are perfected they appear as relics of a bygone era. The main problem, as we conceive it, is that existing models do not generate a sufficient variety of behaviour. Therefore when a new situation occurs, the result is to discredit existing models, and what is worse, economic analysis. By bringing in a wider variety of considerations—from the presence of the production sector of the economy to the impracticality of manipulating totals of government spending and the necessity of marketing the government debt—we hope to generate a wide enough variety of economic behaviours to be appropriate to the historical conditions experienced by real economies in different regimes. The detailed assumptions embodied in this paper are all open to question and further analysis. If the economics profession focuses on some of them—and more importantly, their inter-relationships—this endeavour will have been successful. In the meantime, we leave the dynamical specification of the model and its econometric estimation to future papers.

2. Production, profit, investment, wages and employment

This section sets out a macro model of the productive sector of an economy more or less familiar from capital and growth theory. We abstract from technical progress and population growth, as is proper to a static world. In contrast to the standard Keynesian and monetarist treatments of macroeconomic models, the aim is to *derive* expressions for gross investment, unemployment and profit as functions of the interest rate and the price level in the economy. As a by-product we provide a discussion of the theoretical basis of the Phillips curve.

We assume that the macro behaviour of the production sector results in the solution of the following mathematical program:

$$\max_{Y,I,N} PY - rPI - \omega(P)N$$

such that

$$Y = f((I-\delta)K + I, N)$$
$$I \leq 0, \quad N \geq N_0.$$

Here Y, I and N are, respectively, *gross national product*, *gross investment* and *gross employment* in real terms, while P represents the *price level* (the GNP deflator). We take the *capital stock* K, the *rate of depreciation of capital* δ, and the *labour force* N_0, as fixed. In order to model the results of collective bargaining, we take the *wage rate* ω as a function of the price level. The objective function of this program represents a *net profit* to the productive sector of the economy. Costs consist of the wage bill and new investment. We are assuming that investment is financed internally, or by new securities, associated with a depreciation charge r or by bonds or loans at interest rate r, which is the prime rate in the money market. Considering the static model as the steady state equilibrium of a dynamic model, new investment I represents a continuing stream of investment additional to the existing capital stock K. Thus, at a new equilibrium the capital stock will be increased if $I > \delta K$. Similarly, unemployment will exist if U, which is defined to be $N_0 - N$, is strictly positive. In the solution of this program, we are of course historically justified in ignoring the constraints $I \geq 0$ and $N \leq N_0$. in this section we take P, r and $\omega(P)$ as given. Moreover, in the sequel we shall not distinguish optimal values of variables notationally.

We make the standard assumption about the production function f. Namely, we assume f strictly concave and twice continuously differentiable. More specifically, we assume

$$f_K = f_I > 0, \quad f_N = -f_U > 0, \quad f_{KK} < 0, \quad f_{NN} < 0, \quad f_{KN} = f_{NK} \geq 0,$$

and *strictly decreasing returns to scale* (negative curvature), i.e.

$$f_{NN} f_{KK} > f_{KN}^2.$$

(Here we use the standard notation to denote partial derivatives.) The expressions f_K and f_N are of course the *marginal products of capital* and *labour*, MPC and MPL, respectively. The *marginal responses of the MPC and MPL to increases in the capital stock* are given respectively by f_{KK} and f_{NK}. Similarly, these effects due to *increases in employment* are given by f_{KN} $(= f_{NK})$ and f_{NN}, respectively.

Under our assumptions, necessary and sufficient conditions for a production optimum (rewriting f to absorb $(1-\delta)K$) are given by the following three equations which simultaneously determine investment, employment and (positive) profit as functions of r and P.

Investment equation: $$f_K(I,N) = r \tag{2.1}$$

Employment equation: $$Pf_N(I,N) = \omega(P) \tag{2.2}$$

Definition of profit: $$P\pi = PY - rPI - \omega(P)N - r(1-\delta)K. \tag{2.3}$$

Note that equation (2.2) represents management (left-hand side) and union (right-hand side) behaviour functions. We shall term the latter the *wage escalation function.*

In order to study capital market and government behaviour effects on real activity, we must study the effects of changes in the price level P and the interest rate r. It is convenient in this time of inflation to express these changes as total derivatives with respect to P of the quantities of interest—namely, investment, unemployment and profit—as:

$$I = I(r,P), \quad U = N_0 - N = U(r,P) \quad \text{and} \quad \pi = \pi(r,P).$$

Now (2.1) implies that

$$\frac{dI}{dP} = I_r \frac{dr}{dP} + I_P$$

where $$I_r = \frac{f_{NN}}{(f_{NN}f_{KK} - f_{KN}^2)} < 0 \tag{2.4}$$

and $$I_P = \frac{(f_N - \omega_P)(-f_{KN})}{P(f_{NN}f_{KK} - f_{KN}^2)}. \tag{2.5}$$

Notice that under our assumptions (2.5) implies that the partial derivative of investment with respect to price depends on the relative magnitudes of the marginal product of labour f_N and the derivative of the wage rate with respect to price ω_P. The latter, which we term the *marginal wage escalation*, represents the outcome of collective bargaining; in neoclassical production theory it is of course taken to be constant. In a regime of cost push inflation, the *elasticity of the wage rate with respect to the price level* $\in (\omega; P) \triangleq \omega_P P/\omega$ could be expected to be larger than unity. In a regime of rapid demand pull inflation, this elasticity might be expected to be below unity. In general we may define the *effective marginal wage escalation* as $\omega_P - f_N$. Hence:

marginal wage ecalation is the sum of the marginal product of labour and the effective marginal wage escalation.

In neoclassical theory effective marginal wage escalation is of course *zero.*

Turning to the total derivative of gross investment with respect to the price level, we find that investment can be expected to remain strong with inflation, i.e.

$$\frac{dI}{dP} > 0 \quad \text{if, and only if,} \quad \frac{\omega_P - f_N}{f_{NN}} \Big/ \frac{r}{f_{KN}} > \in(r;P) \triangleq \frac{dr}{dP}\,\frac{P}{r}.$$

Hence

the marginal response of unemployment to an increase in the price level will be positive
if, and only if, *the ratio of:*
the effective marginal wage escalation per unit marginal response of the MPL to an increase in the labour force
to:
the cost of capital per unit marginal response of the MPC to an increase in the labour force
exceeds:
the elasticity of the cost of capital with respect to the price level.

Thus, only if the effective wage escalation is negative, i.e. wages increase less than the marginal product of labour, or the interest rate falls with an increasing price level, can investment remain strong in the face of an increase in the price level.

A similar analysis of equation (2.2) leads to an expression for the total derivative of unemployment with respect to the price level as

$$\frac{dU}{dP} = U_r \frac{dr}{dP} + U_P$$

where
$$U_r = \frac{f_{KN}}{(f_{NN}f_{KK} - f_{KN}^2)} > 0 \tag{2.6}$$

and
$$U_P = \frac{(f_N - \omega_P)(-f_{KK})}{P(f_{NN}f_{KK} - f_{NK}^2)}. \tag{2.7}$$

These expressions allow us to develop a *theory* of the Phillips curve. First, however, we emphasize that the causality embodied in the empirical Phillips curve is wrong—here the price level determines unemployment, not, as is commonly assumed in policy making from

the empirical Phillips curve, the reverse. From expressions (2.6) and (2.7), it follows that there will be a local Phillips curve around the equilibrium, i.e.

$$\frac{dU}{dP} < 0 \quad \text{if, and only if,} \quad \frac{(\omega_P - f_N)}{f_{KN}} \Big/ \frac{r}{f_{KK}} > \in(r;P). \qquad (2.8)$$

Hence

the marginal response of unemployment to an increase in the price level will be negative
if, and only if, *the ratio of:*
the effective marginal wage escalation per unit response of the MPC to an increase in the labour force
to:
the cost of capital per unit marginal response of the MPC to an increase in the capital stock
exceeds:
the elasticity of the cost of capital with respect to the price level.

