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THE PRICE, OUTPUT AND EXCHANGE RATE-OVERSHOOTING EFFECTS OF MONETARY, FISCAL AND EXCHANGE INTERVENTION POLICY IN A TWO-COUNTRY DISEQUILIBRIUM MODEL

Neil Rankin

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Centre for Economic Policy Research
6 Duke of York Street
London SW1Y 6LA

Tel: 01 930 2963

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ABSTRACT

Monetary, fiscal and exchange intervention policy are examined in a symmetric, two-country, two-period model. Money wages are rigid in period one, causing unemployment. In each period there is a single world output, traded in a perfectly competitive world market. The exchange rate is flexible, and there is perfect capital mobility with perfect foresight. Aoki's method is used to obtain comparative static results, which include as special cases small open and closed economies. Whereas monetary policy effects in this model are consistent with the Mundell-Fleming-Dornbusch framework, fiscal policy always causes higher domestic output and a nominal depreciation, and may well lower foreign output.

JEL classification: 431

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Neil Rankin
Department of Economics
Queen Mary College
Mile End Road
London
E1 4NS

Tel: 01 980 4811 X3561

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NON-TECHNICAL SUMMARY

The "disequilibrium" approach to macroeconomic theory has provided some valuable insights into open economies, but it has tended to focus on fixed exchange rate regimes. Most of the standard analysis of open-economy, flexible exchange rate models has been based on the work of Mundell, Fleming and Dornbusch. It follows a traditional approach of postulating directly the model's structural relationships. In this paper, we seek to re-examine these standard results using a "disequilibrium" framework.

To model flexible exchange rates properly it is necessary to include the capital account, and thus bonds as well as money. Decisions to purchase bonds are related to current and future consumption decisions and are inherently intertemporal. The model must therefore be dynamic if the capital account is to be analysed properly. Accordingly, we use a two-period framework, in which agents have perfect foresight. The analysis derives the behaviour of individuals from microeconomic foundations: this ensures wealth effects are not overlooked, which is a common criticism of the Mundell-Fleming-Dornbusch framework.

In the model considered in this paper "disequilibrium" arises from the rigidity of money wages in the first period, which causes an excess supply of labour. The goods market, on the other hand, is assumed to clear in each period. There is a single world output. As a result a nominal depreciation does not operate through the real exchange rate, which is fixed; instead, it is fully passed on to the domestic price level. This in turn affects consumption through the real balance effect and the real interest rate, and production through the real wage. In the capital market, there is perfect international mobility, so that "uncovered interest parity" holds.

The policy changes analysed in the paper are permanent increases in the money supply and in government spending (balanced by

adjustments in lump-sum taxes), and in foreign exchange reserves (balanced by new money issues). We adapt a technique due to Aoki, who has shown that a linear, symmetric, two-country model may be re-written in terms of variables which are the sums and differences of their counterparts in the individual country, and that the resulting model may be solved as two independent systems - one in the sums and one in the differences. The system of sums clearly describes the behaviour of the aggregate world economy; this is also equivalent to a completely closed economy which has the same economic structure as the two original economies. The system involving the sum variables, i.e. the aggregate world economy, can be solved independently of the "difference" system: the system involving the differences can therefore be thought of as representing an open economy with the same economic structure, but which is too "small" to affect the world economy. Each economy in the symmetric two-country model therefore behaves as an unweighted average of the sum and difference systems. This, of course, is only natural: in terms of relative size, such an economy lies half-way between the two extremes of the closed and the small open economies.

For monetary policy, the predictions of the disequilibrium model are consistent with those of the "standard" analysis. An expansion of the money supply causes domestic output to expand, foreign output to contract, and the exchange rate to depreciate. Whether the latter "overshoots" depends on the values of the structural parameters of the model. For fiscal policy, however, the disequilibrium and the standard models behave quite differently. In the disequilibrium model an increase in government spending causes domestic output to expand, even if the country is "small". Foreign output need not expand, and might well contract. In addition, the real interest rate could fall rather than rise. Perhaps the most striking result is that the exchange rate unambiguously depreciates, rather than appreciates. Fiscal policy appears to have such a different result in the disequilibrium model because this model takes account of the effects of lifetime wealth on consumption and the demand for money.

The less commonly studied instrument of exchange rate intervention is shown to be equivalent, in a "small" open economy, to a money-financed increase in government spending. However, with two symmetric countries, exchange rate intervention is equivalent to a money-financed fiscal expansion at home and a contraction of the same nature abroad. In this case, exchange rate intervention represents a genuinely new policy instrument from the viewpoint of a single government.

1. Introduction

The "disequilibrium" approach to macroeconomic theory has provided some valuable insights into open economies, as witnessed by the two recent collections of articles on this subject, by Cuddington et al. (1984), and Henin et al. (1985). However, much of this work has assumed fixed exchange rates. To model flexible exchange rates in a serious way, it is necessary to include the capital account and thus bonds as well as money, which in turn requires a dynamic model in order to avoid crude simplifiacations. These features are gradually being incorporated into the literature, as the articles by Cuddington (Chapter 5) and Henin and Marois (Chapter 3), in the volumes referred to, show. However, in the meantime most of the standard results on open-economy, flexible exchange rate models, have been obtained under the traditional approach of directly postulating the structural relationships. An emerging problem with these models is their complexity as more features are incorporated, resulting in the need to resort to simulations rather than analysis in order to study their properties. This has particularly arisen with attempts to extend Dornbusch's (1976) framework to include dynamics due to wealth effects and wealth accumulation, as for example in Giavazzi and Sheen (1985).

The model constructed in this paper draws on both approaches to open economy macroeconomics, by attempting to answer the questions most commonly addressed in "directly postulated" models by using a "disequilibrium" methodology . In addition to flexible exchange rates, the capital account and a two-period horizon combined with perfect foresight, the model is based on the notion that while prices are perfectly flexible, money wages are rigid in the first period and flexible in the second. Walrasian equilibrium therefore pertains in the second period, or "long run", but there is excess supply in the labour market in the first period, or "short run".

The implications of this framework for policy effects are then studied, first, for the "small" open economy (Section 3); and second , for the two-country case (Section 4). In addition to considering the effects of the usual monetary and fiscal instruments, we also consider those of foreign exchange intervention policy. In a world of floating exchange rates, this is clearly an extra policy instrument which any government has available; though one question which arises concerning it, is whether it represents a new and independent instrument, or whether it is equivalent to some combination of existing instruments. To obtain comparative static results in the two-country model, we make use of the convenient simplification popularised by Aoki (1981), whereby, if the countries are symmetrical, the system may be "decoupled" into one of aggregates and differences. This has advantages, not merely in simplifying the algebra, but also in providing intuitions for the results obtained.

The particular model specification used here offers a number of potential benefits. Apart from the general aid towards self-consistent model-building which the general equilibrium methodology provides, it ensures that wealth effects are not either ignored, or added in as a distinct feature to income and other effects. This should be particularly useful in view of the acknowledged importance of wealth effects in exchange rate behaviour. Furthermore, it is to be hoped that the derivation of structural relationships from individuals' optimisation problems would provide extra restrictions to help in obtaining comparative static results. This would overcome the growing need observed in other studies to examine the model's properties by simulation.

Two papers of which the present one may be seen as a development should particularly be mentioned. In the tradition of "directly postulated" models is Argy and Salop's (1983) study, which extends the seminal two-country, flexible exchange rate model of Mundell (1968) to include the labour market and hence allow the consideration of both nominal and real wage rigidities. Our model takes this further by adding an intertemporal dimension, enabling the exchange rate "overshooting" question to be studied. In the alternative, "disequilibrium", tradition is the two-country, two-period model of Persson (1982), whose assumption of a fixed first-period and flexible second-period wage we adopt. However, we replace his restrictive "cash-in-advance" formulation of money demand by a utility-of--real-balances formulation, which avoids some of the very special results imposed by the former, and enables sensible comparisons to be made with the established results of Mundell and Dornbusch.

Our results, as far as monetary policy is concerned, are consistent with, and may hence be regarded as syntheses and extensions of, those of Mundell (1968) and Dornbusch (1976). That is, in the current period, an expansionary monetary policy increases prices and output at home, but decreases them abroad, while causing the exchange rate to depreciate. Since output is endogenous, whether the exchange rate "overshoots" depends on parameter values, as Dornbusch finds. In any event, the current balance improves and the real interest rate falls.

