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David Laidler

Patrick O'Shea

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THE UNITED KINGDOM 1954-1970

by

David Laidler
and

Patrick O'Shea

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AN EMPIRICAL MACRO MODEL OF AN OPEN ECONOMY UNDER FIXED
EXCHANGE RATES: THE UNITED KINGDOM 1954-1970*

by

David Laidler and Patrick O'Shea

University of Western Ontario and Reserve Bank of Australia

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I

INTRODUCTION

By their very nature, the analytic models which we use to teach macroeconomics to our students, and to organize our thinking about policy issues, are highly simplified. There is nothing wrong with leaving out of a model factors that are present in the real world of course, provided that what is left out is, given the purpose of the model, unimportant relative to what is left in. One test of whether the appropriate selection has been made is to compare the predictions of the model with empirical evidence, but we impose this discipline on ourselves only sporadically when dealing with small analytic models. It is true that widely used components of such models, for example, the aggregate demand for money function, have been subjected to empirical investigation. However, we do not usually test any small model as a whole against empirical evidence. Nowhere does this neglect of empirical testing lead to more difficulties than in the area of macroeconomics of inflation in open economies. The literature presents us with models in which the "law of one price" rules at all times for all goods, and others in which it holds only for "tradable" goods, and with others in which it is a long-run but not a short-run law; in some models the balance of payments immediately responds to offset the effects on the money supply of domestic policy, and others in which it does so only gradually; in some models perfect capital mobility is assumed, and in others complete immobility, and so on.

It is our contention that only empirical work can bring any discipline to the existing proliferation of models and analytic results. In this paper we construct a small-scale model that determines the behavior of real income, prices, the balance of payments and the money supply in an open economy. We then subject the model as a whole to empirical testing, and then draw conclusions from that

testing about which aspects of the model do appear to be consistent with the evidence and which do not. Thus we seek to make a three-fold contribution. First, we present (yet another) small analytic model; second, we generate evidence about its empirical content; finally, and perhaps most important, we provide an example of how empirical work may be used to discipline and guide the process of model building even at a high degree of aggregation and abstraction.

II

THE MODEL

Our model consists of six equations: a demand for money function, an output equation, an expectations augmented Phillips curve, expressions determining inflation expectations and the balance of payments, and lastly a money supply identity. These equations are all log-linear with the exception of the additive money supply identity, to which a standard log-linear approximation is used. There are four exogenous variables: the "natural" level of output Y^* , the foreign price level Π , the exchange rate E , and domestic credit extended by the banking system C . The six endogenous variables are actual output Y , the domestic price level P , the price level that is expected to rule in the next period P^e , the level of foreign exchange reserves R , and the quantity of nominal money balances supplied M_s and demanded M_d . We abstract from economic growth and treat Y^* , which also stands for permanent income in two of the model's behavior relationships, as a constant. Finally we indicate time lags by subscripts -1 , -2 , etc., and use Δ as the first time difference operator.

The demand for money function is straightforward. It makes the demand for real balances depend solely upon permanent income. Because the latter variable is constant in this model, the precise form of this function is

irrelevant. It is convenient, therefore, to write it with units of measurement so chosen that both real balances demanded and permanent income per period take a value of unity, thus

$$\frac{M_d}{P} = Y^* \cong 1 \quad (i)$$

This relationship ignores the well-established role of an opportunity cost variable in determining the demand for real balances. However, it is an empirical question, which will be taken up below, as to just how much accuracy is here sacrificed to analytic simplicity by this omission.

The model's output equation is

$$Y = \left[\left(\frac{M_s}{M_d} \right)^{\alpha_1} \cdot \left(\frac{\Pi}{P} E \right)^{\alpha_2} \right]^{-1} \quad (ii)$$

It says that output (including that of net exports), is equal to permanent income when the demand for money equals the supply of money, and when, at the going exchange rate, the domestic price level equals that ruling abroad.

The term $\frac{M_s}{M_d}$ is included to capture the influence that monetary factors can have on domestic output by way of their influence on private expenditure. To distinguish between the quantity of money demanded and supplied as we do here means that the economy is permitted to be "off" its demand for money function. It is a commonplace of verbal discussions of the transmission mechanism of monetary policy that the existence of an excess supply (or demand) of cash balances leads to a revision of the private sector's spending plans. When it comes to formal modelling of the role of monetary policy it is much less common to find such an idea translated into algebra, but that is all that is done here.¹ It is worth noting explicitly that equation (ii) in no way rules out a chain of causation that runs from excess cash to an increase in output

by way of attempts to substitute financial assets for money, a consequent fall in interest rates and an increase in investment expenditure; nor does it rule out a direct real balance effect on current consumption. The equation simply states that a stock disequilibrium in the money market will lead to a change in the rate of flow of output in response to the public's attempts to eliminate that stock disequilibrium; it is silent about the channels through which this will occur, and about the composition of the resulting change in output.

Clearly the significance of the term $\frac{\Pi}{P} E$ in equation (ii) depends upon the units in which the variables are measured. With the exchange rate set at unity, then, given the units of measurement of Π , those for P are chosen so that, in the absence of any other disequilibrating force, the balance of payments will be equal to zero when domestic and foreign prices are equal. Equation (ii) thus says that, given money market equilibrium, aggregate output will be at its full employment level when the balance of payments is in equilibrium, that is, when the balance of trade just fills the gap between domestic expenditure and output at full employment and simultaneously offsets any long-run equilibrium capital flows.

The expectations augmented Phillips curve is written as follows.

$$\frac{P}{P}_{-1} = \left(\frac{P^e}{P}\right)_{-1} \cdot \left(\frac{Y}{Y^*}\right)_{-1}^{\beta} \quad (\text{iii})$$

The variable $\frac{Y}{Y^*}$ is a commonly used excess demand proxy while $\frac{P^e}{P}$, the expected rate of inflation, is given by,

$$\frac{P^e}{P} = \left(\frac{\Pi}{\Pi}\right)_{-1} \cdot \left(\frac{\Pi}{P} E\right)^{\epsilon} \quad (\text{iv})$$

According to equation (iv), prices are expected to rise at the rate observed

to be ruling abroad, provided that domestic and foreign prices are equal to one another in the sense already discussed.² If they are not, then domestic prices are expected to move more rapidly (or slowly) in order that such equality be established. In short, the public expect the general price level to move towards a value compatible with balance of payments equilibrium. Equation (iv) tells us that an exogenous change in the exchange rate would have a "catch up" effect on domestic prices, but implicit in it is the assumption that exchange rate movements are always unanticipated.

The balance of payments equation is written, with R the level of reserves,

$$\frac{R}{R_{-1}} = \left(\frac{M_s}{M_d} \right)^{\gamma_1} \cdot \left(\frac{\Pi}{P} E \right)^{\gamma_2} \quad (v)$$

This expression abstracts from many factors that might be considered important, on a priori grounds, for the balance of payments: for example, foreign and domestic income levels, or generalized asset as opposed to specifically monetary disequilibrium. The importance or otherwise of these omissions is once more an empirical issue which will be taken up below. The presence of $\frac{M_s}{M_d}$ here implies that, when the public attempts to adjust to monetary disequilibrium, the resulting changes in expenditure flows may involve foreign goods and assets, and may also divert domestic production from or into exports, as well as leading to changes in domestic output. This monetary disequilibrium term does not therefore reflect exclusively capital account transactions. Moreover, though relative prices would certainly be expected to influence the trade account, and are included in the output equation (ii) for just that reason, one should not associate the term $\frac{\Pi}{P} E$ in equation (v) solely with the current account. If domestic prices are "too high" then any speculation against the domestic currency that this might provoke would influence the capital account.