Thus, unless the marginal response of the interest rate to an increase in the price level is negative, i.e. $dr/dP < 0$, effective wage escalation must be negative, i.e. wages must rise less than the marginal product of labour, in order to induce the investment to yield a net drop in unemployment as the price level rises. In light of the recent unrestrained wage negotiations in Western economies, it is perhaps not surprising that the phenomenon of 'stagflation' has become prevalent.

Finally, from (2.3) we may express real profit π as

$$\pi = Y - r(I + (1-\delta)K) + \frac{\omega}{p}(U - N_0). \qquad (2.9)$$

Under our present assumption of strictly decreasing returns to scale, real profit π from production will be strictly positive. It might be argued that constant returns to scale is a more plausible assumption for a macroeconomic production function, although we do not find the empirical evidence particularly compelling. Assuming constant returns to scale, some accounting definition of profit in terms of the return $r(I + (1-\delta)K)$ on real capital would suffice for our purposes. However, this would require hypotheses about the sources of corporate finance and surplus distribution which merits careful empirical study.

Returning to our present assumption, the total derivative of profit with respect to the price level is

$$\frac{d\pi}{dP} = \pi_r \frac{dr}{dP} + \pi_P$$

where

$$\pi_r = -(1-\delta)K - r\left(I_r + \frac{I}{r}\right) + \frac{\omega}{P}U_r \tag{2.10}$$

and

$$\pi_P = \frac{dY}{dP} - rI_P - \frac{N_0}{P}\left(\omega_P - \frac{\omega}{P}\right) + \frac{\omega_P}{P}U + \frac{\omega}{P}\left(U_P - \frac{U}{P}\right). \tag{2.11}$$

The signs of the partial derivatives in both (2.10) and (2.11) are indeterminate. In (2.10), the first and third term, representing respectively the *effects of payment for existing capital services and unemployment*, are respectively negative and positive. However, the second term, representing the *investment effect*, is positive or negative according as the elasticity of investment with respect to interest rate $\in(I;r)$ is $<$ or > 1. The first term of the partial derivative of real profit with respect to the price level represents the *output effect*, and is positive or negative according to the operations of the financial and government sectors of the economy. The second term represents the *investment effect*, and will be positive or negative according as the partial derivative of investment with respect to price I_P is $<$ or > 0. The third term represents the *effects of the wage rate*, and will be positive or negative according as the elasticity of wages with respect to price $\in(\omega;P)$ is $<$ or > 1. The fourth term represents the *direct unemployment effect*, that is, wages saved by unemployment, and is always positive. The fifth term, however, represents the *indirect unemployment effect*, and is positive or negative according as the elasticity of unemployment with respect to price is $<$ or > 1.

It will also prove useful to express the total derivative of profit with respect to price, $d\pi/dP$, in terms of the total derivatives of the components as

$$\frac{d\pi}{dP} = \frac{dY}{dP} - \frac{dr}{dP}\left(I + (1-\delta)K\right) - r\frac{dI}{dP} - \frac{N_0}{P}\left(\omega_P - \frac{\omega}{P}\right) + \frac{\omega_P}{P}U + \frac{\omega}{P}\left(\frac{dU}{dP} - \frac{U}{P}\right). \tag{2.12}$$

The terms in expression (2.12) correspond to those in expression (2.11) for the partial derivative of profit with respect to the price level, but are in terms of *total* rather than *partial* derivatives.

3. Consumption, government behaviour, trade balance and international capital transfers

This section details the functions and identities underlying the national income identity of standard macroeconomic theory. We shall utilize a consumption function depending on wealth and a tax function that expresses the progressivity of tax structures in modern Western economies. In addition, we assume that government expenditure depends on nominal GNP and unemployment as well as a shift parameter representing discretionary policy making.

In the previous section we detailed the determination of real income Y as the supply of real output. In this section we detail the division of real expenditure into the various components of demand for real output as

$$C + I + G + X/P + F/P.$$

Here X represents the total value of *net* goods and service *exports* (signed positively, imports will be signed negatively) in current dollars, pounds, etc. This is expressed in value terms to allow exogenous changes in the terms of trade and quantities to be examined simultaneously. *Net foreign capital exports* F ($+$, imports are treated as $-$) are treated similarly. Investment I as a function of the interest rate r and the price level P has been treated in §2.

We assume the standard *consumption function* for real disposable income:

$$C = c(Y - T, W).$$

Real wealth W is the sum of capital, real money stock, and the real market value of government bonds. It will be defined precisely in §4. Real wealth has been included in the consumption function to give Pigou effects on consumption and savings behaviour, i.e. c_W is assumed to be positive. We specify the standard *tax function*:

$$T = t(PY, \tau)/P,$$

to express the progressivity of the tax structure in current dollar returns.

Following our work with Wildavsky and Crecine mentioned above, we take real government expenditure to be given by a *government expenditure function* as:

$$G = g(PY, U; \gamma)/P.$$

In our micro work at the Bureau and Office of Management and Budget Division levels, we have found a heavy dependence of agency

appropriations and expenditures on price variables including both the GNP deflator and wage rates for labour services. Although it might be argued that there should be an explicit dependence of real government expenditure on the interest rate due to the servicing of the national debt, we have found that the enormous uncontrollable components of government expenditure give an inertia to the time path of government expenditure quite sufficient to absorb changes in national debt service. On the other hand, it is clear that the process reacts to the level of unemployment. In recent months we have seen increments of several billion dollars in order to combat the current and expected high unemployment in fiscal 1975, 1976 and 1977. Although it may be argued that the margin for discretionary fiscal policy without major changes is small, nevertheless, in the analysis of the macro economy, one wishes to know the effects of discretionary policy making of the federal government. In the model this is expressed as the shift parameter γ. Here we are thinking of fundamental (upward) changes in the level of government expenditure such as those occasioned by the Space Race, the Vietnam War, the Great Society, major unemployment programmes, etc.

These elements are combined in the *national income identity*

$$Y = c(Y - T, W) + I(r, P) + G + X/P + F/P, \tag{3.1}$$

which is, of course, an equilibrium condition.

The picture is completed by the *government expenditure identity*:

$$G = T + \Delta. \tag{3.2}$$

Here Δ represents the *government deficit* ($+$, surplus is treated as $-$).

Having set out the basis for fiscal policy, we now turn to an analysis of the financial sector of the macro economy.

4. Capital markets and monetary policy

In this section we set out a money market equation which is radically different to that used by both the Keynesian and monetarist schools of macroeconomics. Although we shall implicitly deal with credit, unlike the recent model of Brunner and Meltzer (1974), we do not specify a separate equation for credit equilibrium. Such an approach is necessitated in their work by a separate treatment of the price index for capital goods and the general price level of the economy; we feel such a treatment is unnecessary to capture the behaviour of the financial

system, at least in our comparative static model. However, we treat the stock market explicitly as a major determinant for the demand for investment funds on the banking system. The bond market is handled implicitly in the manner of the recent work of Blinder and Solow (1973, 1974). The supply of money is assumed to react endogenously to real output, the interest rate and the price level through the behaviour of the private banking system, and to react exogenously through the open market operations of the central bank. As we shall see, Keynes's famous speculative demand for money is properly on the supply side of our money equation.

Although we are well aware of the controversy surrounding the definition of money, see, for example, Klein (1974) and Avery (1974), for our purpose we find it prudent to use an inclusive definition of money as:

> *currency + demand deposits + time deposits in the entire financial sector.*

Unlike the standard textbook treatment, we shall deal in some detail with the components of both the demand for money and the supply of money, separately. At this point it is worthwhile to enunciate the difference between our conception of the supply and demand for money and the classical notions as utilized by Keynes. Classically, the 'demand' for real money balances was that by the private sector—*including banks and financial intermediaries*—from the Treasury and the central bank in terms of currency, issue and purchase of government securities, and credit expansion through lowered reserve requirements, rediscount rates, etc., at constant prices. With this interpretation, the 'supply' of money was the amount of currency and deposits commensurate with these governmental policies, conveniently thought of as fixed exogenously in terms of constant prices. Here, our concern with real money balances involves the total amount of currency and financial sector *credits* (including individual and corporate *borrowings*, i.e. *credit*) needed to support the *real activities* given in the model in terms of Y, I, C and G. Thus our *demand* for real money balances is a behavioural function reflecting mainly real variables, as, for example, does the classical transactions demand. On the other hand, our *supply* of real money balances is a behavioural function representing the behaviour of individuals and organizations in the financial sector—*both public and private*. This allows consideration of, among other things, the reaction of private banks and financial intermediaries to the price level, marketing arrangements for government debt, and foreign capital transfers—in the determination of the supply of real money

balances to support real activity.