Fiscal policy, on the other hand produces results which may be seriously at odds with the basic Mundell and Dornbusch models. Some such conflicts, for the "small" country case, have also been recorded by Branson and Buiter (1983), and Giavazzi and Sheen (1985). We show that in a two-country setting, the foreign repercussions of a fiscal reflation are not unambiguously expansionary, as they are in Mundell's model; nor does the interest rate unambiguously rise. On the other hand, the ambiguity over the response of the current exchange rate found in Mundell is resolved in our model in favour of an unambiguous depreciation.

The third policy instrument, foreign exchange intervention, is found to be an effective means of exchange rate control, despite the presence of perfect capital mobility. However, in the "small" country case, it can be shown not to represent an independent new instrument of policy, whereas this limitation does not apply in the two-country setting.

2. The Structure of the Individual Economy

(i) Overview

The world lasts for two periods. There are three agents in the economy: a representative firm, a representative household, and the government. The model is non-stochastic, and all agents are endowed with "perfect foresight". In any period, two commodities change hands - domestically-traded labour, and an internationally-traded good.

The assumption of a single, homogeneous, international product of course means that the real exchange rate in any period is identically equal to unity and hence exogenous, even - as in Section 4 - when the country is "large". This assumption has been the common one in the open-economy "disequilibrium" literature, originating with Dixit (1978). By comparison, in directly-postulated models, the more usual assumption has been (at least, implicitly) that the economy produces an internationally differentiated product, so that its real exchange rate is endogenous. The cost of this added complexity, however, may be that money is omitted entirely - as in Giavazzi and Sheen (1985) - so that only real and not nominal exchange rate movements can be studied, and monetary policy cannot be considered. Here, we particularly wish to make comparisons between monetary and fiscal policy, as in the original work of Mundell (1968), and so we choose instead - and for the time being - the simplest possible sectoral structure. When the country is "large", there is of course still an endogenous intertemporal real exchange rate - namely the real interest rate.

Two assets are issued by each government: money, and interest-bearing bonds. These are the only assets: output is perishable, and hence there is no physical capital or investment. Since there is no uncertainty, and an internationally--perfect capital market, the "uncovered interest parity" condition always holds: that the nominal interest rate between the two periods in each country differs only by the expected (and actual) rate of depreciation between the two currencies.

The assumption of a fixed money wage in the first period and a flexible one during the second, means that output is endogenous in the first period - which may be thought of as the "short run" - but exogenous in the second period - which may be thought of as the "long run". In each period, labour is the only input to production, and the labour supply is exogenous (as a result of there being no utility of leisure, so that households always supply their full endowment of time to the labour market). We suppose the money wage is above the market--clearing level in the first period, creating excess supply of labour (the alternative regime with too low a money wage, causing excess demand in the labour market, will not be discussed). In this case, with perfect price flexibility, permitting the goods market to clear, firms are permanently on their "notional" labour demand curves, and there is a unique positive relationship between the price level and employment, caused by price increases lowering the real wage and stimulating the demand for labour. In the second period, with both the price and the wage levels perfectly flexible, output is fixed by the exogenous labour supply.

This set-up captures the widely acceptable idea that there is short-run stickiness of some prices in the economy causing output to deviate from its "full employment" level, but that over a longer period all prices adjust, ensuring full employment. A more specific justification for it can be given in terms of the "rational anticipatory pricing" behaviour proposed by Green and Laffont (1981). Here it is assumed that the price of a commodity is set one period in advance at a level "rationally" expected to clear the market, but cannot be adjusted in response to contemporaneous shocks. The asymmetry we propose between wage and price flexibility in the first period is partly a concession to the conventional view that the price of labour is less flexible than the price of goods, but partly also dictated by the assumption of a single internationally-traded good. If there is disequilibrium in the market for the latter, a scheme of international quantity--rationing must be defined, and this is inevitably somewhat arbitrary (see, for example, Dixit and Norman (1980, Chapter 8)). Such an asymmetry of course prevents the occurrence of "Keynesian unemployment" in Malinvaud's (1977) sense, confining the economy rather to "orthodox" Keynesian unemployment of the sort that exists on the boundary between regimes C and K. It also means that under a fixed exchange rate, first-period output would be exogenous in a small country, as in the model of Dixit (1978).

(ii) Behaviour of the individual household

Households obtain utility from consumption in both periods of life, but not from leisure. They may save in two ways: by accumulating money or bonds. Since bonds pay interest and money does not, a key issue - as in any monetary general equilibrium model - is why money is held at all. In the absence of uncertainty, the motive must be a transactions one. A simple formalisation of this, favoured by a number of recent authors (including Persson (1982), and Svensson (1986)), is to add an extra constraint to the choice problem, imposing that the nominal value of goods purchases in any period may not exceed the initial money balances held. However, this "cash-in-advance" constraint, first proposed by Clower (1967), implies an unrealistically rigid proportionality between spending and the demand for money. In Persson's (1982) two-country model, otherwise very similar to the one constructed here, it has the unlikely consequence that a monetary expansion in one country has no effect on the price level or output abroad.

An alternative simple hypothesis is to postulate that the possession of real money balances directly provides utility, which will be the approach adopted here. Real balances are imagined to provide "liquidity services", for example by reducing the time and effort required to make purchases of goods. The cash-in-advance constraint can equivalently be formalised this way, by treating real balances as perfect complements to consumption. By allowing a less extreme relationship than perfect complementarity, a more flexible model of money demand may thus be obtained.

In a finite-horizon framework such as our two-period one, an additional question arises. The household will not wish to hold money (or, indeed, bonds) at the end of the second period. This will cause the value of money to fall to zero (i.e.

prices in terms of money to become infinite) in the second period. In turn, this would result in a zero demand for money at the end of the first period, so that money would effectively drop out of the model entirely. This is a well-known difficulty for finite-horizon monetary general equilibrium models - see, for example, Hahn (1982, Chapter 1). To overcome it, we assume that utility is also derived from real balances held at the end of the second period. This may be thought of as a "precautionary" demand, held against some subjectively-perceived - but implicit - possibility that the world might not last for only two periods after all. In single-period models, both of "disequilibrium" and "equilibrium" varieties, such an assumption is of course very widely encountered and understood.

With this introduction, the consumer's choice problem may be presented as:

$$\text{maximise} \quad u(c_1, \frac{M_1^h}{P_2}; c_2, \frac{M_1^h}{P_2})$$

$$\text{subject to} \quad a = c_1 + dc_2 + id\frac{M_1^h}{P_2} + d\frac{M_2^h}{P_2} \qquad (1)$$

where a = exogenous lifetime wealth, c_t = consumption in period t, M_t^h = nominal money holdings at the end of period t, P_t = money price of the output, i = nominal interest rate, d = 1/(1+r) where r is the real interest rate. Note that P_2 rather than P_1 has been used as the deflator of M_1^h. Since M_1^h is implicitly held solely for transactions to be made in period 2, it is clearly the price level in this period which is the relevant one.

Solving this problem evidently results in demand functions whose arguments are (a,i,d). To fix the signs of the partial derivatives, more structure needs to be placed on preferences. It seems reasonable for example, that all four arguments of u(.) should be regarded as "normal" goods; and that c_1, c_2 and $\frac{M_2^h}{P_2}$ should be net substitutes. The rationale for including $\frac{M_1^h}{P_2}$ in u(.), however, implies that $\frac{M_1^h}{P_2}$ and c_2 might well be net complements - though with less than perfect complementarity. Given that perfect complementarity imposes some very special results - as in the case of Persson's (1982) model - we initially employed two alternative parameterisations of u(.), one imposing net substitutability, and the other, net complementarity, between $\frac{M_1^h}{P_2}$ and c_2, in the expectation that these might generate contrasting outcomes. Perhaps surprisingly, this preliminary investigation produced very similar results in both cases. In what follows, therefore, we have chosen to present only the case where $\frac{M_1^h}{P_2}$ and c_2 are net substitutes. This does not mean that the "net complements" case is unimportant: a deeper understanding of the properties of the model may yet require us to return to it.

In what follows, we adopt the very simple Cobb-Douglas parameterisation of u(.). This is described in Appendix A. The demand functions then have the following forms:

$$c_1 = c_1(\underset{+}{a}) \tag{2}$$

$$\frac{M_1^h}{P_2} = m_1(\underset{+}{a},\underset{-}{i},\underset{-}{d}) \tag{3}$$

$$c_2 = c_2(\underset{+}{a},\underset{-}{d}) \tag{4}$$

$$\frac{M_2^h}{P_2} = m_2(\underset{+}{a},\underset{-}{d}) \tag{5}$$

where the signs of the partial derivatives are indicated beneath the relevant variables.