The model's final equation, the money supply identity, needs no comment.

$$M_s = R + C \quad (vi)$$

It is convenient to rewrite this model explicitly in logarithmic terms. Only two "tricks" are involved here. First, $\frac{R}{M_s}$ is defined as μ and treated as a constant in order to obtain an approximation to the logarithmic first difference of equation (vi). Secondly, recall that Y^* and E are equal to unity so that their logs are zero. With lower case letters standing for logarithms, the model is as follows.

$$m_d = p \quad (1)$$

$$y = \alpha_1 (m_s - m_d)_{-1} + \alpha_2 (\pi - p)_{-1} \quad (2)$$

$$\Delta p = (p^e - p)_{-1} + \beta y_{-1} \quad (3)$$

$$p^e - p = \Delta \pi + \varepsilon (\pi - p) \quad (4)$$

$$\Delta r = \gamma_1 (m_s - m_d)_{-1} + \gamma_2 (\pi - p)_{-1} \quad (5)$$

$$\Delta m_s = \mu \Delta r + (1 - \mu) \Delta c \quad (6)$$

If we substitute equation (1) into equations (2) and (5), and equation (4) into equation (3) the resulting four equations may be solved for any of the endogenous variables. It will suffice to illustrate the model's properties if we present only the reduced-form equation for y . It is,

$$\begin{aligned} y = & \alpha_1 (1 - \mu) \Delta c_{-1} - (1 - \varepsilon) (1 - \mu) \alpha_1 \Delta c_{-2} + \alpha_2 \Delta \pi_{-1} \\ & - [(2 - \mu \gamma_1) \alpha_2 + (1 - \mu \gamma_2) \alpha_1 + \varepsilon \alpha_1] \Delta \pi_{-2} \\ & + [(1 - \mu \gamma_1) \alpha_2 + (1 - \mu \gamma_2) \alpha_1] \Delta \pi_{-3} \\ & + [2 - \varepsilon - \mu \gamma_1] y_{-1} - [1 + \varepsilon + \beta (\alpha_1 + \alpha_2) - (1 - \varepsilon) \mu \gamma_1] y_{-2} \\ & + \beta [(1 - \mu \gamma_1) \alpha_2 + (1 - \mu \gamma_2) \alpha_1] y_{-3} \end{aligned} \quad (7)$$

Consider first of all the steady state properties of this equation. Holding the value of each variable in equation (7) constant over time, and indicating such constancy by putting a "hat" over the variable, we may reduce (7) to

$$\hat{y} = \epsilon\alpha_1(1 - \mu)\hat{\Delta c} - \epsilon\alpha_1\hat{\Delta\pi} \quad (8)$$

Equation (8) seems to imply that the steady state value for y is not necessarily zero, that the "natural" level of income is not the only long-run solution for the model. Mathematically speaking this is indeed the case, but the model's economic properties require that we consider this matter a little further.

We have treated Y^* as representing permanent income and it is hard to sustain this interpretation if actual income perpetually and systematically deviates from this level. Moreover, equation (3) implies that, if y takes any value other than zero, then the actual and expected inflation rates would differ from one another. It is hard to believe that the rule for the formation of inflation expectations embedded in this model would be maintained by economic agents if it perpetually and systematically misled them. It can be shown that the steady state solution of the model for Δp has it equal to $\Delta\pi$ regardless of the value of Δc . Thus, a value for \hat{y} other than zero would imply that domestic and world prices were at a relative level incompatible with balance of payments equilibrium. However, if we set \hat{y} at zero so that relative prices are in equilibrium we find that equation (8) implies

$$\hat{\Delta c} = \frac{1}{1 - \mu} \hat{\Delta\pi} \quad (9)$$

This is precisely the rate of domestic credit expansion which will just satisfy the rate of growth of the demand for money with no change in foreign exchange reserves. Hence our formulation of inflation expectations has implicit in it the assumption that agents expect the monetary authorities to aim at maintaining,

in the long run, a constant level of reserves. If the rate of domestic credit expansion appropriate to that end is adhered to, the model will converge on full employment. If it is not, then the resulting "steady state" solution for income can persist only for so long as agents fail to realize that the expectations that they are holding will not, in the long run, be fulfilled.³

The properties of the model in what we might term a "false" steady state are of some interest. Suppose that, in the economy being analyzed, the conduct of monetary policy had initially been consistent with long-run balance of payments equilibrium, and suppose that the world inflation rate had then increased. Equation (8) tells us that if the domestic authorities maintained the rate of domestic credit expansion constant, unemployment would result. At the same time a balance of payments surplus and a tendency for the domestic inflation rate to increase up to the world level would accompany real stagnation. In short, a failure of the authorities to adjust domestic monetary policy to changed conditions in the rest of the world, when the general public expects a fixed exchange rate to be maintained, is the explanation that this model would offer for the phenomenon of persistent "stagflation" in an open economy. On the other hand, the model also tells us that a rate of domestic credit expansion too rapid to enable the exchange rate to be maintained in the long run will be accompanied by what is often termed "over full employment" but by an inflation rate equal, in the long run, to that ruling in the rest of the world.⁴

The other properties of the model, as revealed by equation (7) hold no surprises. It can be shown that the third-order difference equation that describes the behavior of the endogenous variables when they are away from their steady state values may or may not be stable, and may or may not generate

cyclical behavior depending upon the relative sizes of the various parameters of the model; but it is worth noting that, if the model did turn out to be unstable, it would seem appropriate to introduce extra constraints into its structure along the lines of Hicks' (1950) business cycle model. One of the endogenous variables is, after all, income, and it would hardly make sense for this to expand without limit regardless of productive capacity constraints. Similarly there is nothing remarkable about the impact multipliers in equation (7). Those on the domestic credit expansion rate alternate in sign, with a preponderance of positive effects, while those on the world inflation rate, though also alternating in sign, show a preponderance of negative influence: we have already seen as much in our discussion of the model's steady state properties.

Be that as it may, how much attention we should pay to this model's properties must ultimately depend upon the degree to which they reflect those of an actual economy. At this stage we do not know whether our model is telling us anything about the world we live in, and so we now turn to a discussion of the empirical tests which we have carried out upon it.

III

EMPIRICAL ESTIMATION

In order to render our model empirically testable against British data, a number of adjustments must be made to it, adjustments which, however, make no important difference to its analytic properties. Consider first of all our "permanent" or "natural" income variable Y^* . This cannot be treated as a constant in any economy that is systematically growing over time so we treat Y^* as the trend value of income in any year. Having done this, we are no longer able to choose units of measurement so that this variable is always equal to

unity, and we must make two further adjustments to our analysis.⁵ First of all the variable y becomes the logarithm of the ratio of actual to trend income--rather than simply the log of actual income as it is when permanent income is set equal to unity. Second, when permanent income varies, it becomes necessary to postulate a particular form for the demand for real balances function (equation (1)). We choose a log-linear form, so that equation (1) becomes

$$M = \delta_0 + \delta_1 y^* + p \quad (1')$$

Consider next the choice of units in terms of which domestic and foreign prices, and the exchange rate, are measured. In the preceding analysis the exchange rate was set at unity and hence vanished. Domestic and foreign price levels were measured so as to be equal to one another when at levels compatible with long-run balance of payments equilibrium. For empirical purposes the exchange rate and domestic and foreign prices must be measured by index numbers. These are given a value of unity for 1970. The expression $(\pi - p)$ is thus replaced by $(\pi + e + a - p)$ in equations (2), (3), (4) and (5): e is the log of the exchange rate, which did, of course, change during the period to which the model was fitted, while a stands for the amount by which the log of domestic prices fell short of a value compatible with long-run balance of payments equilibrium, given the value of world prices and the exchange rate, in 1970s. It is worth noting that initially, instead of a coefficient of unity being imposed on $\Delta\pi_{-1}$ in equation (4), this coefficient is estimated as $\epsilon^{1.6}$.