Consider first this supply of money so conceived. We must detail the behaviour function m of the financial sector of the economy. We take the *supply of nominal money balances* by the entire financial sector to be given by:

$$M = m\left(r, P, \nu(1-\mu)\Delta + \frac{B}{rP},\ \mu\Delta;\ F, \rho, R, \eta\right).$$

The supply of money is assumed to depend endogenously on interest rate r, the price level P, the *total stock of government bonds held by the domestic public*, and the *proportion* $\mu(\in [0,1])$ *of the current deficit* Δ *monetized* by the central banking authorities (a flow). The parameter $\nu(\in [0,1])$ represents the *proportion of government debt not sold abroad* as foreign dollar or pounds, etc., reserves. The symbol B represents the *existing stock of government bonds* held by the public (excluding foreign holdings) where each bond is assumed to have a face value of one dollar, pound, etc. The supply of money is assumed to depend exogenously on net foreign capital transfers F, the current level of *reserve requirement* ρ, the *rediscount rate* R, and a parameter η representing the *central bank open market activity level.*

Here, in the specification of the supply of nominal money function m, is the place for Keynes's celebrated 'speculative demand' for money, which as we have seen is actually a supply of earning assets to the financial system by the public at large. We assume that the partial derivative of the supply of money function with respect to the interest rate m_r is positive, for even though the supply of idle balances by the public to the banking system may increase as r falls *à la* Keynes, the supply of credit will contract due to bankers' attitudes to risk. This was the story in the Great Depression, and has appeared in the pages of *Business Week* and *The Economist* in recent months in the statement that bankers are currently taking the opportunity to rationalize their loan structure towards better credit risks. On the other hand, as interest rates rise, the supply of credit will increase due to the supply of idle balances by the public who are taking advantage of the higher financial rate of return. The credit effects of this increase in idle balances may be multiplied many times over when newer riskier instruments, such as certificates of deposit, municipal tax notes, etc., are being shown amongst bank assets. It is clear that changes in this gearing have recently taken place in the major financial capitals of the Western world due to a change in bankers' attitudes from *asset* management to *loan* management (*cf.* Burns 1974). The attitudes of the private and central banking authorities will depend on price

level effects as well; so that we assume that the partial derivative of the supply of money function with respect to the price level m_P is positive with elasticity approximately equal to one.

The specification of the supply of money function m will in general be extremely complicated. For example, we agree with a view recently put forward by Klein (1974) that an increase in reserve requirement offset by open market purchases, which keeps the central bank's supply of money constant, will raise the costs to banks of producing deposits and lead to a fall in the rate of interest paid on deposits. However, its possible contracting effect will depend on whether any subsequent decreased supply of idle balances by the public to the banking system will decrease the supply of credit to borrowers in the economy or not—ultimately this is an empirical matter. We agree with Klein that one should distinguish a long-term interest rate as a measure of the rate of return on an asset yielding no monetary services, and therefore as the opportunity cost of holding an asset yielding monetary services; and a short-term interest rate as a measure of the rate of return on an asset yielding a significant monetary service flow, and therefore as the foregone pecuniary return on close substitutes for money. However, at this level of our model, we feel such complication is unnecessary.

We take the partial derivative of the supply of money with respect to the stock of bonds held by the public m_3 to be positive, since a large proportion of government bonds will either be held directly as assets by the financial sector or supplied as idle balances by the public from interest payments. We asume the partial derivative of money with respect to the increment in the money supply occasioned by federal deficit m_4 to be positive, as this increment has a positive effect on base money held by the central bank. Similar arguments require the partial derivative of the supply of money with respect to net foreign capital exports m_F to be negative.

As is assumed classically, we take the partial derivatives of the supply of money with respect to reserve requirements ρ and the rediscount rate R, i.e. m_ρ and m_R, to be negative. We take the partial derivative of the money supply with respect to the central banking open market activity level parameter η, m_η, to be positive, as η represents the level of net purchases of government securities in the market by the central bank.

To summarize, we make the following assumptions concerning the partial derivatives of the supply of nominal money function:

$$m_r > 0, \quad m_P > 0 \ (\in (m;P) \approx 1), \quad m_3 > 0, \quad m_4 > 0; \qquad (4.1)$$
$$m_F < 0, \quad m_\rho < 0, \quad m_R < 0, \quad m_\mu > 0.$$

In reduced form, the supply of nominal money balances M, given the exogenous variables and parameters discussed above, can be taken as a function $M(Y, r, P; F, \rho, R, \eta)$ of real output Y, the interest rate r and the price level P. Thus the total derivative of the supply of nominal money balances with respect to price is given by

$$\frac{dM}{dP} = M_{Y\cdot}\frac{dY}{dP} + M_r\frac{dr}{dP} + M_P,$$

where

$$M_{Y\cdot} = [\nu(1-\mu)m_3 + \mu m_4]\,(g_{PY\cdot} - t_{PY\cdot}) \tag{4.2}$$

$$M_r = m_r + [\nu(1-\mu)m_3 + \mu m_4]\,\frac{U_r}{P} - \frac{m_3 B}{r^2 P} \tag{4.3}$$

$$M_P = m_P + [\nu(1-\mu)m_3 + \mu m_4]\,\frac{(g_{PY\cdot} - t_{PY\cdot})Y + g_U U_P - \Delta}{P^2} - \frac{m_3 B}{rP^2}. \tag{4.4}$$

The partial derivative of the supply of nominal money balances with respect to real output $M_{Y\cdot}$ will be positive or negative according as the *net marginal nominal government impact with respect to nominal GNP*, $g_{PY\cdot} - t_{PY\cdot}$, is positive or negative. Since $g_{PY\cdot}$ and $t_{PY\cdot}$ are respectively the *marginal responses of normal government expenditures and tax receipts to nominal GNP*, when

> *the net marginal nominal government impact is positive, regular government activity is expansionary; when it is negative, regular government activity is contracting.*

The effective contraction of government activity due to negative net marginal nominal government impact through the effects of progressive tax structures in inflationary periods was first pointed out by Gramlich (1968). We shall see the importance of the sign of the net marginal nominal government impact for the relation between monetary and fiscal policy in the next section.

Since the first two terms of the partial derivative of the supply of nominal money balances with respect to the interest rate M_r are positive (*cf.* (4.1) and (2.4)), its sign will depend on the relative magnitude of the third, negative term. This represents the (marginal) contracting effect on the supply of money of a fall in the value of government securities held as assets by financial sector institutions and customers due to an increment in interest rate. The third term of expression (4.4) for the partial derivative of the supply of nominal money balances with respect to the price level M_P represents a similar effect due to the price level.

Hence the signs of both M_r and M_P are *a priori* indeterminate. In the case of M_r, the sign will depend directly on the relative strengths of the direct expansionary response due to increased returns on deposits and borrowings from the financial sector m_r and the response due to a change in value of government assets held by the public m_3. We shall take the direct effect to be overwhelming in the sequel, so that $M_r > 0$. In the case of M_P, similar considerations are mitigated by the presence of the second term in (4.4) which is of indeterminate sign. In a regime in which effective wage escalation is negative so that $U_P < 0$ (*cf.* (2.7)) and net marginal government impact is nearly neutral, i.e. of whatever sign $g_{PY} - t_{PY}$ is near zero, this term will be negative and the combined effects of the second and third terms are likely to overwhelm the first to yield $M_P < 0$. In a period of rapid cost push inflation, when effective wage escalation is positive and $U_P > 0$, and when net marginal government impact is strongly positive, the result is likely to go the other way, i.e. $M_P > 0$. In the sequel we shall assume that $M_P < 0$.