Since leisure provides no utility and thus labour supply is exogenous, the consumer's lifetime wealth or assets, a, is exogenous to him whether or not he faces rationing in the labour market. a is made up as follows:

$$a = \frac{M_0^h}{P_1} + y_1 - \tau_1 + d\{y_2 - \tau_2\} \tag{6}$$

where M_0^h = money inherited at the start of period 1, y_t = real output and income in period t, τ_t = a lump-sum tax in period t. It is clear from this that profits as well as labour income are assumed to be immediately distributed to the consumer.

(iii) Behaviour of the individual government

In any period, the government makes real purchases of output, g_t, and imposes a lump-sum tax on the consumer, τ_t. It may also intervene in the foreign exchange market, by adjusting its stock of foreign currency reserves, F_t. In period 1, it has a choice of two methods of financing the deficit: by issuing bonds or money. In period 2, there will be no willing purchasers of bonds, while the government must redeem those that were issued in period 1. Hence any deficit must be financed only by money.

The world supply of the currency at the end of period t we denote M_t. Since this is either held by domestic households or as reserves of the foreign government, we have $M_t = M_t^h + F_t^*$, where * indicates a foreign variable. We assume that, while there is a positive money stock when the world begins (M_0), there are no outstanding foreign exchange reserves or government debt. The budget constraints for the two periods are thus:

$$P_1 g_1 + E_1 F_1 - P_1 \tau_1 = M_1 - M_0 + qB$$

$$P_2 g_2 + E_2 F_2 - F_1 - P_2 \tau_2 + B = M_2 - M_1$$

E_t is the nominal exchange rate in period t, measured as the price of foreign currency in terms of domestic currency (thus a rise in E_t represents a "depreciation"). B is the bond stock outstanding at the end of period 1, where bonds are promises of one unit of money in the following period, selling for price q (hence $i = 1/q - 1$).

Eliminating B between periods gives the intertemporal budget constraint:

$$g_1 + dg_2 - \{\tau_1 + d\tau_2\} = \frac{1}{1+i}\frac{M_2}{P_1} + \frac{i}{1+i}\frac{M_1}{P_1} - \frac{M_0}{P_1} - \frac{1}{1+i^*}\frac{F_2}{P_1^*} - \frac{i^*}{1+i^*}\frac{F_1}{P_1^*} \quad (7)$$

(noting $d = qP_2/P_1$, $P_t = E_t P_t^*$). Clearly, of the eight policy instruments (g_1, g_2; τ_1, τ_2; M_1, M_2; F_1, F_2), only seven are independent. The results of any comparative static exercise will be sensitive to the choice of which instrument is assumed to respond passively when another is changed. In the case of monetary and fiscal policy, it is desirable, if we are to distinguish the "pure" forms of either policy, not to allow either M_2 or M_1 a passive, budget-balancing role. Also, since g_1 and g_2, being real purchases of output, are bound to have some real effects, it is desirable to treat these too as exogenous. Hence, in general, we select τ_2 for the role. (In the case of changes in F_1 or F_2, a different assumption may be preferable - see below.) Since τ_2 as it appears in consumers' lifetime assets, "a", is then endogenous, it is convenient to substitute it out of (6) using (7), obtaining:

$$a = y_1 + dy_2 - \{g_1 + dg_2\} + \frac{i}{1+i}\frac{M_1}{P_1} + \frac{1}{1+i}\frac{M_2}{P_1} - \frac{i*}{1+i*}\frac{F_1}{P_1^*} - \frac{1}{1+i*}\frac{F_2}{P_1^*} \quad (8)$$

(noting $M_0^h = M_0$, from the assumption $F_0^* = 0$).

An important consequence of perfect foresight and of having a single consumer whose life is co-extensive with that of the economy, is that government bonds will not be regarded as net wealth, and hence government debt will be neutral. With τ_2 as the "passive" policy instrument, a cut in τ_1 will result in more bonds being issued, but will have no real effects - as may be seen directly from the fact that τ_1 has been eliminated from (8). For the same reason, a rise in g_1, which again results in more bonds being issued, will have identical effects to an equal rise in g_1 and τ_1 - i.e. bond-financing is equivalent to tax-financing.

This feature of the model may appear to limit its potential for analysing fiscal policy, but this is not necessarily the case. For bonds to be regarded as net wealth, what is needed is an additional generation of consumers who live for only one period, and who might therefore receive a tax cut or subsidy but yet not have to pay for it. Consider the introduction of such a consumer. A very simple case would be where the consumer has no initial assets, and receives income only from a government subsidy. If, furthermore, he obtains utility only from consumption, then his choice problem reduces to the trivial one of completely spending the subsidy received. An increase in the subsidy will then affect the economy in exactly the same way as an increase in g_1: by adding an equal amount to the demand for output. Thus, in what follows, an increase in g_1 may be given two interpretations: either as an increase in real government purchases of output financed by issuing bonds which are <u>not</u> "net wealth"; or as a subsidy/tax cut financed by issuing bonds which <u>are</u> "net wealth".

3. A Small Open Economy

We now examine first the equilibrium conditions, and thence the comparative static effects of monetary and fiscal policy, under the assumption that the economy is a price-taker in the international markets for goods and capital. Since there is a single ouput, traded in an internationally-integrated market, the "law of one price" always holds, i.e. $P_t = E_t P^*_t$. In the "small" country case, P^*_t is fixed, so P_t and E_t move exactly together, and we may solve for the equilibrium in terms of P_t, leaving E_t implicit.

Secondly, since there is an internationally-integrated capital market, and no uncertainty, domestic bonds and foreign bonds must be perfect substitutes from the point of view of investors. That is, $1/q = E_2/E_1 q^*$: q and $E_1 q^*$ are the domestic currency prices of domestic and foreign bonds (respectively), and 1 and E_2 are their respective domestic currency redemption values, which must be in the same ratio to the purchase prices if the returns are to be equal. Equivalently, $1+i = \{1+i^*\}E_2/E_1$, which is the discrete-time version of the "uncovered interest parity" condition that the domestic interest rate should equal the foreign interest rate plus the rate of depreciation. In the "small country" case, i^* is fixed, so the movement of E_2 (and thus P_2) is implied by that of E_1 (and thus P_1) together with that of i.

Note finally that since there is a single world output, the domestic and foreign real interest rates (and hence real discount factors, d and d*) must always be equal, since there is then only one intertemporal relative price to be determined. In the "small country" case, d* is fixed and thus so is d.

From these observations, it can be seen that in the "small country" case, the endogenous variables to be solved for can be reduced to two in number: P and i. The equilibrium conditions determining the solution values are:

$$\frac{M}{P_1\{1+i\}d} = m_1(a,i,d) + \frac{F^*}{P_1\{1+i\}d} \tag{9}$$

$$y_1(P_1) - c_1(a) - g_1 = -d\{\bar{y}_2 - c_2(a,d) - g_2\} + \frac{F}{P^*_1} - \frac{F^*}{P_1} \tag{10}$$

where

$$a = y_1(P_1) + d\bar{y}_2 - \{g_1 + dg_2\} + \frac{M}{P_1} - \frac{F}{P_1^*} \qquad (11)$$

(9) imposes money market equilibrium (note that $P_1\{1+i\}d = P_2$, since $d = P_2/P_1\{1+i\}$). (10) imposes balance of payments equilibrium: the L.H.S. equals the current account surplus (excess of output over absorption), while the R.H.S. equals the capital account deficit (present value of the excess of future absorption over output and official intervention). (10) is equivalently – and perhaps more obviously – the intertemporal budget constraint for the whole country (or for the rest of the world), obtainable by combining the intertemporal constraints of the household and of the government ((1) and (8)). Output in period 1 is shown as an increasing function of P_1, and in period 2 as exogenous, for the reasons explained in Section 2. Note also that we have constrained $M_1 = M_2 \equiv M$, $F_1 = F_2 \equiv F$ and $P_1^* = P_2^* \equiv P^*$ in (10) and (11). Shocks to these variables are thus taken to be "permanent" rather than "temporary".

The absence from the system (9)-(11) of any goods market clearing conditions or of an equilibrium condition for the money market in period 2, should perhaps be explained. The former is due to the "small country" assumption, which means the country can buy and sell all it likes at the world price P_t^*. The latter would be superfluous, since, by Walras's Law, if the markets for period 1 and period 2 output together with period 1 money are in equilibrium, so also must be the market for period 2 money.