Finally the balance of payments equation and the money supply identity need some modification to make them compatible with postwar British data. Equation (5) determines the "balance of official settlements," or "total currency flow" concept of the balance of payments, and is written as if this

balance was identical to an economy's change in foreign exchange reserves. In fact, a payments imbalance may be met either by reserve changes, or by official borrowing or lending overseas. Moreover, even under nominally fixed rates, exchange rate changes do take place, and lead to changes in the value of foreign exchange reserves that are unrelated to international movements of currencies. In dealing with these problems we followed Jonson (1974) in re-defining the money supply identity as

$$M \equiv C + (R - L) \quad (\text{vi}')$$

where L is the monetary authorities' net foreign indebtedness, so that equation (6) becomes

$$\Delta M_s = \mu_1 \Delta C + \mu_2 \Delta r + (1 - \mu_1 - \mu_2) \Delta \ell \quad (6')$$

For the British economy, C has sometimes exceeded M so that (R - L) becomes negative and its logarithm is not defined. It thus proves convenient to include L as an extra exogenous variable on the right-hand side of equation (5) which then becomes,

$$\Delta r = \gamma_1^1 (M_s - M_d)_{-1} + \gamma_2^1 (\pi + e + a - p)_{-1} + \gamma_3 \Delta \ell \quad (5')$$

$$\text{with } \gamma_1^1 \equiv \frac{\mu_2}{\mu_2 + \mu_3} \gamma_1, \quad \gamma_2^1 \equiv \frac{\mu_2}{\mu_2 + \mu_3} \gamma_2 \quad \text{and} \quad \gamma_3 \equiv - \frac{(1 - \mu_1 - \mu_2)}{\mu_2}$$

The model was fitted to annual data for the British economy for the period 1954-70. These are set out in an Appendix. Y is real gross domestic product at market prices. Y* was obtained by fitting a log-linear trend to these data, so that y is the residual of the actual income series about that trend.⁷ P is the consumer price index, Π is a GNP weighted average of the price indices for seventeen other countries, while E, the exchange rate, is a similarly weighted average of the prices of those countries' currencies in terms of sterling. In both cases the weights are geometric so that $e + \pi$ yields a value

for the log of the foreign price level in terms of domestic currency. The money supply series used is for the (broad) M_3 definition of money, C is domestic credit outstanding (also broadly defined) while the series for R , and L have already been described. All of these monetary data come from Jonson (1975) where their precise derivation is described. Suffice it here to note that the change in the value of official reserves that arises from the exchange rate change of 1967 is attributed to Δl , in the observation for that year, and hence is treated, as it should be, as an exogenous change in reserves.

The model was estimated, with all cross and within equation constraints on parameter values implied by the model imposed, by Full Information Maximum Likelihood Techniques, using the program developed by Dr. Clifford Wymer. The results are presented in Table 1, and are far from satisfactory. Only the Phillips curve and the approximation to the money supply identity provide us with plausible, well-determined, parameter estimates; the parameters of the demand for money function are highly implausible and their standard errors are enormous; while the parameters α_1 , α_2 and γ_1 take the wrong sign. In short, appealing though our model may be as an analytic abstraction, it clearly leaves out factors that have been of considerable importance in the real world.

One obvious omission from the original model is fiscal policy. To revert to natural numbers for a moment, with T the average tax rate for the economy, and G government expenditure, the model's original output equation (ii) was respecified as

$$Y = k \left[\left(\frac{M_s}{M_d} \right)^{\alpha_1} \cdot \left(\frac{P}{E} \right)^{\alpha_2} \cdot T^{-\rho} \right] Y^* + G \quad (ii')$$

A log-linear approximation to this expression may, following a formula provided

TABLE 1

<u>Parameter</u>	<u>Estimate</u>	<u>Asymptotic Standard Error</u>	<u>T</u>
δ_0	-21.188	2987.590	.01
δ_1	8.214	1047.849	.01
α_1	-.0003	.053	.01
α_2	-.172	.078	2.22
β	1.072	.253	4.24
ϵ	.166	.053	3.10
ϵ^1	.853	.223	3.82
γ_1	.006	.793	.01
γ_2	1.912	1.006	1.90
μ_1	.287	.064	4.51
μ_2	.731	.062	11.73
a	.098	.027	3.44

by Wymer (1976), be derived as follows.⁸

$$y = \alpha_1^1 (m_s - m_d)_{-1} + \alpha_2^1 (\pi + e + a - p)_{-1} - \alpha_3^1 t_{-1} + \alpha_4^1 g \quad (2'')$$

$$\text{where } \alpha_1^1 = k\alpha_1, \alpha_2^1 = k\alpha_2, \alpha_3^1 = k\rho \text{ and } \alpha_4^1 = (1 - k).$$

All terms in this expression are to be interpreted as deviations of the logarithm of the variable in question from its steady state value. For the variable y this presents nothing new, because y^* is the steady state value of the log of income. Nor does this present any problems for the expressions $(\pi + e + a - p)$ and $(m_s - m_d)$ for these too are already defined so as to equal zero when the model is in its steady state. However, t and g are the deviations of the tax rate and government expenditure respectively from their steady state values, and this raises two issues.

The first of these is a straightforward one of measurement: how do we estimate the "steady state" value of these two exogenous variables? In the case of government expenditure this was taken to be the log-linear trend value of the variable, and, in the case of the tax rate, which was trend free, the mean value of the variable should have been used.⁹ Government expenditure is measured by central and local government expenditures on current and capital account, and the tax rate by the ratio of taxes minus transfer payments (excluding national health service accounts) to national income. Both series come from Jonson (1975) and are presented in the Data Appendix to this paper.¹⁰

The second issue raised by equation (1'') concerns the properties of the model once it is modified in this way. In particular, because g and t are deviations from a steady state value of the variables in question, what we may term "long-run crowding out" is imposed upon the model: in the steady state, the value of both these fiscal policy variables is, by definition,

zero.¹¹ "Short-run crowding out" is of course left open as an empirical issue.

The results obtained with the modified model are presented in Table 2, and speak for themselves. The improvement produced by introducing the fiscal policy variables is quite dramatic. Not only do these variables themselves carry well-determined coefficients, and of reasonable orders of magnitude, but virtually all the problems with other parameters, so evident in Table 1, are also cleared up. Only α_1 remains with a wrong sign, and α_2 , though of correct sign, is not well-determined. The problem here appears to be one of multicollinearity. In Britain, the years after 1967 saw a lower exchange rate, tight monetary policy and tight fiscal policy. We have already seen what happens when fiscal policy variables are omitted from equation (2). Further experiments, whose detailed results need not concern us here, show that less is lost by omitting monetary variables from equation (1) than by leaving them in and instead omitting the international relative price level term.¹² Moreover, the reader will have noted that ϵ^1 , the coefficient of $\Delta\pi$ in equation (4), in fact is estimated (to three decimals) as precisely equal to its theoretically assigned value of unity. Thus, with this coefficient constrained to be exactly one, and α_1 constrained to zero we get the results presented in Table 3. These are only marginally different from those presented in Table 2, and are worth commenting on at some length.

