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3 The effects of American policies – a new classical interpretation

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I Introduction and summary

The object of this paper is to investigate the effects of US fiscal and monetary shocks on the world economy within a world macroeconomic model.

US policies over the past five years have been the object of admiration and vilification, exposition and caricature, both in the US itself and perhaps even more so in Europe. Some have argued that tight money and high deficits would not affect real interest rates or anything much except the rate of inflation and private saving. Others have argued that they would make recovery impossible by driving real interest rates to unheard-of levels. Yet others have argued that the high deficits have stimulated the world economy in a 'locomotive' manner. Established forecasters' reputations have been dented while some outsiders in the US forecasting game have scored hits (notably recently, monetarists and supply siders). Confusion reigns supreme, even over the ground rules of this discussion. The one common factor is the passionate intensity with which all views are held; the combination of Ronald Reagan and Paul Volcker has fired passions across the intellectual and political spectrum.

It is my contention that the effects of US policies cannot be understood in a US context alone; a closed-economy model will not do. I will be arguing that 'crowding out' is occurring on a *world* scale and that the 'injured parties' are outside the US in the main; furthermore, the scale of financing required for the US deficit has only been feasible through the *world* capital market.

This points to an understanding of a linked economic system. How could this be achieved? Some espouse vector-autoregressive methods to locate the sources of world business cycle shocks and the nature of their persistence – e.g. Saidi and Huber (1983). By its nature this work – while it has valuable uses – cannot identify structural relationships; therefore, one cannot easily interpret the results in terms of causal mechanisms.

One method of explanation appears to be available. One can set out a causal (or 'structural') system purporting to describe the linked economies; one can ask what effects this indicates for US policies and then check whether that set of effects appears broadly to have occurred in fact. This is the method I adopt in this paper.

In brief, I shall be using a description which relies importantly on two key features – rational expectations and wealth effects of government bonds. This description is parameterised, as best I have so far been able to achieve, using estimates of post-war behaviour (some estimates of our own, some a priori impositions, some previous work). The description yields a clear 'story' of the effects of monetary shocks and (bond-financed) fiscal shocks; this story is clear in spite of the 'largeness' of the model, because the model is constructed according to a very clear set of theoretical restrictions and it can therefore be simply understood – the number of equations is not a measure of intellectual complexity. Finally, I shall argue that the story fits the recent five-year episode rather plausibly, reconciling many of the details whose coincidence has appeared so baffling to different schools of interpretation.

Before going any further, a brief defence of the two main features would be wise. Rational expectations I regard as the analogue of routinely-assumed optimising behaviour in the information field, it is an 'as-if' assumption with the same status as the 'profit-maximising' or 'utility-maximising' assumptions we make about firms and consumers. It yields strong predictions and we have good reason to believe that competitive pressures exist in the real world driving people towards this norm of behaviour.

Wealth effects of government bonds have been carefully analysed by Barro (1974), to whom is due the revival among economists of the Ricardian equivalence theorem. As Barro notes, there are two main reasons why bonds could be net wealth to rational agents; the first occurs if the agent leaves no bequest. The second occurs if the income tax system is progressive, in effect insuring against income shocks; in this case higher future taxes will fall more on the lucky than on the unlucky and risk-averse agents will discount the tax stream to below the present value of the bonds. Empirical work to date has tended to support the view that bonds are net wealth (but not 100% net wealth) in line with these two aspects. These points are discussed further in Minford and Peel (1983, Chapter 9).

I now proceed to describe the model and so the nature of my explanation of recent events. Then I discuss the simulations of US policy. Finally, I review recent events and draw some tentative policy implications.

II The Liverpool international transmission model

The model is macroeconomic in the sense that it has no 'supply-side' at this stage; the equilibrium (or 'natural') values of output, real interest rates, real exchange rates, etc., are taken as exogenous.

The essence of our approach is fairly simple. We have linked together nine annual country models of identical structure, and added equations for the trade (only) of other countries, divided into three blocks. Hence the interesting detail relates primarily to the nine (major OECD) countries.

Each country model has the structure set out in Minford et al. (1984). (For detailed support of the following account, the reader is referred there). The model consists of:

(a) an inter-related set of private sector demands for stocks of money, government bonds (and net foreign assets), and durable goods, and for a flow of non-durable consumption goods; these demands depend on wealth and real returns.
(b) a government supply function of (narrow M1) money which together with the government and foreign sector budget constraints determines also the supply of bonds plus foreign assets.
(c) efficient financial markets in the operational sense that expected returns are equated across domestic and international financial assets.
(d) rational expectations which is implemented operationally by using the model's forecasts as the expectations.
(e) the supply of output is modelled via a price equation derived from an aggregate production function as a mark-up over costs which varies with the level of output.
(f) the labour market has a significantly large union sector; the non-union sector clears continuously (at levels heavily influenced by social security benefits). But the union's real wage target is seen as the outcome of intertemporal maximisation of their members' incomes and, given adjustment costs in firms' demand for labour, this gives rise to a union real wage which is a mark-up over expected non-union real wages and also dependent on lagged union real wages and firms' other cost factors. This real wage target is translated into a one year nominal wage contract on the basis of expected inflation. Aggregating together union and non-union wages and substituting out firms' demand for labour, we obtain a reduced form real wage equation positively related to output, lagged real wages and employer taxes on labour and negatively to unexpected inflation, benefits and employee taxes. Hence if there is unanticipated inflation, real wages fall, and so do output costs; the supply curve of output therefore shifts outwards temporarily.

In subsequent periods, real wages gradually return to equilibrium and output with it. This Lucas-type supply function is however derived by a rather different route from that chosen by Lucas and Rapping (1969).