(i) Monetary Policy

Differentiating with respect to M allows us to examine the effect of a permanent increase in the money supply, since we have assumed $M_2 = M_1$. The increase in M_1 itself, since (g_1, τ_1) remain unchanged, is an open market operation. However, since the bonds withdrawn by this are not "net wealth", such an operation is equivalent to raising M_1 by cutting τ_1, i.e. to a "helicopter drop" of money. In period 2, the increase in M_2 is bound to be a "helicopter drop", since it must be matched by a cut in τ_2.

The expressions for the multipliers are readily obtained as:

$$\frac{dP_1}{dM} = \underset{-}{\left(\frac{m_1}{1+i} + m_{1i}\right)}\underset{+}{\{c_{1a} + dc_{2a}\}}/P_1\underset{-}{J_1} > 0 \tag{12}$$

$$\frac{di}{dM} = y_P\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}/P_2\underset{-}{J_1} = \ ? \tag{13}$$

where

$$J_1 = \underset{-}{\left(\frac{m_1}{1+i} + m_{1i}\right)}\left(y_P\{1-c_{1a}-dc_{2a}\} + \underset{+}{\{c_{1a}+dc_{2a}\}}\frac{M}{P^2}\right) < 0 \tag{14}$$

Here, letter subscripts refer to the partial derivatives of the function concerned. J_1 is the Jacobean determinant of the system (9)-(11). We evaluate it assuming initial values of zero for official reserves and the current account. The signs of the component expressions are indicated beneath them: these are either deducible directly from the signs of the partial derivatives already assumed earlier, or, where not, we shall explain them in what follows.

The term $\frac{m_1}{1+i} + m_{1i}$ is prima facie ambiguous, but under Cobb-Douglas utility must be negative, as Appendix A proves. From the lifetime budget constraint of the consumer, (1), note that the income derivatives must satisfy the adding-up constraint:

$$c_{1a} + dc_{2a} + idm_{1a} + dm_{2a} = 1 \tag{15}$$

Under "normality", it follows that $1-c_{1a}-dc_{2a} > 0$. These signs then ensure $J_1 < 0$ and $dP_1/dM > 0$. Comparing (15) with (13), however, it can be seen that the necessary and sufficient condition for $di/dM < 0$ is $m_{1a} < m_{2a}$, which may or may not hold.

A monetary expansion thus unambiguously raises the current price level. From this we know that current output rises and the exchange rate depreciates. However, as regards the interest rate, this will fall if and only if the propensity to hold money out of lifetime wealth is greater in the second than in the first period. It thus is possible that either a fall or a rise in the interest rate will result. This in turn determines whether exchange rate "overshooting" will occur. From $1+i = \{1+i^*\}E_2/E_1$, if i falls the period 2 exchange rate must depreciate by less than the period 1 exchange rate, and vice versa.

These results are very similar to those of Dornbusch (1976), who finds that when current output is endogenous, either over- or undershooting may be the outcome. The essential reason for this, as in Dornbusch's model, is the rigidity of a current price variable - in the present case, of the money wage. A comparison may easily be made with the Walrasian equilibrium. The only difference to the equilibrium conditions (9)-(11) which this makes is that y_1 is then exogenous. Thus, the relevant multipliers are found by setting $y_p = 0$ in (12)-(14). This yields $(dP_1/dM)(M/P_1) = 1$ and $di/dM = 0$, i.e. the price rise is proportional to the increase in M and there is no change in the interest rate, and nor, therefore, any over- or undershooting of the exchange rate. Money in this case is completely neutral.

(ii) Fiscal Policy

The response to a permanent increase in government spending may be found by differentiating (9)-(11) with respect fo g_1 and g_2, setting $dg_1 = dg_2 = dg$. This yields:

$$\frac{dP_1}{dg} = \Big(\underset{-}{\frac{m_1}{1+i}} + m_{1i}\Big)\{1-\underset{+}{c_{1a}}-dc_{2a}\}\{1+d\}/\underset{-}{J_1} > 0 \tag{16}$$

$$\frac{di}{dg} = -\frac{m_1}{P_1}\{1-c_{1a}-\underset{?}{dc_{2a}}-idm_{1a}-dm_{1a}\}\{1+d\}/\underset{-}{J_1} = ? \tag{17}$$

The effect on the current price and thus the output level is unambiguously expansionary. Since P_1 rises, the current exchange rate depreciates. The effect on the interest rate depends on the ambiguous expression encountered earlier: this time $m_{1a} < m_{2a}$ is clearly a necessary and sufficient condition for the interest rate to <u>rise</u>. If this happens, then from $1+i = \{1+i^*\}E_2/E_1$, the period 2 exchange rate depreciates by <u>more</u> than the period 1 exchange rate, i.e. there is "undershooting". Conversely, if $m_{1a} > m_{2a}$, i falls and the exchange rate overshoots.

These results are notably different from those implied by Dornbusch's (1976) model, where the exchange rate immediately appreciates to its long-run level and the price level remains unchanged, in both the short and the long run. In fact, in its implications for fiscal policy, the Dornbusch model is no different from the original static Mundell-Fleming model of the textbooks, in which higher government spending completely crowds out the current account surplus via exchange rate appreciation, so that fiscal policy is powerless. Two serious limitations of this framework have been pointed out by Branson and Buiter (1983). The first is that an exchange rate depreciation is assumed not to affect the current price level and nor, therefore, to have any direct effect on money market equilibrium; while the second is that the trade deficit and the resulting fall in foreign asset holdings over time are assumed to have no wealth effects feeding back into the model, so that the deficit is allowed to persist indefinitely. Clearly the present model suffers from neither of these defects, and when they are made good we find, like Branson and Buiter (1983), that fiscal policy in a small country <u>does</u> positively affect aggregate demand, and thus output and the price level, despite flexible exchange rates and perfect capital mobility.

These differences in assumptions would also appear to be responsible for the second conflict between our findings and those of the Mundell-Dornbusch framework: that, rather than appreciating, the exchange rate depreciates in the short run, and quite possibly (if $m_{1a} < m_{2a}$) depreciates still further in the long run. The response of the <u>real</u> exchange rate to fiscal policy in a model which does permit wealth effects has been studied recently for the case of a small country by Giavazzi and Sheen (1985). They find that either real appreciation or depreciation is possible, in the case of a balanced-budget expansion. However, this may provide little guide as to the expected <u>nominal</u> exchange rate movements, which cannot be investigated in their model owing to the absence of money. Hence the present finding that there is an unambiguous nominal exchange rate depreciation, while consistent with their rejection of Mundell-Dornbusch, appears not to be one which has been widely recorded for a small economy with perfect capital mobility.

(iii) Exchange Intervention Policy

A foreign currency intervention is most usually thought of as an open market operation in the foreign exchange market, exactly analogous to such an operation in the domestic bond market, in that it involves the issuing of money in order to purchase the other asset. In this case, therefore, the counterpart of a rise in F is not a rise in τ_2 - which has so far been the "passive" policy instrument - but a rise in M. From the government budget constraint (7) (continuing to consider the case $F_1 = F_2 = F$, $M_1 = M_2 = M$), the necessary change in M is $dM = E_1 dF$. This we shall assume in deriving the multipliers (in fact evaluating in symmetric equilibrium where $E_1 = 1$). Note that $M - E_1 F$ is "domestic credit", as usually defined, so that such a policy is one of leaving domestic credit expansion unaffected.

The multipliers thus obtained are:

$$\frac{dP_1}{dF} = \frac{1}{P_1}\Big(\frac{m_1}{1+i} + \underset{-}{m_{1i}}\Big)/\underset{-}{J_1} > 0 \qquad (18)$$

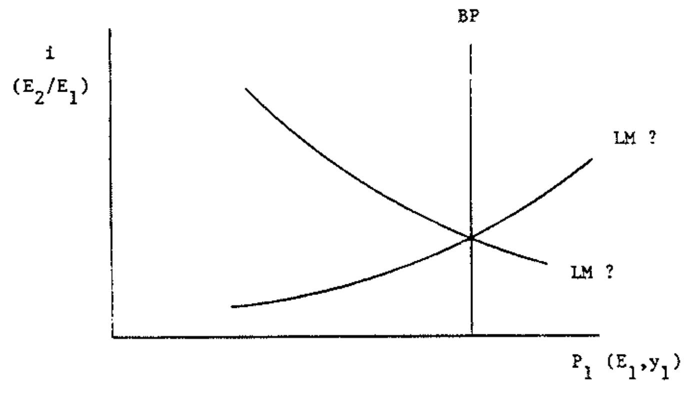
$$\frac{di}{dF} = \frac{1}{P_2}\{1-c_{1a}-dc_{2a}-\underset{?}{idm_{1a}}-dm_{1a}\}\Big(\underset{?}{y_P - \frac{M}{P_1^2}}\Big)/\underset{-}{J_1} = ? \qquad (19)$$

An open market foreign currency purchase hence unambiguously raises the price level, and so, equivalently, achieves a devaluation of the exchange rate and a rise in output. The effect on the interest rate, and so on exchange rate dynamics, is doubly ambiguous. The familiar expression in the income derivatives is positive if $m_{1a} < m_{2a}$; while, as we move away from the "Walrasian" case in which $y_P = 0$, the expression $y_P - \frac{M}{P_1^2}$ becomes less negative and will be positive for a sufficiently large y_P. Under these assumptions, the interest rate falls and the exchange rate overshoots.