Let us begin with specifics. All the coefficients are of the right sign, and with the exception of α_2 are highly statistically significant. Moreover, they are of plausible orders of magnitude. To begin with, μ_1 and μ_2 do approximate the ratios of domestic credit and reserves to the money supply-- and there is no technical reason why this should be the case. The coefficient ϵ tells us that domestic prices do indeed tend to approach an equilibrium level vis-à-vis foreign prices, closing 20% of any existing gap in any year. Moreover, a , which tells us in principle about the extent to which sterling was

TABLE 2

<u>Parameter</u>	<u>Estimate</u>	<u>Asymptotic Standard Error</u>	<u>T</u>
δ_0	.928	.138	6.73
δ_1	.397	.032	12.64
α_1^1	-.058	.086	.68
α_2^1	.140	.102	1.36
α_3^1	.286	.062	4.59
α_4^1	.221	.053	4.199
β	1.591	.202	7.88
ϵ	.213	.057	3.71
ϵ^1	1.000 (3)	.215	4.66
γ_1	-2.258	.748	3.02
γ_2	2.861	.989	2.89
μ_1	.277	.055	5.04
μ_2	.756	.051	14.08
a	.098	.029	3.44
α_0	-.342	.057	5.95

TABLE 3

<u>Parameter</u>	<u>Estimate</u>	<u>Asymptotic Standard Error</u>	<u>T</u>
δ_0	.916	.140	6.55
δ_1	.398	.031	13.00
α_1^1	0	value imposed	
α_2^1	.062	.054	1.15
α_3^1	.231	.042	5.54
α_4^1	.171	.039	4.43
β	1.445	.195	7.42
ϵ	.202	.054	3.73
ϵ^1	1.000	value imposed	
γ_1	-2.410	.801	3.01
γ_2	3.094	1.070	2.89
μ_1	.263	.053	4.97
μ_2	.773	.048	15.97
a	.102	.015	6.94
α_0	-.294	.045	6.49

overvalued in 1970, suggests that the amount in question was about 10%. If, as is widely believed, the British exchange rate was an equilibrium one in the second half of the 1950s, then simple arithmetic applied to the data in the Appendix tells us that the currency was overvalued by about 8% in 1970: well within one standard error of the estimate provided by our model. The estimate of income elasticity of demand for money, 0.4, is certainly too low. Our tentative suggestion is that the omission of an interest rate from the demand for money function lies at the root of this. Interest rates did, on balance, rise over the period to which our model is fitted. The model's structure forces the rising velocity of circulation, to which theory tells us this should have led, to be attributed to rising permanent income, hence biasing downwards our measure of the income elasticity of demand for money.

It may well be that misspecification of the demand for money function lies at the root of our inability to find a role for the quantity of money to play in influencing domestic output, but we must be careful not to push this argument too far. Our model does after all attribute a well-determined role to monetary policy in influencing the balance of payments. In any event, a value of zero for α_1 does not mean that monetary policy does not influence expenditure on goods and services; rather it implies that, to the extent to which it does so, the goods in question are imported, diverted from exports, or drawn from existing inventories, rather than being added to current output. Nevertheless, on the classic issue of monetary versus fiscal policy as an influence on economic activity, our results are clearcut: as far as Britain under Bretton Woods was concerned, government expenditure and taxes were the decisive policy variables influencing real income. The influence of monetary policy was on the balance of payments. It would be surprising if the inclusion of a better specified demand for money function in the model altered these results.¹³

The performance of the model can be further assessed from the results of dynamic simulation exercises. These were carried out for the years 1954-71, or one year beyond the period to which the model was fitted. These results are portrayed in the various panels of Chart 1, while goodness of fit statistics are given in Table 4. Two shortcomings of the model are immediately apparent from these exercises. First, the balance of payments equation performs badly despite the statistical significance of its parameters. Second, although the model stays reasonably well "on track" until 1969, it begins to go wrong in 1970 and produces nonsense results for 1971. Attempts to estimate the model to an extended time series that includes the period of floating exchange rates that began in 1972 have proved futile so far; its poor performance for the two preceding years suggests that the factors causing this are not solely associated with a change in the exchange rate regime.¹⁴ Our conjectures about these matters are discussed in the following, and final, section of this paper.

IV

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

The empirical results presented in the last few pages tell us something about recent British economic history, and about the validity of the model which generated them. They also raise at least as many questions as they settle. Let us begin with what we have learned about economic history.

We have already noted the strong evidence pointing to the importance of fiscal policy as an influence on real income, and to monetary policy as an influence on the balance of payments. It appears that what is often termed the "global monetarist" view of the behavior of an open economy under fixed exchange rates is very relevant to the interpretation of British economic history in the 1950s and 60s. This conclusion is strengthened by the extremely robust

TABLE 4

Goodness of Fit of Model in Dynamic Simulation

<u>Equation and Dependent Variable</u>	<u>1956-70</u>	<u>R² 1956-71</u>
2, y	.550	.439
2, Δy	.220	.102
3, Δp	.251	.288
5, Δr	-.590	-.112
6, ΔM	.505	.161

Note: R^2 is defined as $1 - \frac{(\sum (x - \hat{x})^2)}{(\sum (x - \bar{x})^2)}$ where \hat{x} is the predicted

value of the dependent variable and \bar{x} its mean value. A negative value therefore implies that the mean of the dependent variable is a better predictor of its actual value than is the model being tested here.

parameter estimates obtained for the expectations augmented Phillips curve. There, the expectations in question, and hence the behavior of domestic prices, are dominated by world prices.

The estimate of a , the amount by which sterling was undervalued in 1970, supports the view that the 15% devaluation of 1967 was excessive by more than 10 percentage points.¹⁵ Given that our Phillips curve accords a systematic influence to relative price level disparities in driving domestic inflation, these results also support the view that the 1967 devaluation gave a substantial boost to the British inflation rate in the late 1960s. However, the extremely poor simulation results for 1970/71 imply that foreign inflation and devaluation catch-up effects cannot, by themselves, account for the acceleration in the British inflation rate that took place during those two years.¹⁶

Our empirical work yields two strong implications about the model with which this paper began, and about the many closely related models with which the theoretical literature abounds. First, the systematic influence of fiscal variables on real income implies that models which ignore such factors should be treated with great care. Of course it is permissible to leave fiscal matters to one side in an analytic exercise on an "other things equal" basis. However that phrase must, in the light of our results, be interpreted as meaning "fiscal variables do not change" rather than "fiscal variables have so little influence that they may safely be ignored." Second, we have seen in our empirical work that monetary policy had no discernible effect on domestic variables. Even if we do not take that result literally, it nevertheless strongly suggests that models which approach the dynamics of the influence of money on the balance of payments by emphasizing first the influence of money on domestic output and prices, and second the influence of relative price levels on the balance of trade, are probably misleading.¹⁷ Monetary policy seems to

have had a direct impact on the balance of payments in Britain in the 1950s and 60s, and it would be surprising if further work on other economies proved these results to be exceptional. Models in which money directly influences the balance of payments, even in the short run, thus get considerable support from our results.¹⁸