Turning now to the demand for money, we retain the classical transactions demand for money modified *à la* Friedman to react to the level of wealth W in the economy. Thus the *transactions demand for money* is given by the function

$$\tau(Y, W) \quad \text{with} \quad \tau_{Y} > 0, \ \ \tau_{W} < 0.$$

We assume that τ_{Y}, the *marginal propensity to require (real) income in (real) money balances to cover transactions* increases with wealth, i.e. that $\tau_{W} > 0$.

We define *real wealth* to be the sum of the real value of capital, money and government bonds. In symbols, real wealth is defined as:

$$W = [(1-\delta)K + I] + \left(\frac{M}{P} + \mu\nu\Delta\right) + \left[(1-\mu)\nu\Delta + \frac{B}{rP}\right].$$

Recall that the reduced form of the supply of real money balances by the entire financial sector M/P detailed above is a function of r, P and Y; ν represents the proportion of government debt held domestically; and B represents the existing stock of government bonds held by the domestic public. This definition of wealth makes several simplifying assumptions whose ultimate justification can only be determined empirically. We are ignorning wealth effects (on domestic consumption and transactions demand for real money balances) due domestic holdings abroad, but not those due to foreign claims on domestic capital stock. Similarly, we are ignoring wealth effects of

the 'hot' capital flow whose nominal net value is embodied in F. These assumptions are perhaps *a priori* justifiable for effects on the behaviour of domestic agents in the economy. Less immediate—at least in a dynamic context—is the justification of the 'government bond illusion' embodied in adding the term $(1-\mu)\nu\Delta$ to the current value of the stock of government securities in the economy. In the present comparative static context, this assumes that domestic individuals and corporations view their equilibrium holdings of the additional government securities required to help finance the current government deficit as genuine assets whose value is not eroded in the resulting state of the economy.

Thus, we find that the total derivative of wealth with respect to price is given by

$$\frac{dW}{dP} = W_r \frac{dr}{dP} + W_P$$

where

$$W_r = I_r + \frac{M_r}{P} - \frac{M}{P^2} + \nu g_U U_r - \frac{B}{rP^2}$$

and

$$W_P = I_P + \frac{M_P}{P} - \frac{M}{P^2} + \nu(g_{PY} - t_{PY})Y + \nu g_U U_P - \frac{B}{rP^2}.$$

We assume the *stock market index*, such as the Dow-Jones or Financial Times index, reacts endogenously to real profits π and real output Y from the production sector, and to the interest rate r and the general price level P from the financial sector. It of course also reacts exogenously to exports of goods and services X and foreign capital exports F. Thus, the functional dependencies are as

$$S = s(\pi, Y, r, P; X, F).$$

We assume the stock market index reacts positively to real profit and real output and negatively to interest rate and price level. Similarly, it reacts positively to exports and negatively to foreign capital transfers. This behaviour is set out in the following assumptions about partial derivatives of the *stock market index function* s:

$$s_\pi > 0, \quad s_Y > 0, \quad s_r < 0, \quad s_P < 0; \quad s_X > 0, \quad s_F < 0.$$

We are now in a position to detail the second component of the demand for money as the *demand for real money balances to finance investment* as bank or other financial institution *credits* (and thus including *credit*); viz.

$$\lambda(S)I \quad \text{where} \quad 0 \leq \lambda(S) \leq 1 \quad \text{and} \quad \lambda_S < 0.$$

The function $\lambda(S)$ expresses that proportion of investment financed through the banking system which augments the transaction demand. That is, it reflects the proportion of investment not financed internally or through new corporate security or bond issues. The stock and corporate bond markets are assumed to clear, but we assume that $\lambda_S < 0$. Thus a rise in the stock market index yields a lower demand on the banking system for investment finance and conversely.

Putting these two components together yields the demand for money as

$$L \triangleq \tau(Y, W) + \lambda(S)I.$$

We emphasize that our demand for money is *not* identified with the supply by the public of earning assets to the financial system. Rather, it is demand by the public for currency and deposits, both current and time, including both personal and corporate borrowing. Nevertheless, the reduced form of the demand for money is the more or less familiar:

$$L = l(Y, r, P; X, F).$$

The total derivative of the demand for money with respect to price is given by

$$\frac{dL}{dP} = l_{Y\cdot}\frac{dY}{dP} + l_r\frac{dr}{dP} + l_P, \tag{4.5}$$

where

$$l_{Y\cdot} = \tau_{Y\cdot} + \lambda_S(s_\pi + s_{Y\cdot}) + \frac{\tau_{W\cdot}}{P}M_{Y\cdot} + \tau_{W\cdot}\nu(g_{PY\cdot} - t_{PY\cdot}) \tag{4.6}$$

$$l_r = (\lambda_S s_\pi I)\pi_r + (\lambda + \tau_{N\cdot})I_r + \frac{\tau_{W\cdot}}{P}M_r + \lambda_S I s_r - \frac{\tau_{W\cdot}B}{Pr^2} + \frac{(\tau_{W\cdot}\nu g_U)}{P}U_r \tag{4.7}$$

$$l_P = (\lambda_S s_\pi I)\pi_P + (\lambda + \tau_{W\cdot})I_P + \frac{\tau_{W\cdot}}{P}M_P + \lambda_S I s_P + \frac{\tau_{W\cdot}\nu g_U}{P}U_P + \frac{W}{P^2}\left[M - \frac{B}{r} + \nu(t_{PY\cdot} - g_{PY\cdot})PY + \nu\Delta\right]. \tag{4.8}$$

Much of the controversy between the Keynesian and monetarist schools of macroeconomics has centered on the signs of the partial derivatives of the demand for money function l. These, of course, determine the position and slope of the LM curve at a new equilibrium. With our demand for money function we may expect that $l_{Y\cdot} > 0$, as the only negative term in four is the last. Indeed $\tau_{Y\cdot} > 0$, $\lambda_S < 0$ and is small, the partial derivative of the supply of nominal money with respect to real output $M_{Y\cdot}$ is positive, and $g_{PY\cdot} \approx t_{PY\cdot}$.

The crucial partial derivative of the demand for money with respect to the interest rate l_r consists of five terms which lead to indeterminacy of sign. The profit term can be positive or negative according as π_r is negative or positive. The investment term is negative, since I_r is negative (*cf.* (2.4)). The money supply term is positive, since we assume the partial derivative of the supply of nominal money with respect to the interest rate M_r is positive. The stock market index term is also positive, while the government bond term is negative. Consistent with Professor Friedman's arguments, the negative sign of l_r in standard Keynesian *IS–LM* analysis *could be* reversed here through wealth effects on transactions demand through the money supply and the stock market, or through direct effects on investment demand when profits fall with rising interest rates (*cf.* (2.11)). Note also that the unemployment component of wealth represents a transfer of current income from rich to poor in return for a future flow in the other direction.

The partial derivative of the demand for money with respect to the price level l_P consists of six terms and is also indeterminate. The profit term is positive or negative according as the partial derivative of profit with respect to the price level π_P is negative or positive (*cf.* §2). The investment term is positive or negative according as the partial derivative of investment with respect to the price level I_P is positive or negative (*cf.* (2.5)). The unemployment term is positive or negative according as the partial derivative of unemployment with respect to the price level U_P is positive or negative (*cf.* (2.8)). The money supply term is negative, as we assume the partial derivative of the supply of nominal money with respect to the price level is negative. The stock market index term is also positive, while the money and bond term is negative. We may expect l_P to be positive when investment and unemployment are rising with the price level, i.e. $I_P > 0$, $U_P > 0$, in spite of the positive response of profit to the price level, i.e. $\pi_P > 0$, presently occurring in most Western economies.