Some simple intuitions for the unambiguous effects of the three policies in raising the price and output levels, and in depreciating the current exchange rate, can be given, for this small open economy. First, it is clear that the three effects mentioned are in this case uniquely linked, since any rise in the price level must be associated with a rise in output and a depreciation of the exchange rate, and vice versa. Second, it may be noted that the model defined by (9)-(11) has a recursive structure. From (11), "a" is only a function of P_1, and not of i. Thus (10), the balance of payments equilibrium condition, defines P_1 by itself. This is essentially a result of the fact that the real interest rate is exogenous in a small country, and neither output nor consumption depend on the nominal interest rate (this last being an artefact - though not an implausible one - of Cobb--Douglas utility).

The recursive structure means the equilibrium may be depicted as:

Fig.1



The BP line, depicting (10), is clearly vertical. However the LM line, depicting (9), has an ambiguous slope. A rise in M, g or F-and-M must shift the BP line right, raising P_1, E_1 and y_1. This may be seen by examination of (10) in conjunction with (11). All such changes result in higher desired spending in both periods, i.e. higher desired lifetime spending by the whole economy. To maintain equality with lifetime output, either desired lifetime spending must be reduced, or lifetime output must be increased - both of which require a rise in the period 1 price level.

A key difference from the Mundell-Fleming model consists in the fact that, there, rather than the real exchange rate being fixed and the price level being flexible, the reverse is the case. Thus, if there is a rise in demand in the goods market, then to the extent that this is not met by a rise in actual output (as occurs under a fiscal expansion), it must be choked off by a rise in the real (and thus, given a fixed price, also in the nominal) exchange rate, which crowds out the current surplus; rather than by a rise in the price level, and thus a fall in the nominal exchange rate, which crowds out private consumption via the real balance effect.

A closer examination of the structure of the model also demonstrates that exchange intervention is not in fact an independent new policy instrument in the small open economy, but is equivalent to a money-financed increase in government spending in the first period, i.e. to a combination of the usual monetary and fiscal instruments. This follows from the fact that F/P_1^* enters (9)-(11) always and only in the same way as g_1 does. Intuitively, since there is no demand by foreigners for domestic currency to hold (except by the foreign government, whose demand is exogenous), then any domestic currency sold by the government to foreigners in exchange for reserves, will be immediately converted by them into a purchase of domestic output. Thus, an open market purchase of reserves is equivalent to the government buying up output - as occurs with government spending - and exchanging it directly with foreigners in return for foreign currency. This second part of the operation has no real effects - at least, in the small open economy case - because, since government spending is in any case treated as "waste", it matters not at all whether the government retains the output it has bought, or exchanges it for (equally intrinsically useless) reserves.

4. A Two-Country Model

In this section, the world is taken to consist of two countries whose individual structure is as described above. To simplify the analysis, we assume complete symmetry between the two countries, though some modifications of this can readily be made. In this world, P_t^*, i^* and d are no longer exogenous. To preserve symmetry in the expression of the equilibrium conditions, we solve the model in terms of $(P_1, P_1^*; i, i^*; d)$. Using $P_1 = E_1 P_1^*$, movements in E_1 may then be deduced from those in both P_1 and P_1^*; while using $1+i = \{1+i^*\}E_2/E_1$, movements in E_2/E_1 may be deduced from those in both i and i^*.

The equilibrium conditions we thus write as:

$$y_1(P_1) + y_1(P_1^*) = c_1(a) + c_1^*(a^*) + g_1 + g_1^* \quad (20)$$

$$\bar{y}_2 + \bar{y}_2^* = c_2(a,d) + c_2^*(a^*,d) + g_2 + g_2^* \quad (21)$$

$$\frac{M}{P_1\{1+i\}d} = m_1(a,i,d) + \frac{F^*}{P_1\{1+i\}d} \quad (22)$$

$$\frac{M^*}{P_1^*\{1+i^*\}d} = m_1^*(a^*,i^*,d) + \frac{F}{P_1^*\{1+i^*\}d} \quad (23)$$

$$y_1(P_1) - c_1(a) - g_1 = -d\{\bar{y}_2 - c_2(a,d) - g_2\} + \frac{F}{P_1^*} - \frac{F^*}{P_1} \quad (24)$$

where

$$a = y_1(P_1) + d\bar{y}_2 - \{g_1 + dg_2\} + \frac{M}{P_1} - \frac{F}{P_1^*} \quad (25)$$

$$a^* = y_1^*(P_1^*) + d\bar{y}_2^* - \{g_1^* + dg_2^*\} + \frac{M^*}{P_1^*} - \frac{F^*}{P_1} \quad (26)$$

(22) and (24) are carried over from the "small country" case. (20) and (21) impose equilibrium in the world markets for period 1 and period 2 output, while (23) provides for equilibrium in the foreign money market.

We again consider the effects of permanent increases in M, g and F-and-M in the home country. In this case there are two additional variables whose response to these policy changes is of particular interest: the foreign price level, P_1^* (and thus the foreign output level); and the world real interest rate or discount factor, d.

It has been shown by Aoki (1981) that a linear, symmetric, two-country model may be re-written in terms of variables which are the sums and differences of their counterparts in the individual country, and that the resulting model may be solved as two independent systems - one in the sums and one in the differences. This is valuable not merely for the simplification of the mathematics which it provides, but also because the decoupled systems have useful interpretations. The system of sums clearly describes the behaviour of the aggregate world economy; i.e., equivalently, of a completely closed economy but with an identical structure. The system of differences - rather less obviously - describes the behaviour of the corresponding small open economy. This follows intuitively from the fact that, if the economy is "small" relative to the world, then the "sum" variables, and those of the foreign country, can be treated as unaffected by changes in the economy. An economy in a symmetric two-country model will be seen to have behaviour which is an unweighted average of that in the sum and difference systems. This, of course, appears natural when it is realised that, in terms of relative size, such an economy lies half-way between the two extremes of the closed, and of the small open, economies.

In the present model, non-linearities prevent the expression of the equilibrium conditions themselves in sum and difference forms. However, since our main interest in the first instance is in infinitesimal changes, we can use the linearity of the differentiated system to apply Aoki's method to the derivation and understanding of the comparative static multipliers. Thus, for any country-specific variable X, define $X^a \equiv X + X^*$, $X^d \equiv X - X^*$. Then by the independence of the sum and difference systems, for any X,Y,

$$dY^a/dX^d = dY^d/dX^a = 0 \tag{27}$$

$$dY/dX = \tfrac{1}{2}\{dY^a/dX^a + dY^d/dX^d\} \tag{28}$$

$$dY^*/dX = \tfrac{1}{2}\{dY^a/dX^a - dY^d/dX^d\} \tag{29}$$

Table 1 summarises the multipliers obtained for the sum and difference sytems, and Table 2 summarises the results of combining these - in the ways just explained - to obtain multipliers of own-policy effects and cross-policy effects. The essentials of the algebra by which these are derived are given in Appendix B. Where the signs are ambiguous, sufficient, or necessary and sufficient (introduced by "iff") conditions for them to take a particular sign are shown. Note that Table 2 also includes the effects on the current account surplus, b ($\equiv y_1 - c_1 - g_1$).

A reasonable intuitive understanding of the model may be gained by starting with the consideration of Table 1. Note first that the independence of the sum and difference systems results in the multipliers on the off-diagonal blocks being zero, and hence these are blanked out. Second, from the earlier discussion, the multipliers of the aggregate system may be interpreted as those of the closed economy, and those of the difference system may be interpreted as those of the small open economy. The latter, therefore, have already been presented and discussed in Section 3. In the present context, their additional role in indicating the effects of differential policy changes in the two countries on differences between variables has an interesting implication. We know that the variables E_1 and E_2/E_1 depend only on differences: specifically, $dE_1 = dP_1^d/P_1$ and $d(E_2/E_1) = di^d/(1+i)$, in symmetric equilibrium. Therefore the exchange rate responses to policy changes in the home country alone will be unaffected by the extension to two countries. This shows up clearly in Table 2.