Our work has opened up a number of issues that require further investigation. It seems to us that the following are the most important. To begin with, our theoretical analysis showed that the inflation expectations mechanism embedded in the model implies that agents attributed a well-defined goal to the monetary authorities.¹⁹ That mechanism proved to be the most empirically robust part of the model, but throughout our empirical work policy variables were treated as totally exogenous. It would clearly be worthwhile investigating the consequences of including alternative explicit policy reaction functions in future work. The model's behavior both when the public's expectations about the authorities' behavior are consistent with it, and when they are not, could then be investigated. The latter is an important alternative because, as we have seen, the private sector in our model never anticipates an exchange rate change, and yet one did take place during the period to which the model was, more or less successfully, fitted. Closely related to the matter of a policy reaction function are questions concerning the public sector's budget constraint. In our work so far, monetary and fiscal policy have been treated as independent of one another and it would be worthwhile investigating whether linking them by way of a budget constraint might change the model's rather strong conclusions about the unimportance of monetary policy for domestic variables.

The second aspect of our model that might benefit from further elaborations is its linkage to the rest of the world. The only foreign variable that

has entered the forgoing analysis is the world price level. If one were to construct an explicit model of the rest of the world, one would surely have a term involving monetary disequilibrium entering the balance of payments equation there too. If the two models were to be linked together to form a closed system they would have to have a single balance of payments equation in common which would include monetary disequilibrium in both of them. Therefore, as it stands, the balance of payments equation of our model is inadequately specified, except under the very special assumption that the rest of the world is always in monetary equilibrium. Perhaps this assumption was adequate for the world economy of the 1950s and early 1960s, but it was surely not valid for the period of the Vietnam War inflation that led to the collapse of the Bretton Woods system. We conjecture that the omitted factor, monetary disequilibrium in the world economy, being unimportant for most of the period to which our model was fitted, did not prevent our estimating it. However we also conjecture that this same omitted factor underlies the model's breakdown after 1969. If further work supports these conjectures, then it will have important implications for the validity of all those open economy models which are linked to the rest of the world by prices alone. It will mean that they are perhaps adequate for analyzing the response of such an economy to domestic shocks against the background of a tranquil world economy, but that they do not properly capture the channels whereby instability in the world economy is transmitted to an open economy.²⁰