Demand and supply in the financial system set the interest rate r given Y and P (and the exogenous and fixed variables and parameters) as in *IS–LM* analysis. Here, however, there is no need for the speculative demand which in explicit form is foreign to a deterministic, static economy. As such it enters our model implicitly on the supply side of the *money market equilibrium condition*:

$$M(Y, r, P; F, \rho, R, \eta)/P = l(Y, r, P; X, F). \tag{4.9}$$

Note that our specification of the supply of money function can produce the Keynesian liquidity trap through the money market equi-

librium condition (4.9) when η is constant. That is, in this situation the behaviour of the financial system itself determines the money supply. As to government policy, the idea is that the η parameter can overwhelm the effects of the other variables and parameters on the money supply function m. This parameter is, of course, under the control of the central bank through their open market operations.

This completes the specification of our model of the macro economy; we now turn to its comparative static analysis.

5. Comparative static analysis

In this section we perform the standard comparative static analysis on our model. Attention will be focused on the signs of the total derivatives of the major indicators of the state of the model economy, namely, the real gross national product Y, the price level P, the rate of interest r, the flow of real investment I, the level of unemployment U, and the level of real profit π. We shall see that under various ancillary assumptions the model is capable of producing a range of behaviour from the classical nineteenth century economy to that of the modern day. It turns out that this range of behaviour depends on the relative magnitudes of three ratios which are a composite of certain local responses of the model about the current equilibrium. These ratios—the real activity/money market marginal response ratios with respect to changes in real output, interest rate and the price level—contain the appropriate partial derivatives of consumption from wealth, investment and government expenditure in their numerators and those of the excess demand for nominal money in their denominators.

For convenience we collect here the six equations determining the six variables I, U, π, Y, r, and P:

Production

Investment equation: $$f_K(I, N_0 - U) = r \tag{5.1}$$

Employment equation: $$Pf_N(I, N_0 - U) = w(P) \tag{5.2}$$

Definition of profit: $$P\pi = PY - rPI - w(P)N - r(1-\delta)PK \tag{5.3}$$

Expenditure

National income identity:

$$Y = c(Y - T, W) + I(r, P) + G + X/P + F/P \tag{5.4}$$

Government income identity: $$G = T + \Delta \tag{5.5}$$

Capital and Money Markets

Money market equilibrium:

$$M(Y, r, P; \eta, F)/P = l(Y, r, P; X, F). \tag{5.6}$$

We also list the parameters on which these equations depend:

- K – existing capital stock
- δ – rate of capital depreciation
- N_0 – work force
- X – net exports
- F – net foreign capital transfers
- τ – gross tax rate
- γ – level of government activity
- Δ – real government deficit
- ν – proportion of new government debt held domestically
- μ – proportion of new government debt monetized
- B – existing stock of government bonds
- η – open market activity level
- ρ – rediscount rate
- R – reserve requirement.

Thus we have a system which can be considered as a 6-dimensional vector equation

$$F(X) = 0$$

involving the 6 variables represented by the vector $X = (I, U, \pi, Y, r, P)$. We shall assume that the specification of the nonlinear vector function F is such that a solution to these equations exists for reasonable values of the parameters. Then our method is to create a linear system in the total differentials of the variables by taking partial derivatives of the component functions of F. That is, we obtain the linear vector system

$$\frac{\partial F}{\partial X} \cdot dX = 0.$$

We may solve this system for the total derivatives of the variables of interest, both with respect to each other and the policy parameters: level of government deficit Δ, tax rate τ, level of government expenditure γ, and level of central bank open market activity η. For a given period, we may interpret Δ as the government deficit, τ as the marginal tax rate, γ as the planned change in obligational authority

for the consolidated budget and η as net open market purchases of the central bank—all in real terms, i.e. in constant dollars, pounds, etc. Note that in a dynamic version of the model—at least in the US context—trust fund lending and spending will effect the lag structure of the response of nominal government expenditures G to γ.

We made use of the structure of our system in §2 to obtain the total derivatives of investment, unemployment and profit with respect to the price level and the interest rate. This amounts to eliminating the first three equations from our linearized system. Since this system is homogeneous, we can use the remaining three equations to obtain expressions for the partial derivatives of the interest rate and real gross national product with respect to price. The resulting five total derivatives with respect to price, dI/dP, dU/dP, $d\pi/dP$, dY/dP, dr/dP, can then be used to obtain all the total derivatives of interest.

Now substitutng the government income identity (5.5) into the national income identity (5.4), using the money market equation (5.6), and differentiating, yields the two-equation linear system

$$\frac{dY}{dP} - \alpha \frac{dr}{dP} = \beta$$

$$\frac{dY}{dP} + \chi \frac{dr}{dP} = \psi$$

whose solution is given by

$$\frac{dr}{dP} = \frac{\psi - \beta}{\alpha + \chi} \tag{5.7}$$

$$\frac{dY}{dP} = \frac{\alpha\psi + \beta\chi}{\alpha + \chi} \tag{5.8}$$

where

$$\begin{aligned}
\alpha &= \frac{c_{II}W_r + I_r + (1 - c_{I})g_U U_r/P}{(1 - c_{I})(1 - g_{PI})} \\
\beta &= \frac{(1 - c_{I})[g_{PI}Y - G + g_U U_P]/P + c_{II}W_P + I_P}{(1 - c_{I})(1 - g_{PI})} \\
\chi &= \frac{Pl_r - M_r}{Pl_{I} - M_{I}} \\
\psi &= \frac{M_P - Pl_P - l}{Pl_{I} - M_{I}}.
\end{aligned} \tag{5.9}$$

We are now in a position to obtain the total derivatives of price with respect to the policy parameters Δ, τ, γ and η. Total differentiation

of the government income identity (5.5) yields the total derivative of price with respect to the government deficit as

$$\frac{dP}{d\Delta} = \frac{P}{(g_{PY} - t_{PY})\left(Y + \frac{dY}{dP}P\right) + g_U \frac{dU}{dP} - \Delta}.$$

Thus

the marginal response of the price level to an increase in real government deficit
is given by *the ratio of: the price level*
to:
the sum of the first order approximations to net real government impact, the change in real unemployment spending and the real goverment surplus.

Observe that

in regimes when the net marginal government impact and effective wage escalation are positive, *the response of the price level to an increase in government deficit is* positive.

We can now obtain the total derivatives of the other variables with respect to government deficit using the chain rule as, for example,

$$\frac{dY}{d\Delta} = \frac{dY}{dP}\frac{dP}{d\Delta}.$$

Similarly, total differentiation of the government income identity (5.5) yields the partial derivatives of the price level with respect to the tax parameter and the government activity level as

$$\frac{dP}{d\tau} = -\frac{t_\tau}{P}\frac{dP}{d\Delta} \qquad \text{and} \qquad \frac{dP}{d\gamma} = \frac{g_\gamma}{P}\frac{dP}{d\Delta}.$$

Thus, as might be expected,

the marginal responses of the price level to increases in the marginal tax rate and government activity levels are, respectively, of the opposite and the same sign as that to an increase in real government deficit.

Finally, total differentiation of the money market equilibrium condition (5.6) yields the total derivative of the price level with respect to

the open market activity parameter η. We define the *excess demand for nominal money* (including credit) in dollars, pounds, etc. as

$$X^M \triangleq Pl - M.$$

Then the *marginal response of the excess demand for nominal money to an increase in the price level* is given by

$$\frac{dX^M}{dP} = \frac{\partial X^M}{\partial P} + \frac{\partial X^M}{\partial Y}\frac{dY}{dP} + \frac{\partial X^M}{\partial r}\frac{dr}{dP}, \tag{5.10}$$

that is,

> *the sum of the direct effects of the increase in price level and the indirect effects through changes in real output and the interest rate.*

We may now write the total derivative of the price level with respect to the open market activity parameter as

$$\frac{dP}{d\eta} = \frac{M}{dX^M/dP} = \frac{\eta dP}{dX^M} \cdot M.$$

Hence

> *the marginal response of the price level to an increase in net purchases of government securities*
> is given by *the ratio of:*
> *the first order approximation to marginal change in the nominal value of net purchases of government securities*
> *to:*
> *the marginal change in the excess demand for nominal money*
> *times:*
> *the nominal money supply.*

We are now in a position to analyse the response of our model to changes in the policy parameters.