The behaviour of the aggregate/closed economy system, summarised in the upper part of Table 1, is worthy of closer scrutiny. The equilibrium conditions for the closed economy are:

$$y_1(P_1) = c_1(a) + g_1 \tag{30}$$

$$\bar{y}_2 = c_2(a,d) + g_2 \tag{31}$$

$$\frac{M}{P_1(1+i)d} = m_1(a,i,d) \tag{32}$$

Table 1 : Comparative Statics of Aggregates and Differences

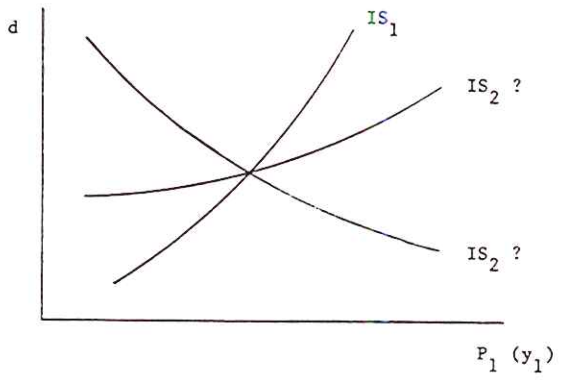
Increase in:	Effect on:	aggregates			differences	
		P_1^a	d	i^a	P_1^d	i^d
aggregates	M^a	+	+	− iff $m_{1a} < m_{2a}$		
	g^a	+	− iff $y_P[1 - c_{1a} - dc_{2a}] + [c_{1a} - c_{2a}]M/P_1^2 < 0$	+ if $m_{1a} < m_{2a}$, $y_P[1 - c_{1a} - dc_{2a}] + [c_{1a} - c_{2a}]M/P_1^2 < 0$		
	F^a	0	0	0		
differences	M^d				+	− iff $m_{1a} < m_{2a}$
	g^d				+	+ iff $m_{1a} < m_{2a}$
	F^d				+	− if $m_{1a} < m_{2a}$, $y_P - M/P_1^2 > 0$

where

$$a \;=\; y_1(P_1) + d\bar{y}_2 - \{g_1 + dg_2\} + \frac{M}{P_1} \qquad (33)$$

This system too is recursive. Since "a" is independent of i , (30) and (31) determine (a,d) alone, leaving i to be determined residually by (32). Thus it may be depicted in two dimensions:

Fig.2



IS_1 and IS_2 plot the goods market-clearing loci for each of the two periods, (30) and (31). The slope of IS_2 is ambiguous, but simple algebra shows it must cut IS_1 from above. A rise in M, by raising consumption demand in both periods, unambiguously shifts both curves to the right, thus raising P_1, and hence y_1. A rise in g (= g_1 = g_2) has similar consequences. The effects on d are ambiguous from the diagram, but in fact positive under monetary policy, as Table 1 states.

In the closed economy, foreign exchange reserves make no appearance, for obvious reasons. One would accordingly expect to find, as Table 1 shows, that foreign exchange intervention has no effect on aggregate variables. This indeed makes intuitive sense: an equal purchase of foreign exchange, financed by money, by both governments, results in world private sector holdings of all assets being unaffected, and in the two governments' merely having swapped each others currencies.

Having obtained these insights into the properties of the aggregate/closed

Table 2 : Comparative Statics of Home and Foreign Effects

Increase in:	Effect on:	P_1	P_1^*	E_1	i	i^*	E_2/E_1	d	b
2-country model	M	+	−	+	− if $m_{1a} < m_{2a}$	− if $m_{1a} < m_{2a}$	− iff $m_{1a} < m_{2a}$	+	+
	g	+	+ iff $y_P[1-c_{1a}-dc_{2a}] + [c_{1a}-c_{2a}]M/P_1^2 < 0$	+	+ if $m_{1a} < m_{2a}$, $y_P[1-c_{1a}-dc_{2a}] + [c_{1a}-c_{2a}]M/P_1^2 < 0$	+ iff $y_P[1-c_{1a}-dc_{2a}] + [c_{1a}-c_{2a}]M/P_1^2 < 0$	+ iff $m_{1a} < m_{2a}$	− iff $y_P[1-c_{1a}-dc_{2a}] + [c_{1a}-c_{2a}]M/P_1^2 < 0$	?
	F	+	−	+	− if $m_{1a} < m_{2a}$, $y_P - M/P_1^2 > 0$	− if $m_{1a} < m_{2a}$, $y_P - M/P_1^2 > 0$	− if $m_{1a} < m_{2a}$, $y_P - M/P_1^2 > 0$	0	+
1-country model	M	+		+	− iff $m_{1a} < m_{2a}$		− iff $m_{1a} < m_{2a}$		+
	g	+		+	+ iff $m_{1a} < m_{2a}$		+ iff $m_{1a} < m_{2a}$		?
	F	+		+	− if $m_{1a} < m_{2a}$, $y_P - M/P_1^2 > 0$		− if $m_{1a} < m_{2a}$, $y_P - M/P_1^2 > 0$		+

economy and difference/small open economy systems, we may turn to a direct examination of the multipliers for the two-country model, which are summarised in Table 2.

(i) Monetary Policy

From the table, it is clear that, with regard to the effects on those variables for which a comparison can be made with the "small country" case, there are few differences. An increased money supply still raises the price level at home, and causes the exchange rate to overshoot its long-run depreciation if and only if $m_{1a} < m_{2a}$. It also creates a current account surplus in the first period. While, as noted, the condition for exchange rate overshooting is unchanged, the likelihood that the home interest rate will fall is increased, since $m_{1a} < m_{2a}$ is sufficient but no longer necessary for this. It is now possible that i will fall and yet there will be exchange rate undershooting, since, from $1+i = \{1+i^*\}E_2/E_1$, this can occur if i* falls by more than i, which of course is ruled out if the country is "small".

Unlike the home effect, the sign of the effect on the foreign price level, and thus on foreign output, cannot be immediately deduced from the signs of the closed and small open economy multipliers (appealing to (29)), since these are counteracting. Nevertheless, as Table 2 indicates, this effect is unambiguously contractionary. This is identical to Mundell's (1968) result, and in contrast to Persson's (1982) result, in which the foreign price and output level are unaffected. the contrast with the latter is presumably due to the more flexible specification permitted for money demand, which - as already noted - Persson admits to be responsible for the absence of an effect. However, his conjecture that, if money demand were permitted to depend on the interest rate, then the foreign effect could be either expansionary or contractionary, does not appear to be confirmed by our model.

The similarity with Mundell's conclusions does not extend to the interest rate. It is true that the real interest rate falls (i.e. d rises), as Mundell finds; but both the domestic and foreign nominal interest rates could either fall or rise. A fall in the foreign nominal interest rate is not a precondition for foreign output to fall, as in Mundell's model, since money demand no longer depends only on current income and the nominal interest rate.

(ii) Fiscal Policy

From the table, the effect of a permanent rise in government spending on the domestic price level and output is unambiguously expansionary. This is to be expected, given the same effects in both the small open and the closed economies (recalling (28)), and is consistent with Mundell. Whereas in Mundell's framework, the two-country setting (or, at least, the assumption that the country is not "small") is necessary for fiscal policy to affect domestic output, we already know this is not true in our framework, so our extension to two countries would have been expected merely to reinforce the effectiveness of fiscal policy.

The effects on the exchange rate are identical to the small country case, for the general reason which was noted above. There is an immediate depreciation of the current rate, and, if $m_{1a} < m_{2a}$, an even greater depreciation of the future rate. By comparison, the Mundell two-country model predicts an ambiguous exchange rate response.

The effect on the foreign price level, and thus on foreign output, turns on the sign of the ambiguous expression $y_p\{1-c_{1a}-dc_{2a}\}+\{c_{1a}-c_{2a}\}M/P_1^2$. To confirm Mundell's result that a fiscal expansion at home also has expansionary effects abroad, we need this to be negative. While this is possible, it is clear that it could easily be positive, as would occur if $c_{1a} > c_{2a}$, i.e. if the marginal propensity to spend lifetime income on current consumption exceeds that on future consumption. Thus the foreign effects of fiscal policy found by Mundell do not seem to be robust to our changes of specification, unlike those of monetary policy.