FIGURE 1a

Deviation of Log of Income From Trend

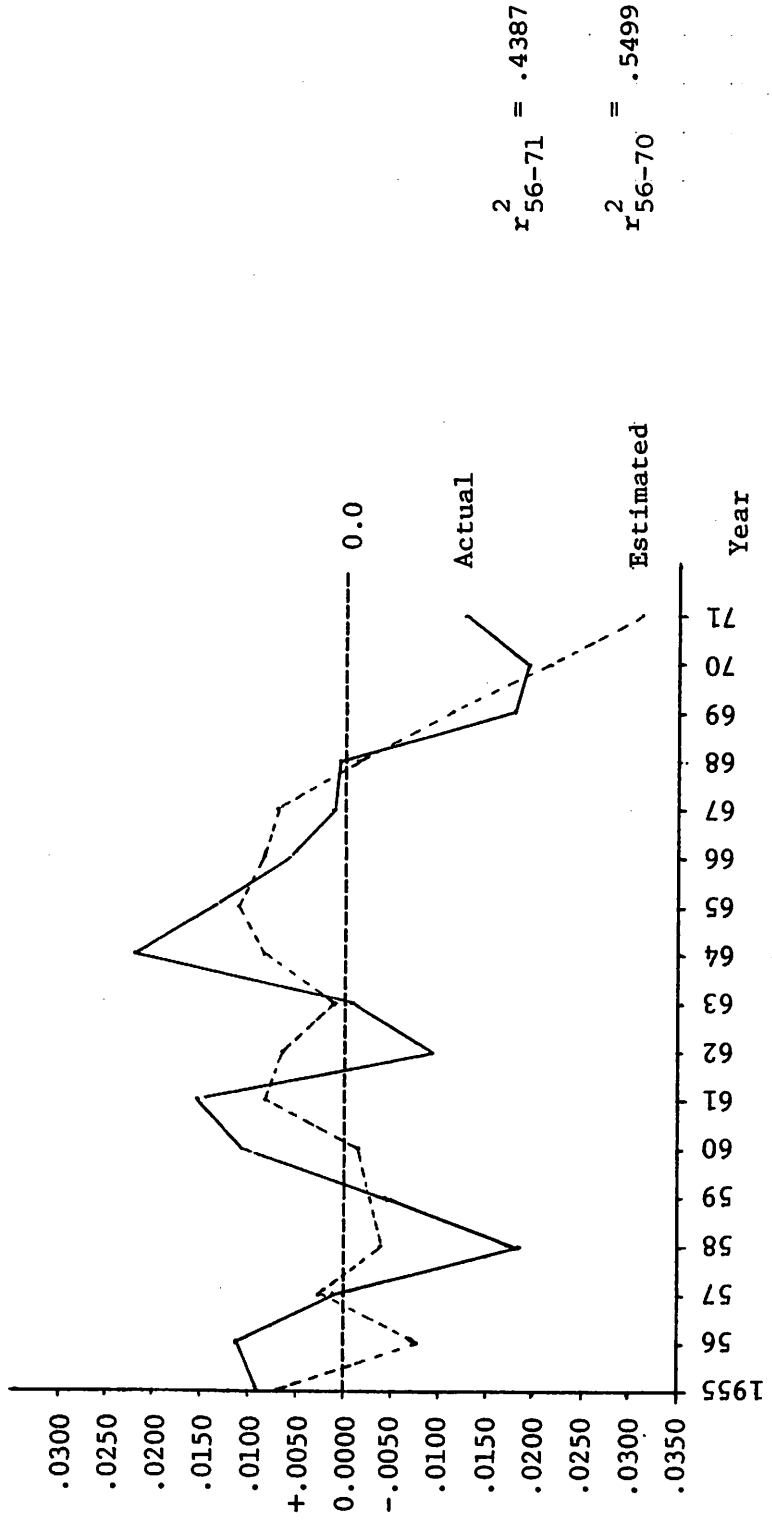


FIGURE 1b

Change in Deviation of Log of Income From Trend

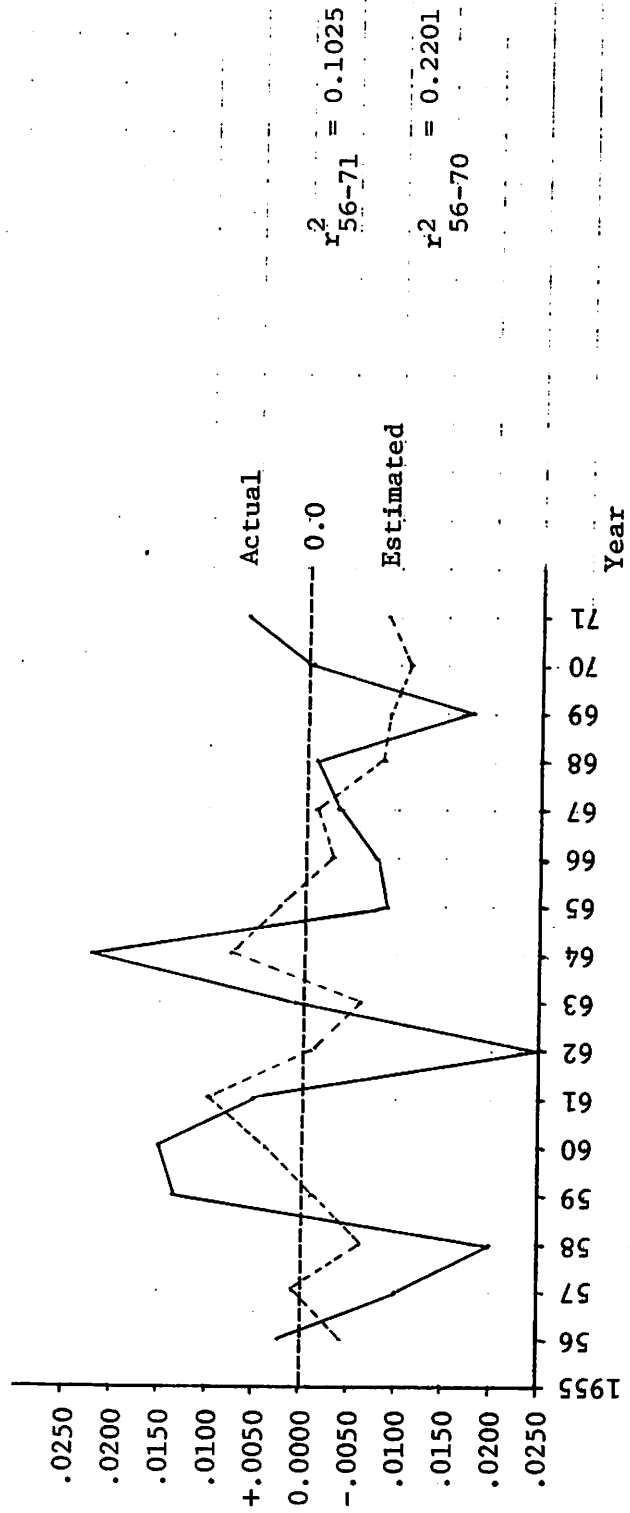
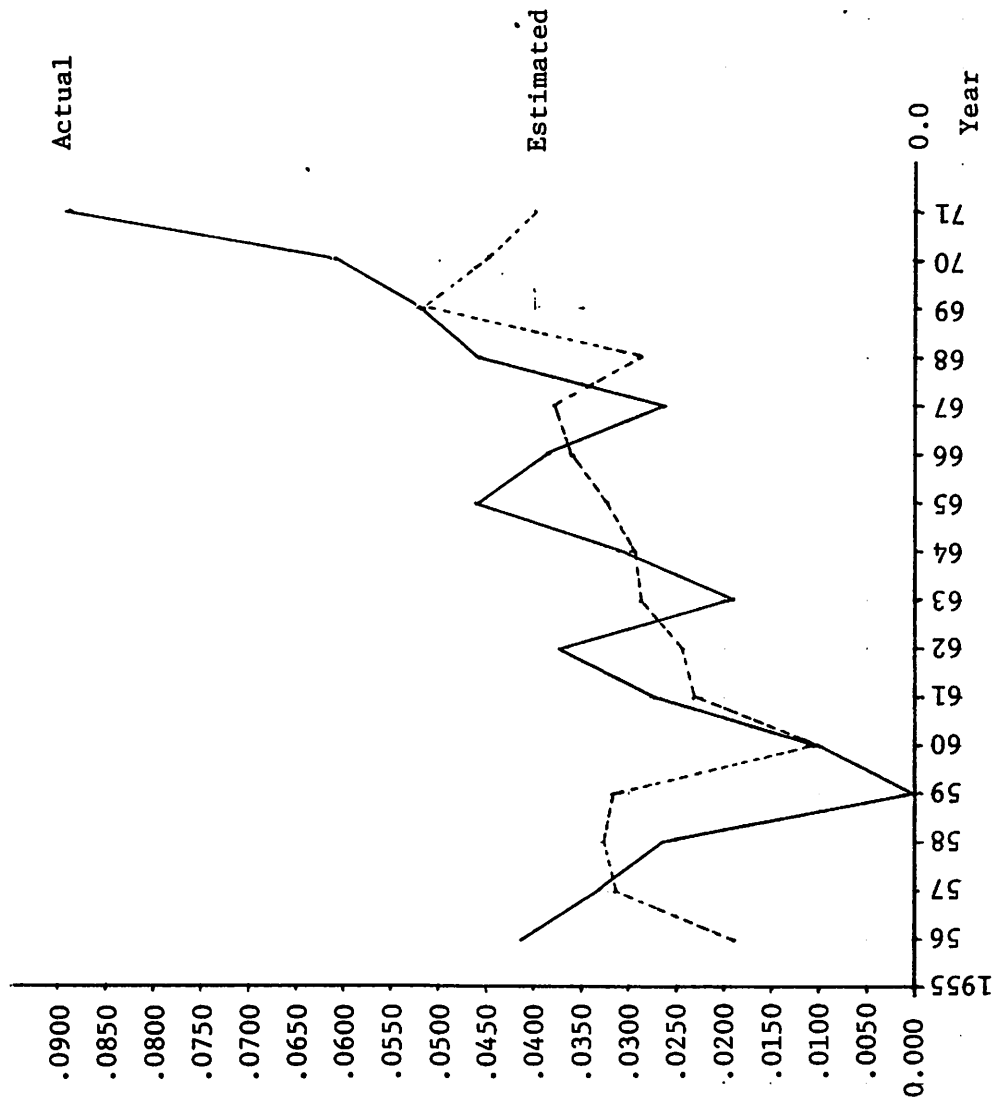