Before doing so, however, it is worth pointing out that our system of six equations is only determined with a fixed value of the real government deficit parameter Δ. Our investigations of the federal budget and expenditure process as cited above, however, suggest that in practice the government deficit drifts—even for a fixed tax rate—in response to changes in the level of government spending. Such changes may be occasioned by both the normal operation of the federal expenditure process and by structural changes in the level of government

activity represented by the parameter γ. We emphasize that this does not contradict the statement made in §1 concerning the inefficacy of fiscal policy. The point is that the President, through the Office of Management and Budget, attempts to set fiscal policy at least eighteen months in advance of any expenditure. In the intervening months, the appropriations and expenditure processes and the course of events result in values of the fiscal policy variables far different to those planned, *cf.* Niskanen (1972). We shall have to take explicit account of the drift of the government deficit parameter Δ over time in the dynamic version of our model.

In order to analyse the response of the equilibrium represented by the solution of our system to changes in the policy parameters, we require various assumptions on the structure of the model. First, we mostly assume that the net marginal nominal government impact with respect to nominal GNP, $g_{PY} - t_{PY}$, is nonnegative.

Secondly, we sometimes assume a regime in which the Phillips curve operates, i.e.

$$\frac{dU}{dP} < 0.$$

Recall that (2.8) shows that this will be so if, and only if,

$$\frac{(\omega_P - f_N)}{f_{KN}} \Big/ \frac{r}{f_{KK}} > \in(r; P).$$

Thus if the effective marginal wage escalation is positive our assumption would permit the interest rate and the price level to move in opposite directions. Otherwise, when the effective marginal wage escalation is negative, the interest rate can, for example, rise with the price level to choke off the investment which would lead to a shortage of new labour. This is, to be sure, an example of the interaction of the productive and financial sectors in our model.

Finally, we need to make some assumptions about the partial derivatives of the supply and demand for money functions. In line with the discussion in the previous section, we shall assume that the partial derivatives of the supply and demand for money with respect to real gross national product and the price level are positive. We shall also make the assumption, consistent with the standard Keynesian position, that the partial derivatives of the supply and demand for money with respect to the interest rate are respectively positive and negative (due in the latter case to the small magnitude of wealth and direct investment effects). Hence

$$M_Y > 0, \quad M_r > 0, \quad M_P < 0, \quad l_Y > 0, \quad l_r < 0, \quad l_P > 0.$$

In terms of the excess demand for nominal money (including credit) X_M, which enters the total derivative of the price level with respect to the central bank open market activity parameter η, these assumptions become

$$\frac{\partial X^M}{\partial Y} > 0, \quad \frac{\partial X^M}{\partial r} < 0, \quad \frac{\partial X^M}{\partial P} > 0.$$

Thus we are assuming that *ceteris paribus*:

> *the marginal responses of the excess demand for nominal money with respect to an increase in real output and the price level are positive, while that to an increase in interest rate is negative,*

providing we assume that *ceteris paribus*, and in the absence of central bank activity, growth in real GNP will generalte excess demand for nominal money, i.e. $Pl_Y > M_Y$. This situation might well be reversed in a regime in which the net marginal nominal government impact is negative.

Of course, while these assumptions may be plausible in certain circumstances, their verification or rejection at any point in time is an empirical matter which awaits econometric estimation of the dynamic version of our model. However, the possible combinations of parameter values are legion; therefore we make the various plausible assumptions below only by way of illustration.

Note that under our assumptions the parameters χ and ψ in the expressions (5.7) and (5.8) for the total derivatives of the interest rate and real GNP with respect to the price level are both negative, viz.

$$\chi = \frac{\partial X^M/\partial r}{\partial X^M/\partial Y} < 0,$$

$$\psi = -\frac{\partial X^M/\partial P}{\partial X^M/\partial Y} < 0.$$

Further, from (5.9)

$$M_r > 0 \quad \text{and} \quad l_r < 0 \quad \text{imply} \quad \alpha + \chi < 0.$$

Hence, since from (5.7) we have that $dr/dP = (\psi - \beta)/(\alpha + \chi)$, it follows that

$$\frac{dr}{dP} \gtrless 0 \qquad \text{according as} \qquad \beta \gtrless \psi.$$

Similarly, since from (5.8) we have that $dY/dP = (\alpha\psi + \beta\chi)/(\alpha + \chi)$, it follows that

$$\frac{dY}{dP} \lesseqgtr 0 \qquad \text{according as} \qquad -\beta\chi \gtreqless \alpha\psi.$$

These conditions may be rewritten in terms of the ratios of the local responses of the model about the current equilibrium mentioned in the introducton to this section. First we define the *real activity/money market real output marginal response ratio* as

$$a \triangleq -\frac{(1-c_{Y\cdot})(1-g_{PY\cdot})}{\partial x^M/\partial Y},$$

which under our current assumptions is negative. Thus

the real activity/money market real output marginal response ratio
is given by *the ratio of:*
minus the product of the first order approximations to private and public domestic savings rates (out of real and nominal GNP respectively)
to:
the marginal ceteris paribus *response of the excess demand for nominal money to an increase in real output.*

Similarly, we define *the real activity/money market price level marginal response ratio* as

$$b \triangleq \frac{c_{W\cdot}W_P + I_P + (1+c_{Y\cdot})[(t_{PY\cdot} - Y - T) - \Delta + g_U U_P]/P}{\partial X^M/\partial P},$$

which under our assumptions is indeterminate. Thus

the real activity/money market price level marginal response ratio
is given by *the ratio of:*
the sum of three real terms involving the marginal ceteris paribus *responses to an increase in the price level of consumption from wealth, investment and consumer savings from government income*
to:
the marginal ceteris paribus *response of the excess demand for nominal money to an increase in the price level.*

Finally, we define the *real activity/money market interest rate marginal response ratio as*

$$c \triangleq \frac{c_{W\cdot}W_r + I_r + (1-c_{Y\cdot})g_{L\cdot}U_r/P}{\partial X/\partial r}$$

which under our assumptions is indeterminate (since although $W_r < 0$ is likely, and $I_r < 0$, the factor $U_r > 0$). Thus

> *the real activity/money market interest rate marginal response ratio*
> is given by *the ratio of:*
> *the sum of three real terms involving the marginal* ceteris paribus *responses to an increase in the interest rate of consumption from wealth, investment and consumer savings from government income*
> *to:*
> *the marginal* ceteris paribus *response of the excess demand for nominal money to an increase in the interest rate.*

Now $\beta \gtrless \psi$ if, and only if, $b \gtrless a$. Hence

$$\frac{dr}{dP} \gtrless 0 \qquad \text{according as} \qquad b \gtrless a,$$

that is,

> *the marginal response of the interest rate to an increase in the price level is positive or negative according as the real activity/money market marginal response ratio to the price level exceeds or falls short of that to real output.*

Further, $-\beta\chi \gtrless \alpha\psi$ if, and only if, $b \gtrless c$. Hence

$$\frac{dY}{dP} \gtrless 0 \qquad \text{according as} \qquad b \gtrless c,$$

that is,

> *the marginal response of real output to an increase in the price level is positive or negative according as the real activity/money market marginal response ratio to the price level exceeds or falls short of that to the interest rate.*

To study the sign of the total derivative of the price level with respect to the open market activity parameter η of the central banking authority, recall that the sign of $dP/d\eta$ depends on the sign of the total derivative of the excess demand for money with respect to the price level dX^M/dP given by (5.10). Note that under our assumptions the partial derivative of the money supply with respect to real output

$$M_{Y^\cdot} = [m_3\,\nu(1-\mu) + m_4\mu](g_{P^\cdot} - t_{P^\cdot}) > 0.$$

Should the marginal increase in tax receipts exceed the marginal increase in government expenditure with respect to nominal GNP, as clearly occurred in the early 1970s, the conclusions given below could be reversed. Hence we see that monetary and fiscal policy are intimately linked within our model; so that

> *within the model neither the extreme Keynesian nor the extreme monetarist position can be universally correct.*

We are now in a position to distinguish four regimes of behaviour of our model with respect to changes in the policy parameters according to the relative position of the parameters a, b and c.