Finally, the fiscal effects on the interest rate are different both from

Mundell's two-country model, and from the small country case of the present model. Whereas Mundell finds an unambiguous rise in the real rate, this now only holds in our model under the same condition, stated above, as is necessary for an expansionary impact on foreign output. This is also the condition for a rise in the foreign nominal rate. As regards the effect on the domestic nominal rate, we saw that the necessary and sufficient condition for this to rise in a small country was $m_{1a} < m_{2a}$; this is now merely a sufficient condition - i.e. a rise becomes more likely - in the two-country model, but provided that the condition for a foreign expansion holds.

(iii) Exchange Intervention Policy

The table shows the effects of a money-financed purchase of foreign exchange to be identical to those in the small open economy, for the variables where comparisons can be made. This follows from the fact that, as was seen above, only differential, and not aggregate, changes in reserves have any effects, and these are always the same as in a small open economy. For the same reason, the effects on the foreign price level and interest rate are simply mirror images of those on the corresponding home variables, while that on the real interest rate is zero.

It was claimed earlier that intervention policy is no longer equivalent to a money-financed fiscal expansion in the two-country setting. Inspection of (20)-(26) shows why this is. F/P_1^* no longer enters the equations identically to g_1: it has a separate influence in the first-period foreign currency market, while g_1 has a separate influence in the first-period goods market. Thus, as far as the home country is concerned, intervention does provide a new policy instrument. It is still true that identical effects could be achieved using other instruments if international coordination was practised: in fact what is needed is a fiscal expansion at home and an equal contraction abroad, both money-financed. However, such a policy combination clearly cannot be operated by a single country alone.

5. Conclusions

In summarising our findings, a number of general observations can be made. First - and as noted in the Introduction - our changes of specification relative to the Mundell-Fleming-Dornbusch framework do not upset the conclusions with regard to monetary policy, but they do upset those with regard to fiscal policy - both in the one-country and the two-country case. In particular, there is no suggestion that fiscal policy might be an ineffective instrument of demand management at home, and only parameter-sensitive evidence that it may have contractionary effects abroad. Second, extending the model from one country to two does not qualitatively alter the results on domestic output, price levels and exchange rates, for monetary, fiscal or exchange intervention policy. What it alters is the effects on interest rates, both real and nominal.

A number of extensions and modifications might be considered. One is to introduce asymmetry into the two-country version. Of particular interest here is where one country has a fixed money wage ("America"), and the other has a fixed real wage, i.e. a money wage fully indexed to the price level ("Europe"). This is the framework of Argy and Salop (1983), who show that a monetary expansion by "Europe" has no real effects, while a fiscal expansion has positive effects at home and (probably) abroad. Their framework contains only one period, but allows differentiated products and hence an endogenous real exchange rate. This latter permits output to change even in the rigid real wage country, since it is the consumer's real wage which is taken to be rigid, so a real appreciation allows the producer's real wage to fall and stimulates output. In our model output in the rigid real wage country would be exogenous, so that most of the interest would pass to the effects on interest rates and the exchange rate.

The above suggests that to introduce differentiated products would be a valuable extension in its own right. As noted in Section 2, this would overcome some of the difficulties of rationing schemes, and allow a sensible analysis with a fixed price as well as wage, permitting goods market disequilibrium as well as labour market disequilibrium. Such two-country disequilibrium models have been constructed by Lorie and Sheen (1982), Laussel and Montet (1983), and Owen (1985). However, all use a single-period time horizon, which seriously limits their value for the analysis of flexible exchange rates. An exception to this is the disequilibrium model of Cuddington and Vinals (1986), which, however, focuses on a single small country. The likely difficulties of such an approach for a two-country dynamic model are excessive complexity. This is well illustrated by the article by Mathiesen and Steigum, in Henin et al. (1985), in which a framework similar to taht just proposed, but excluding money, is adopted: even with this simplification, a resort to simulation techniques proves necessary.

A final feature which might be introduced is investment. This would fit naturally into an intertemporal framework such as the present one, and would be particularly of interest with regard to fiscal policy, where it would enable a study of possible pernicious long-run effects on the capital stock. This, and the other extensions, provide an agenda for future work.

Appendix A

By the well-known property of Cobb-Douglas utility functions, the value shares in "a" of the four arguments of u(.) must equal the powers to which the latter are raised:

$$c_1/a = \alpha, \quad idm_1/a = \beta, \quad dc_2/a = \gamma, \quad dm_2/a = \delta$$

where $m_1 \equiv M_1/P_2$, $m_2 \equiv M_2/P_2$, $\alpha + \beta + \gamma + \delta = 1$. Thus the demand functions are:

$$c_1 = \alpha a, \qquad m_1 = \beta a/id,$$

$$c_2 = \gamma a/d, \qquad m_2 = \delta a/d$$

From this, $\frac{m_1}{1+i} + m_{1i} = \frac{m_1}{1+i} - \frac{m_1}{i} < 0.$

Appendix B

Totally differentiating (20)-(24), taking note of (25)-(26), gives the system below. We assume symmetry of parameter and variable values, and evaluate at $F = F^* = 0$:

$$\begin{bmatrix} y_P\{1-c_{1a}\}+c_{1a}\frac{M}{P_1^2} & y_P\{1-c_{1a}\}+c_{1a}\frac{M}{P_1^2} & 0 & 0 & -2c_{1a}a_d \\ -y_Pc_{2a}+c_{2a}\frac{M}{P_1^2} & -y_Pc_{2a}+c_{2a}\frac{M}{P_1^2} & 0 & 0 & -2\{c_{2d}+c_{2a}a_d\} \\ -\frac{m_1}{P_1}-m_{1a}(y_P-\frac{M}{P_1^2}) & 0 & -\frac{m_1}{1+i}-m_{1i} & 0 & -m_{1a}a_d \\ 0 & -\frac{m_1}{P_1}-m_{1a}(y_P-\frac{M}{P_1^2}) & 0 & -\frac{m_1}{1+i}-m_{1i} & -m_{1a}a_d \\ y_P\{1-c_{1a}-dc_{2a}\}+\{c_{1a}+dc_{2a}\}\frac{M}{P_1^2} & 0 & 0 & 0 & -\{c_{1a}+dc_{2a}\}a_d-dc_{2d} \end{bmatrix} \begin{bmatrix} dP_1 \\ dP_1^* \\ di \\ di^* \\ dd \end{bmatrix}$$

$$\begin{bmatrix} \frac{c_{1a}}{P_1} & \frac{c_{1a}}{P_1} & 1-\{1+d\}c_{1a} & 1-\{1+d\}c_{1a} & 0 & 0 \\ \frac{c_{2a}}{P_1} & \frac{c_{2a}}{P_1} & 1-\{1+d\}c_{2a} & 1-\{1+d\}c_{2a} & 0 & 0 \\ \frac{m_{1a}}{P_1}-\frac{1}{P_2} & 0 & -\{1+d\}m_{1a} & 0 & -\frac{1}{P_2} & \frac{1}{P_2} \\ 0 & \frac{m_{1a}}{P_1}-\frac{1}{P_2} & 0 & -\{1+d\}m_{1a} & \frac{1}{P_2} & -\frac{1}{P_2} \\ \frac{c_{1a}+dc_{2a}}{P_1} & 0 & \{1+d\}\{1-c_{1a}-dc_{2a}\} & 0 & \frac{1}{P_1} & \frac{1}{P_1} \end{bmatrix} \begin{bmatrix} dM \\ dM^* \\ dg \\ dg^* \\ dF \\ dF^* \end{bmatrix} \qquad \text{(A1)}$$

where $dg = dg_1 = dg_2$.