FIGURE 1c

Rate of Inflation



$$r_{56-71}^2 = 0.2880$$

$$r_{56-70}^2 = 0.2512$$

FIGURE 1d

Proportional Change in Foreign Exchange Reserves

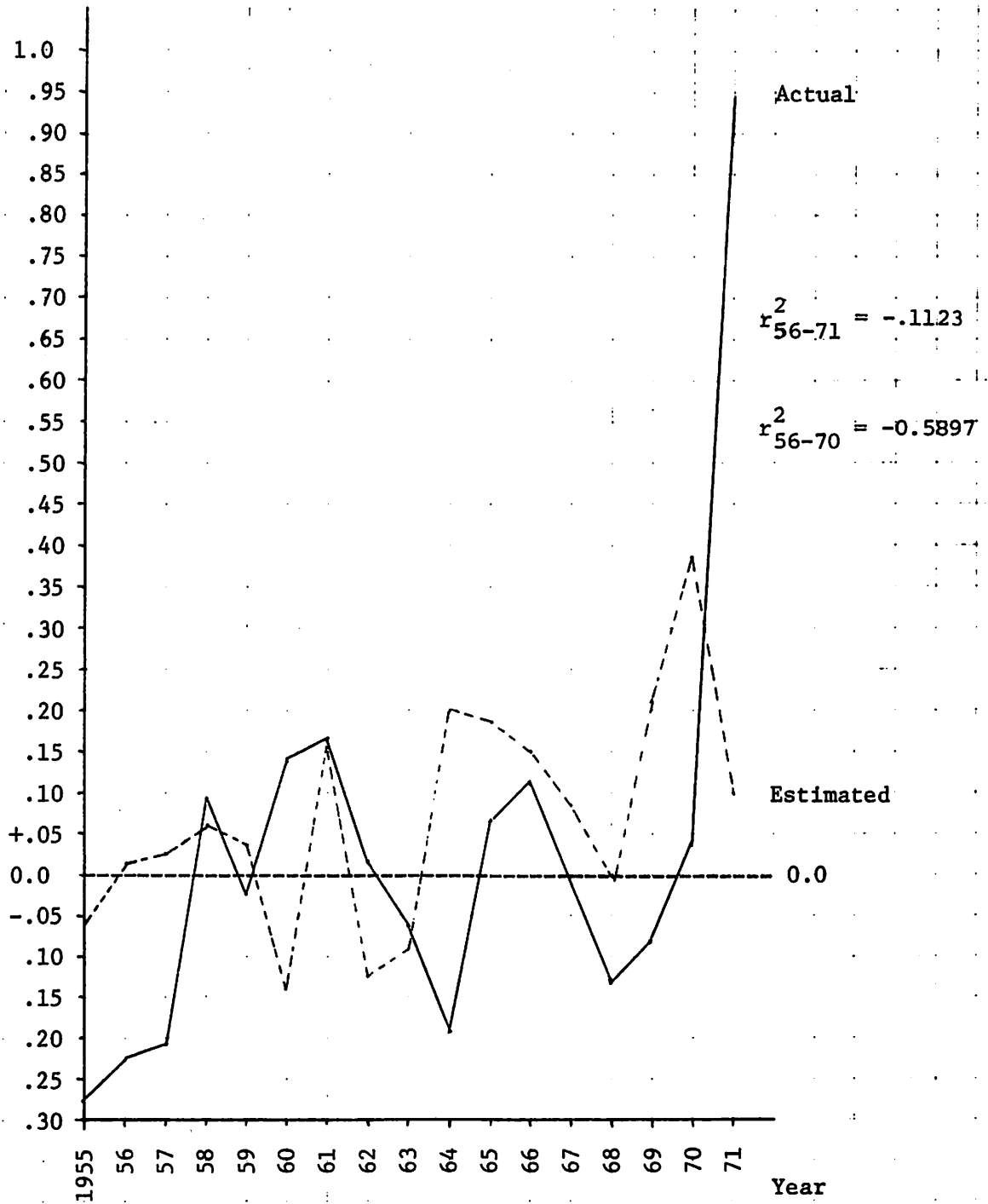
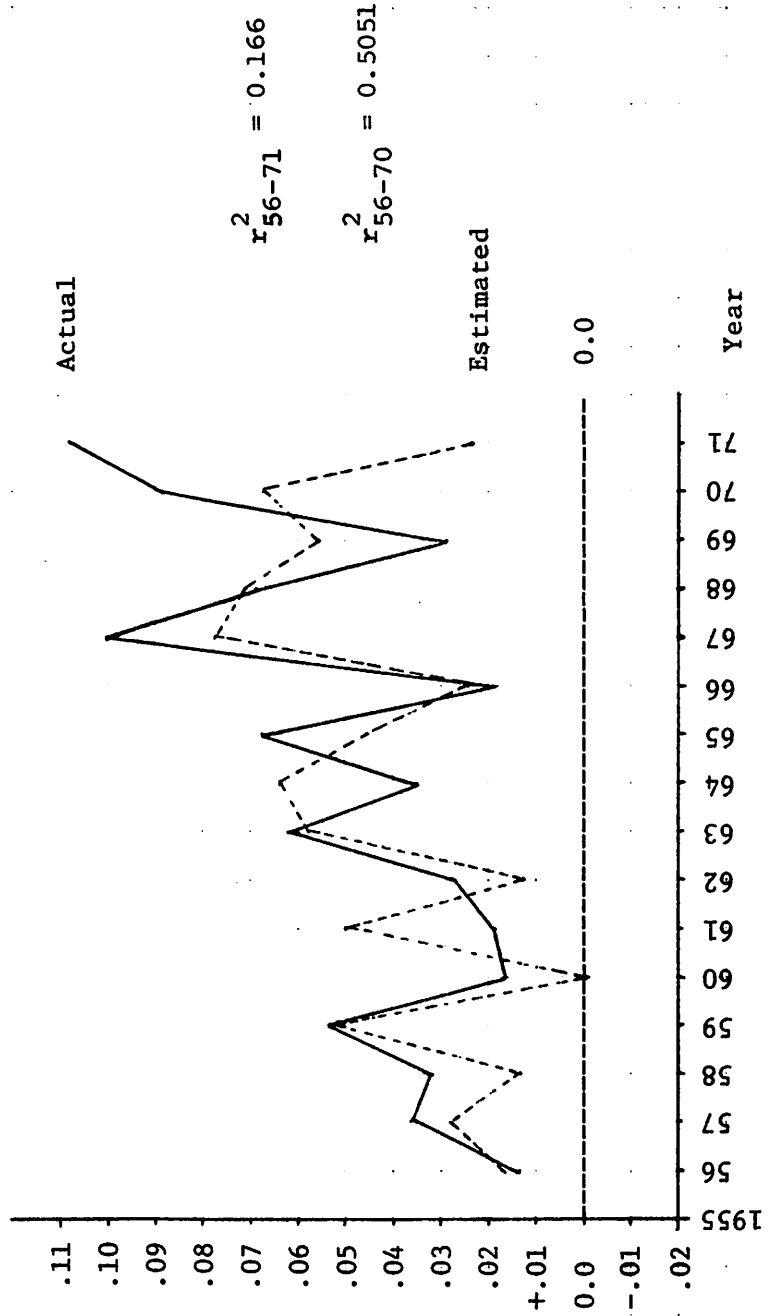


FIGURE 1e

Proportional Rate of Change of Money Supply



APPENDIX A--DATA

	Real Income fbn	Consumer Price 1970=100	World Prices 1970=100	Exchange Rate £/F.C.U. 1970=100	Money Supply fbn	Official Reserves fbn	Loans fbn	Domestic Credit fbn	Government Spending fbn at 1970 Prices	Net Taxes as % of GDP	Unemployment (Great Britain) %
1952	27.77	56.4	64.5	88.0	8.65	.659	.237	8.2	7.18	.215	1.78
53	29.44	57.3	65.0	87.8	8.98	.899	.181	8.26	7.57	.219	1.44
54	30.53	58.3	65.5	87.9	9.35	.986	.142	8.51	7.56	.210	1.19
55	31.77	60.3	65.7	87.7	9.05	.757	.142	8.44	7.46	.215	0.96
56	32.94	62.9	67.0	87.8	9.19	.799	.343	8.73	7.64	.208	1.10
57	33.72	65.0	68.7	87.8	9.52	.812	.343	9.05	7.78	.210	1.31
58	34.19	66.8	71.0	86.8	9.84	1.096	.337	9.08	7.72	.211	1.95
59	35.82	67.2	71.9	85.9	10.38	.977	.200	9.61	8.20	.205	1.94
60	37.60	67.9	73.2	85.7	10.57	1.154	.052	9.47	8.56	.195	1.46
61	39.07	69.8	74.2	85.9	10.78	1.185	.422	10.02	9.06	.200	1.39
62	39.41	72.5	76.0	85.8	11.09	1.002	.047	10.13	9.36	.209	1.74
63	41.12	73.9	77.9	85.8	11.79	.949	.052	10.89	9.76	.199	2.00
64	43.49	76.3	79.6	85.8	12.23	.827	.625	12.03	10.45	.199	1.39
65	44.57	79.9	81.8	85.8	13.08	1.073	1.224	13.23	10.91	.211	1.21
66	45.73	83.0	84.6	85.8	13.32	1.107	1.849	14.06	11.70	.221	1.32
67	47.08	85.2	87.0	86.8	14.73	.992	2.405	16.15	12.80	.229	2.04
68	48.61	89.2	90.4	99.9	15.80	.878	3.701	18.62	12.92	.236	2.13
69	49.38	94.0	94.7	99.8	16.26	.922	3.058	18.39	12.57	.254	2.13
70	51.02	100.0	100.0	100.0	17.78	1.047	1.763	18.49	13.21	.261	2.30
71	52.15	109.4	104.9	99.8	19.78	2.583	.028	17.73	13.50	.245	3.12