Case 1: $c < b < a < 0$.

> *The real activity/money market marginal response ratio to the interest rate is less than that to the price level which is itself less than that to real output.*

All response ratios are negative, i.e. real activity and money market responses move in opposite directions.

This case corresponds to classical behaviour of the model. First, we note that $c < a$ implies that $c < 0$ which occurs if, and only if

$$(1 - c_Y)g_U U_r < -[c_W PW_r + PI_r].$$

This latter condition will be met in the classical economy in which government response to unemployment is nil, i.e. $g_U \equiv 0$, and workers are paid their marginal product, i.e. $\omega_P = \omega$. Further we will have that the partial derivatives of investment I_r and wealth W_r with respect to the interest rate are both negative. The condition $\omega_P = \omega$ implies that the partial derivative of investment with respect to the price level I_P is identically zero and the partial derivative of wealth with respect to the price level W_P is likely to be negative.

In general in this situation we have that

$$\frac{dY}{dP} > 0, \quad \frac{dr}{dP} < 0,$$

which under our assumptions implies that the responses to changes in government activity level are given by

$$\frac{dY}{d\gamma} > 0, \quad \frac{dP}{d\gamma} > 0, \quad \frac{dr}{d\gamma} < 0,$$

since $dP/d\Delta > 0$.

If, however, we are in the classical case with a neutral government, i.e. net marginal nominal government impact is zero, we will have also that

$$\frac{dI}{dP} > 0, \quad \frac{dU}{dP} \equiv 0, \quad \frac{d\pi}{dP} = \frac{dY}{dP} > 0, \quad \frac{dP}{d\Delta} < 0.$$

It follows that a *decrease* in government activity will raise real GNP and the price level, lower the rate of interest, increase investment, leave unemployment unchanged, and, since workers are paid their marginal product, the full increase in real GNP goes to real profit. Similar effects would occur from a decrease in the government deficit Δ or an increase in the tax rate τ.

In either case, the signs of the total derivatives of Y and r with respect to P imply that the total derivative of the excess demand for money with respect to the price level dX^M/dP is positive. Hence the effect of an increase in the money supply through open market operations of the central banking authority is the same as that of an increase in government spending in the first case. Namely, an increase in the money supply occasions an increase in real GNP accompanied by an increase in the price level and a decrease in the rate of interest.

Case 2: $b < c < a < 0$ or $b < a < c$.

> *The real activity/money market marginal response ratio to the price level is less than those to real output and the interest rate (whose relative values are immaterial).*

Thus it is possible that real activity and money market responses to the interest rate could move in the same direction; these responses to price level and real output must move in opposite directions.

In this case the model exhibits two modes of response to fiscal policy according as $dP/d\Delta$ is positive or negative. The first mode corresponds to the extreme Keynesian view of the world in which an increase in the money supply engenders inflation and a decrease in real GNP, while an increase in government spending occasions an increase in real GNP and a decrease in the price level.

> *When the marginal response of the price level to an increase in real government deficit is positive, the model displays the unpleasant modern phenomenon of* stagflation.

Specifically, we have that

$$\frac{dY}{dP} < 0, \quad \frac{dr}{dP} < 0,$$

so that in a regime in which regular government activity is nearly neutral and the Phillips curve operates to yield $dP/d\Delta < 0$,

$$\frac{dY}{d\gamma} > 0, \quad \frac{dP}{d\gamma} < 0, \quad \frac{dr}{d\gamma} > 0.$$

Hence, an increase in government spending increases real GNP, raises the interest rate, and decreases the price level; its effect on investment, unemployment and profit will depend on the response of wages to prices as discussed in §2. The effect of an increase in the real deficit Δ will be similar, while an increase in the rate of taxation τ will be opposite.

In a regime of negative net marginal government impact and positive effective wage escalation, i.e.

> *when nominal tax receipts exceed nominal government spending and wage settlements exceed productivity at the margin to yield a positive marginal response of the price level to an increas in real government deficit, an increase in government spending or deficit increases the price level and unemployment, and decreases real output and the interest rate, while an* increase *in tax rate produces the opposite effect.*

With regard to monetary policy, we see that for the total derivative of the excess demand for money with respect to the price level we have

$$\frac{dX^M}{dP} > 0 \text{ if, and only if, } \frac{\partial X^M}{\partial P} + \frac{\partial X^M}{\partial P}\frac{dr}{dP} > -\frac{\partial X^M}{\partial Y}\frac{dY}{dP}. \quad (5.11)$$

In this situation we have that

$$\frac{dP}{d\eta} > 0, \quad \frac{dY}{d\eta} < 0, \quad \frac{dr}{d\eta} < 0.$$

As in Case 1, an increase in the money supply increases the price level and decreases the rate of interst, but in this case it occasions a *decrease* in real GNP. Conversely, a decrease in the money supply leads to a situation which might be termed *central bankers' bliss.* Namely, a decrease in the money supply leads to a lowering of the price level, an increase in the rate of interest and a growth of real GNP.

In the situation above in which fiscal policy produces stagflation, the likelihood of the counteraction by the expansive monetary policy of the fiscal policy responses of all variables but the rate of interest (which will rise) is increased, due to the increased likelihood of the

failure of expression (5.11) to hold (since $\partial X^M/\partial Y$ is made more strongly positive by a negative M_Y term) leading to $dX^M/dP < 0$.

Case 3: $a < c < b$ or $c < a < b$.

The real activity/money market marginal response ratio to the price level exceeds those to real output and the interest rate (whose relative values are immaterial).

Thus it is possible that only the real activity and money market responses to real output move in opposite directions, while their responses to increases in the price level and the interest rate move together.

This case provides a description of the performance of Western economies during the post-war period. In this situation real GNP, the price level and the interest rate move together in response to policy variables. In the dynamical version of the model, this is the regime consistent with the persisting business cycle; real growth is accompanied by inflation and a tightening of the interest rate while real decline is accompanied by a falling of the price level and interest rate.

Specifically, we have that

$$\frac{dY}{dP} > 0, \quad \frac{dr}{dP} > 0.$$

Hence, it follows that under our usual assumptions $dP/d\Delta > 0$, so that

$$\frac{dY}{d\gamma} > 0, \quad \frac{dP}{d\gamma} > 0, \quad \frac{dr}{d\gamma} > 0.$$

Again, the response of investment, unemployment and profit to government spending will depend on the behaviour of the wage rate with respect to the price level. Further the effects of changes in government deficit Δ and the tax rate τ will be, respectively, the same and opposite as that of a change in government activity level γ.

With regard to monetary policy, providing that

$$0 > \frac{\partial X^M}{\partial r} > -\left[\frac{\partial X^M}{\partial P} + \frac{\partial X^M}{\partial Y}\frac{dY}{dP}\right] \Big/ \frac{dr}{dP},$$

we will have that the total derivative of the excess demand for money with respect to the price level dX^M/dP is positive. Hence, the total derivatives of real GNP and the price level will be given by

$$\frac{dY}{d\eta} > 0, \quad \frac{dP}{d\eta} > 0 \quad \text{so that} \quad \frac{dr}{d\eta} > 0.$$

Hence, although an increase in the money supply occasions growth in real GNP, it is accompanied by an increase in both the price level and the rate of interest. Conversely, the tightening of the money supply decreases the price level and the rate of interest, but only at the expense of a decline in real GNP.

Case 4: $a < b < c$.