Defining aggregates and differences for the country-specific variables as in the text, it is possible by routine manipulations to re-write the system (A1) as the following two independent systems in aggregates and differences:

$$\begin{bmatrix} y_P\{1-c_{1a}\}+c_{1a}\frac{M}{P_1^2} & -2c_{1a}a_d & 0 \\ -y_P c_{2a}+c_{2a}\frac{M}{P_1^2} & -2\{c_{2d}+c_{2a}a_d\} & 0 \\ -\frac{m_1}{P_1}-m_{1a}\left(y_P-\frac{M}{P_1^2}\right) & -m_{1a}a_d & -\frac{m_1}{1+i}-m_{1i} \end{bmatrix} \begin{bmatrix} dP_1^a \\ dd \\ di^a \end{bmatrix}$$

$$= \begin{bmatrix} \frac{c_{1a}}{P_1} & 1-\{1+d\}c_{1a} & 0 \\ \frac{c_{2a}}{P_1} & 1-\{1+d\}c_{2a} & 0 \\ \frac{m_{1a}}{P_1}-\frac{1}{P_2} & -\{1+d\}m_{1a} & 0 \end{bmatrix} \begin{bmatrix} dM^a \\ dg^a \\ dF^a \end{bmatrix} \qquad \text{(A2)}$$

$$\begin{bmatrix} -\frac{m_1}{P_1}-m_{1a}\left(y_P-\frac{M}{P_1^2}\right) & -\frac{m_1}{1+i}-m_{1i} \\ \frac{1}{2}\left(y_P\{1-c_{1a}-dc_{2a}\}+\{c_{1a}+dc_{2a}\}\frac{M}{P_1^2}\right) & 0 \end{bmatrix} \begin{bmatrix} dP_1^d \\ di^d \end{bmatrix}$$

$$= \begin{bmatrix} \frac{m_{1a}}{P_1} - \frac{1}{P_2} & -\{1+d\}m_{1a} & -\frac{2}{P_2} \\ \frac{1}{2}\frac{c_{1a}+dc_{2a}}{P_1} & \frac{1}{2}\{1+d\}\{1-c_{1a}-dc_{2a}\} & \frac{1}{P_1} \end{bmatrix} \begin{bmatrix} dM^d \\ dg^d \\ dF^d \end{bmatrix} \quad (A3)$$

The multipliers resulting from (A3), since they are the same as those for the small open economy, have already been presented in Section 3. Turning attention to (A2), the Jacobean determinant may be evaluated as:

$$J_2 = 2(\underset{-}{\frac{m_1}{1+i} + m_{1i}})(y_P\{\underset{?}{c_{2d}\{1-c_{1a}\}+c_{2a}a_d}\} + \underset{-}{c_{2d}}c_{2a}\frac{M}{P_1^2})$$

The sign of the second term is prima facie ambiguous. However, using the Cobb-Douglas demand functions,

$$c_{2d}\{1-c_{1a}\}+c_{2a}a_d = \{1-\alpha\}(-\gamma a/d^2) + \{\gamma/d\}(\bar{y}_2 - g_2)$$

$$= -(\gamma/d^2)\{(1-\alpha)a - d(\bar{y}_2 - g_2)\}$$

$$= -(\gamma/d^2)\frac{M}{P_1} < 0$$

noting (25), $\alpha a = c_1$, and evaluating at $y_1 - c_1 - g_1 = 0$, i.e. a zero trade surplus (which follows from the assumption of initial symmetry). This establishes $J_2 > 0$.

J_2 provides the denominator for the multipliers in the aggregate/closed economy system. Using Cramer's Rule, these may be solved from (A2). We obtain (in some cases after extensive simplification):

$$\frac{dP_1^a}{dM^a} = 2(\underset{-}{\frac{m_1}{1+i}} + \underset{-}{m_{1i}})c_{2d}c_{1a}/P_1\underset{+}{J_2} > 0$$

$$\frac{dd}{dM^a} = -(\underset{-}{\frac{m_1}{1+i} + m_{1i}})y_P\underset{+}{c_{2a}}/P_1\underset{+}{J_2} > 0$$

$$\frac{di^a}{dM^a} = 2\{\underset{?}{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}}\}y_P\underset{-}{c_{2d}}/P_2\underset{+}{J_2}$$

$$\frac{dP_1^a}{dg^a} = 2\Big(\frac{m_1}{1+i} + \underset{-}{m_{1i}}\Big)\{c_{2d}\{1-c_{1a}\} + \underset{-}{c_{2a}a_d}\}/J_2 \;>\; 0$$

$$\frac{dd}{dg^a} = \Big(y_P\{1-c_{1a}-dc_{2a}\} + \underset{?}{\{c_{1a}-c_{2a}\}}\frac{M}{P_1^2}\Big)/J_2$$

$$\frac{di^a}{dg^a} = c_{2d}\Big\{m_{1a}d\Big(y_P\{1-c_{1a}-dc_{2a}\} + \underset{?}{\{c_{1a}-c_{2a}\}}\frac{M}{P_1^2}\Big) - 2\frac{m_1}{P_1}\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}\Big\}/\underset{+}{J_2}$$

The signs of the components of these expressions are indicated beneath them. Where these are fundamentally ambiguous, this is shown by (?), and the term has been discussed in the main text. Where they are only superficially ambiguous, an explanation of the sign has been given elsewhere.

The multipliers whose properties are summarised in Table 2 are obtained from the aggregate and difference multipliers, noting (28)-(29). The denominator in these expressions is clearly J_1J_2, which is negative. To obtain consolidated expressions for the numerators requires some manipulation. The resulting expressions are:

$$\frac{dP_1}{dM} = \Big(\frac{m_1}{1+i} + m_{1i}\Big)^2\Big\{-2\underset{-}{c_{2d}}c_{1a}\Big(y_P\{1-c_{1a}-dc_{2a}\} + \underset{+}{\{c_{1a}+dc_{2a}\}}\frac{M}{P_1^2}\Big) + y_Pc_{2a}a_d\underset{+}{\{1-c_{1a}-dc_{2a}\}}\Big\}/P_1J_1J_2 \;>\; 0 \quad \text{(A4)}$$

$$\frac{dP_1^*}{dM} = -\Big(\frac{m_1}{1+i} + m_{1i}\Big)^2 y_Pc_{2a}a_d\{1-c_{1a}-dc_{2a}\}/P_1J_1J_2 \;<\; 0 \quad \text{(A5)}$$

$$\frac{di}{dM} = \Big(\frac{m_1}{1+i} + m_{1i}\Big)\Big\{-2y_P\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}\Big(y_P\{c_{2d}\underset{-}{\{1-c_{1a}\}}+c_{2a}a_d\} + \underset{-}{c_{2d}}c_{1a}\frac{M}{P_1^2}\Big) + \{1+i\}dy_Pc_{2a}\frac{m_1}{P_1}\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}\Big\}/P_2J_1J_2 \quad \text{(A6)}$$

$$\frac{di^*}{dM} = \left(\frac{m_1}{1+i} + m_{1i}\right)\{1+i\}dy_p c_{2a}\frac{m_1}{P_1}c_2\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}/P_2 J_1 J_2 \qquad \text{(A7)}$$

$$\frac{dP_1}{dg} = \left(\frac{m_1}{1+i} + m_{1i}\right)^2 \Big\{\underset{+}{y_p\big(-2\{1+d\}\{1-c_{1a}-dc_{2a}\}\underset{-}{\{c_{2d}\{1-c_{1a}\}+c_{2a}a_d\}} + dc_{2a}a_d\{1-c_{1a}-dc_{2a}\}\big)}$$
$$- \frac{M}{P_1^2}\big(-c_{2a}a_d\{1-c_{1a}-dc_{2a}\}+2\{1+d\}c_{1a}c_{2d}\{1-c_{1a}-dc_{2a}\}\big)\Big\}/J_1J_2$$
$$> 0 \qquad \text{(A8)}$$

$$\frac{dP_1^*}{dg} = -\left(\frac{m_1}{1+i} + m_{1i}\right)^2 a_d\underset{+}{\{1-c_{1a}-dc_{2a}\}}\big(\underset{?}{y_p\{1-c_{1a}-dc_{2a}\}+\frac{M}{P_1^2}\{c_{1a}-c_{2a}\}}\big)/J_1J_2 \qquad \text{(A9)}$$

$$\frac{di}{dg} = -\left(\frac{m_1}{1+i} + m_{1i}\right)\Big\{-\frac{m_1}{P_1}c_2\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}\big(\underset{?}{y_p\{1-c_{1a}-dc_{2a}\}+\{c_{1a}-c_{2a}\}\frac{M}{P_1^2}}\big)$$
$$-\{1+d\}\frac{m_1}{P_1}\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}2\big(\underset{+}{-a_d\{1-c_{1a}-dc_{2a}\}}$$
$$\underset{-}{+c_{2d}c_{1a}\frac{M}{P_1^2}}\big)\Big\}/J_1J_2 \qquad \text{(A10)}$$

$$\frac{di^*}{dg} = \left(\frac{m_1}{1+i} + m_{1i}\right)\frac{m_1}{P_1}c_2\underset{?}{\{1-c_{1a}-dc_{2a}-idm_{1a}-dm_{1a}\}}\big(\underset{?}{y_p\{1-c_{1a}-dc_{2a}\}+\{c_{1a}-c_{2a}\}\frac{M}{P_1^2}}\big)/J_1J_2$$
$$\text{(A11)}$$

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