SOURCES

Real Income--Gross Domestic Product (International Financial Statistics, May 1977)
line 99b deflated by consumer prices.

Consumer Prices--International Financial Statistics, May 1977, line 64.

World Prices--a GDP weighted average of the consumer prices of seventeen western industrial countries. The countries used were: Australia; Austria; Belgium; Canada; Denmark; Finland; France; Ireland; Israel; Italy; Japan; Netherlands; New Zealand; Norway; South Africa; Sweden; Switzerland; United States; West Germany. Data on GDP prices and exchange rates for these countries were obtained from International Financial Statistics, May 1977.

Exchange Rate--a GDP weighted average of foreign currency values. International Financial Statistics, May 1977, lines rf and rh.

Money Supply-- M_3 end period.

*Official Reserves--end period, Bank of England Statistical Abstract up to end 1966. Thereafter series generated by adding or subtracting "Official Reserves, Drawing On...etc." e.g., in Bank of England Statistical Abstract No. 2. Table 20.2.

*Loans--Official Reserves minus Integral of Total Currency flow, as given in Statistical Abstract Table 20.2.

*Domestic Credit-- $M_3 - (R - L)$.

*Government Expenditure--central and local government expenditure on current goods and services and capital formation. 1952-1965. Based on data in Feinstein Tables 2 and 39. Thereafter various issues of the Blue Book.

*Taxes--tax receipts net of cash benefits and subsidies (excluding National Health Scheme transactions) 1952-1965. Based on Feinstein Table 14. Thereafter various issues of the Blue Book.

* Data taken from Jonson (1975).

FOOTNOTES

¹We are not claiming that this approach is original to us. For precedents, see, for example, Bergstrom and Wymer (1974), Black (1975), Jonson (1976) or Jonson, Moses and Wymer (1976).

²The Phillips curve contained in Jonson (1976) contains the second term on the right-hand side of equation (iv), but not the first.

³As Joel Fried has pointed out to us, it is a moot point whether a zero rate of change of nominal reserves represents an optimal balance of payments target for a small open economy operating in a world in which world prices are rising. Hence it cannot be taken for granted that the postulat \acute{e} about the private sector's expectations concerning the conduct of policy is a sensible one. The question is fundamentally empirical.

⁴This prediction is of course somewhat embarrassing, because it suggests that those countries which remained linked to the United States by a fixed exchange rate during the 1929-33 downswing should have experienced "over full employment." See pp. 22-23 below for a discussion of our conjecture concerning what it is that is missing from the model at this point.

⁵The use of a trend value for national income as a measure of the level of income that would prevail at the "natural" level of unemployment is not uncommon. Note however that with the apparent slowing down of the British growth rate in the 1970s, there is a considerable problem implicit in its use if it is desired to extend this model to deal with more recent experience.

⁶The reader should note that some of our early experiments, using Ordinary Least Squares, involved us including an "expected" world rate of inflation rather than the actual one, the former being measured by an error-learning formula. The error-learning coefficient that these experiments produced

was unity, so we felt justified in continuing to use the form of the Phillips curve presented here.

⁷It would have been technically feasible to estimate the trend growth rate of income along with all the other parameters of our model. To fit a log-linear trend to the income series as a prior procedure involves imposing an extra a priori constraint upon our estimates. We did not carry out any experiments to ascertain the extent to which our results may or may not have been affected by this procedure.

⁸See Wymer (1976).

⁹In fact two offsetting errors were made by us at this point. First, we used the level of the tax rate rather than its deviation from its mean in our regressions. However, we also permitted an intercept, α_0 , to appear in our regressions. Its estimated values are given in Tables 1 and 2. When we adjust that intercept for the mean level of the tax rate multiplied by the tax elasticity of expenditure, it turns out not to be significantly different from zero.

¹⁰It should be noted that we are acutely aware of the problems raised by treating the ratio of taxes to national income, which clearly has a large endogenous component to it, as a purely exogenous variable. We have not yet been able to find a way of dealing with this problem that preserves our model's simplicity.

¹¹Presumably if the steady state path of government expenditure, or of taxes, were to change, we would also have to consider the possibility that the steady state value of the exchange rate, or domestic prices, would also change. The structure of our model does not permit analysis of issues such as these. Its validity is thus limited to times and places where there were no fundamental long-run changes in the conduct of fiscal policy.

¹²If the parameter α_2 of our model is constrained to be equal to zero, α_1 does become positive, though not statistically significantly so. However the goodness of fit, not only of the expenditure equation, but of all other equations in the model, deteriorates relative to the results presented in Table 3. Note that Jonson (1976) who fits a rather more elaborate model, which is nevertheless similar in many respects to this one, to a much longer run of British data, finds a small but statistically significant impact of monetary disequilibrium on domestic expenditure. In Jonson's model, however, output responds with a long distributed lag to expenditure changes. Our equation (1) is of course an output equation. Thus there is no necessary inconsistency between our results and Jonson's. It is more likely that, given the degree of aggregation of our model, the effects which Jonson finds are completely insignificant. Note however that the Jonson, Moses and Wymer (1976) model of the Australian economy finds a much more significant role for monetary disequilibrium to play in determining domestic expenditure and output in that economy.

¹³It is worth noting that the results obtained in this paper on the relative importance of monetary and fiscal policies are very much more decisive than anyone else has been able to find using the traditional "St. Louis" approach. See, for example, Artis and Nobay (1969).

¹⁴It is worth noting that Peter Jonson has encountered similar difficulties in trying to extend his model of the UK economy to the 1970s. The econometric modelling of the last eight years clearly presents a major challenge which must be faced in due course.

¹⁵The devaluation of 1967 is discussed at greater length, in terms of an early version of the model presented in this paper, in Laidler (1977).

¹⁶Our own conjecture is that the absence of a foreign monetary disequilibrium term discussed in the next couple of pages, may account for this problem. Nevertheless the result is interesting, given that so many people regard the experience of 1970/71 as having generated the crucial set of facts that need to be explained in any account of recent inflationary developments in the UK economy.

¹⁷Such a model is presented in Laidler (1975). Note however that the results already cited of Jonson, Moses and Wymer (1976) for the Australian economy, would tend to suggest that such a model is still of some interest.

¹⁸For an example of such a model see Burton (1978).

¹⁹But cf. footnote 3 above.

²⁰This argument is of course of considerable relevance to the matters discussed in footnote 4 above.

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