> *The real activity/money market marginal response ratio to the interest rate exceeds that to the price level which in turn exceeds that to real output.*

This occasions similar possibilities to Case 3 with regard to the relative responses of real activity and the money market to increases in real output, the price level and the interest rate.

In this case the model can display the behaviour which has been the target of neo-Keynesian fiscal policy in the post-war period, providing (as we saw in Case 2) the marginal response of the price level to an increase in real government deficit is negative. Otherwise the stagflation phenomenon is again possible, accompanied here by an *increased* rate of interest, as a response to increased government activity. With regard to monetary policy, it has two modes of behaviour depending on the sign of the total derivative of the excess demand for money with respect to the price level. One mode yields the target behaviour of monetarist policy in the post-war period; the other yields the preconditions for hyperinflation.

Specifically, we have that

$$\frac{dY}{dP} < 0, \quad \frac{dr}{dP} > 0.$$

It follows that when $dP/d\Delta < 0$,

$$\frac{dY}{d\gamma} > 0, \quad \frac{dP}{d\gamma} < 0, \quad \frac{dr}{d\gamma} < 0.$$

Thus, as in the Keynesian ideal world, an increase in government spending occasions an increase in real GNP and a decrease in the price level and the interest rate. As before, the response of investment, unemployment and profit will depend on the rate of change of the wage rate with respect to the price level. Real GNP, the price level and the rate of interest will respond similarly to an increase in the government deficit Δ and to an *increase* in the tax rate τ.

With regard to monetary policy, we would hope that the total derivative of the excess demand for money with respect to the price level would be negative, i.e.

$$\frac{dX^M}{dP} < 0 \text{ if, and only if, } \left[\frac{\partial X^M}{\partial r}\frac{dr}{dP} + \frac{\partial X^M}{\partial Y}\frac{dY}{dP}\right] > \frac{\partial X^M}{\partial P} > 0. \tag{5.12}$$

Indeed, then we have for the response of the major variables to the open market operation parameter that

$$\frac{dP}{d\eta} < 0, \quad \frac{dY}{d\eta} > 0, \quad \frac{dr}{d\eta} < 0.$$

Hence, an increase in the money supply occasions an increase in real GNP accompanied by a decrease in the price level and the interest rate at equilibrium. This is the situation in which Professor Friedman's argument for a steady increase in the money supply is valid.

It is worth emphasizing that we have seen above that the same response of the model economy obtains when the total derivative of the excess demand for money with respect to price level is positive and the net marginal nominal government impact is negative, i.e. $t_{P1'} > g_{P1'}$, to yield $dP/d\Delta < 0$. Then, in the recently occurring situation in which the marginal tax return exceeded he marginal increment in government expenditure due to inflation, the subsequent effective decrease in government expenditure could be counteracted by an increase in the money supply.

If, on the other hand, the total derivative of the excess demand for money with respect to the price level is positive, i.e. the converse of (5.12) holds, we have the *preconditions for hyperinflation*:

$$\frac{dP}{d\eta} > 0, \quad \frac{dY}{d\eta} < 0, \quad \frac{dr}{d\eta} > 0.$$

In this situation, an increase in the money supply causes an increase in the price level and an accompanying increase in the interest rate together with a decrease in real GNP. A hyperinflation would take place if, in response to the increase in excess demand for money with respect to the price level, the central banking authority continues to increase the money supply, leading to a depression of real activity in the economy and a growth of the interest rate close to one.

To conclude the analysis of the response of the model to internal policy parameters in all four cases, we need merely note that the response of the system to changes in the reserve requirement ratio

ρ and the rediscount rate R are opposite to those of the open market activity level parameter λ of the central banking authority.

Wlith regard to external economic variables taken as parameters in our model—namely, net exports X and net foreign capital transfers F—we note that a decrease in exports, such as that occasioned by the recent oil increase, for example, will lead to a direct decline in real GNP, while an increase in foreign capital reserves on domeestic deposit will have the same effects as an increase in the money supply. In the U.K. at least, it might be argued that net exports X are primarily a function of the wage rate $\omega(P)$, and net foreign capital transfers F primarily a function of the interest rate r, in the domestic economy. Such considerations are easily incorporated in the model. In this connection see McKinnon (1975).

This completes the comparative static analysis of the present model. Further analysis of its behaviour awaits a dynamic specification and the econometric estimation of its parameters.

6. Conclusions and policy recommendations

In this paper we have set out the comparative static version of a model which details the macroeconomic behaviour and interaction of the productive, financial and government sectors of a national economy. The six equations determining real output, investment, employment, profit, the price level and the interest rate have been analysed with respect to both domestic policy parameters and the effects of the global economy as represented in the balance of payments and net foreign capital transfers. The analysis of the productive sector is essentially neoclassical with the exception that the wage rate is allowed to depend on the price level in order to represent collective bargaining processes. This analysis allowed a consideration of output, investment and unemployment in terms of the relative effects of the price level and the rate of interest on capital and labour intensities at equilibrium. A by-product was an analysis of the conditions under with the Phillips curve can be expected to hold.

Although we have retained the textbook national income identity supplemented by a tax function representing a progressive tax structure in nominal GNP, we have replaced the standard government expenditure parameter with a government expenditure function based on our work cited in the Introduction. We have argued that the lags in fiscal policy are such that, barring a major change in government activity level, government expenditure is better modelled as reacting to nominal GNP and unemployment.

Our modelling of the capital markets is radically different to that generally accepted by both Keynesian and monetarist schools of macroeconomics. Although we retain the implicit treatment of the bond market as moving in parallel with the stock market, we have explicitly introduced the stock market index, reacting to the natural financial and real variables, as the principal determinant in the demand for money (including credit) for investment in new capital. This demand has replaced the standard Keynesian speculative demand for money, which in our model appears on the supply side of the money market equation. This demand for money term is, through the stock market, a major link between the financial and productive sectors of the economy. Our treatment of the supply of money intimately links the response of the money market, and hence the economy, to the marginal responses of taxation and government expenditures to changes in nominal GNP.

We have seen that the response of the model to changes in the parameters is capable of exhibiting a wealth of behaviours ranging from the neoclassical to the target behaviour of both the Keynesian and monetarist schools of macroeconomics. Naturally, a thorough analysis of the response of the model in a realistic situation awaits the dynamic specification and estimate of the basic functional forms. This we must leave to future papers.

In the meantime, however, some questions of interest can be raised and tentative policy conclusions put forward. First, it is clearly important to make estimates of the crucial response ratios of the previous section so as to decide the regimes in which the modern Western economies currently find themselves. Unlike the standard textbook analyses, our analysis shows that the effects of domestic policy variables will be radically different depending on the values of these parameters. Secondly, the effects of monetary policy have been seen to depend on the relative magnitudes of the marginal increase in taxation and government spending with respect to nominal GNP, the net marginal nominal government impact. In the situation sometimese assumed in the previous section, i.e. that marginal government spending exceeds marginal government taxation with respect to nominal GNP, we see that we may expect the relative share of government expenditure in GNP to grow with the growth of the economy *however induced*. For the policy recommendations of the monetarist school to be valid in this situation in the target regime, we have seen that the marginal excess demand for money must fall with an increasing price level. Finally, we must emphasize that we have analysed the response of the equilibrium represented by the solution to our model to policy

parameters one at a time. In practice, of course, they are moved simultaneously—often in opposition to each other. In our model the marginal effects of these parameters may be added, but, even if the conditions for the target regimes of both Keynesian and monetarist schools are met, the effects of increased government expenditure could be overwhelmed by a tightening of the money supply to produce a decline in real GNP and an increase in the price level—the modern phenomenon of 'stagflation'. The effects of a tight monetary policy will be exacerbated, *in the absence of a counteracting increase in government activity level*, if the conditions of the Keynesian target regime are met through an excess of the marginal increment of tax take over that of government spending with respect to *nominal* GNP. In our opinion, this has been the principal cause of the current round of inflation and simultaneous recession.

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