(g) The current account external balance depends on the real exchange rate (defined as domestic relative to foreign consumer prices adjusted for the exchange rate) and domestic and foreign 'absorption' (total final expenditure).

Hence the model's features are predominantly 'New Classical'. These features distinguish it from available multi-country models such as Project Link, which tend to be very large, preserve a traditional Keynesian approach, and contain a large number of auxiliary hypotheses besides their Keynesian core. Variation in the auxiliary hypotheses makes it easy for these models to rationalise events ex post without jettisoning that core; but this procedure implies that little of any interest is being tested in prediction.

From an academic viewpoint our aim is to minimise the number of auxiliary hypotheses and so make it possible to test more effectively the core new classical hypotheses. Ideally, we would want to set up a 'Keynesian' alternative model with a minimum of auxiliary hypotheses, to compare with ours; however, at present this lies outside our capability.

The problem much stressed recently in model-building has been the 'Lucas critique' (Lucas, 1976); i.e. that model parameters may change when policies and other parameters of the exogenous environment change. *In principle* we can avoid this problem by specifying *all* expectations (and any relevant higher moments) explicitly. In practice, however, so many enter a model such as this that modelling economy enforces some choice of critical expectations to model explicitly, leaving others to be implicit and so vulnerable to the critique. Empirical trials should tell us how well our choices have been made and whether it would pay us to widen the choice, this is, however, in the nature of empirical work and does not pose a deep-seated challenge to our methods.

The model is based on preliminary econometric estimates using limited information methods; some parameters have been imposed on the basis of previous work, when satisfactory estimates could not be obtained. Full dynamic simulation tests have not yet been possible. Therefore, viewed empirically the model is as yet a tentative construct, far from fully tested. Nevertheless, in so far as its structure reflects a major strand of modern macroeconomic thinking and its parameters are related to available empirical work, its simulation properties are of interest.

III A simplified account of the model

A full listing of the model is provided in Appendix A. However, it may help understanding of the considerable mass of detail there to erect a stylised version, provided it is used with caution in interpreting the full model's simulation results. This version is taken from Minford, Ioannidis and Marwaha (1983). In this section we expound it briefly and relate it to some previous strands in the open economy literature.

For this version we assume two identical countries and adopt a loglinear form. Write the home country model as:

$$y = \delta_\theta \theta - \delta_r r - \delta_e e + \delta_F y_F + \delta_d d + \epsilon_\delta \qquad \text{(IS)}\ (\delta_F < 1) \qquad (1)$$

$$y = \sigma_p(p - \underset{-1}{E}p) + \sigma_e e + \epsilon_s \qquad \text{(PP)} \qquad (2)$$

$$m = \mu_y y + \mu_\theta \theta - \mu_\rho(\underset{-1}{E}p_{+1} - p + r) + p + \epsilon_\mu \qquad \text{(LM)} \qquad (3)$$

$$\Delta m = \phi d + \epsilon_m \qquad \text{(Supply of money)} \qquad (4)$$

$$\Delta d = \epsilon_d \qquad \text{(Deficit process)} \qquad (5)$$

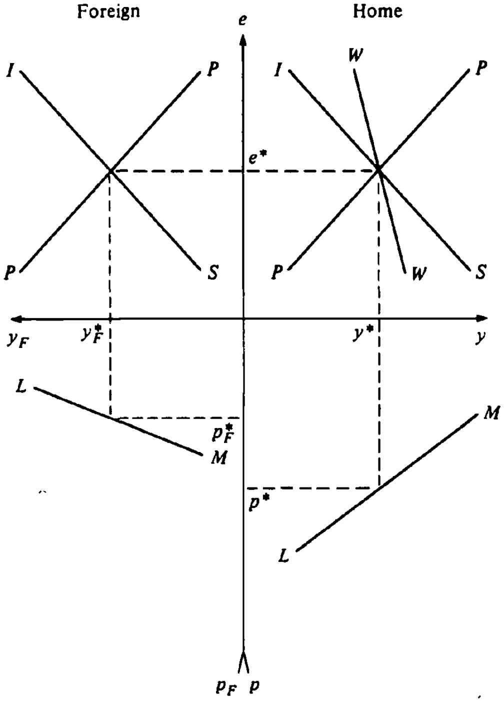
$$x = -\beta_e e - \beta_y y + \beta_F y_F \qquad \text{(Current balance)} \qquad (6)$$

$$\Delta \theta = \phi x \qquad \text{(Balance sheet constraint)} \qquad (7)$$

$$r = r_F - \underset{-1}{E}e_{+1} + e \qquad \text{(Efficient Market condition)} \qquad (8)$$

where y = output (log)
θ = real value of financial wealth (log)
p = prices (log)
m = money supply (log)
r = real interest rate (fraction per annum)
e = real exchan. rate (fractional departure from equilibrium)
d = government deficit, including interest payments (fraction of GDP)
x = current account balance (fraction of GDP)
$\underset{-i}{E}$ = rational expectation on data through $t-i$
F subscript denotes 'foreign'.

All coefficients are positive. The ϵ_j are error terms, which may be



3.1 Full macroeconomic equilibrium in the world economy

autocorrelated. The constant terms have been set at zero implying that all real variables (y, e, θ, r) have equilibrium at zero.

Equations (1) and (3), IS and LM curves, come from the inter-related private sector demand for assets and non-durable consumption. The main point to note is the role of financial wealth, θ, in both goods and money demands.

Equation (2) is the PP, or Phillips, curve which relates output to unanticipated inflation and, the open economy aspects, the real exchange rate; the latter effect arises because as the terms of trade improve (the real exchange rate rises) the consumption real wage increases relative to the own-product real wage.

In equation (4), the money supply function, the assumption is that the government pursues monetary targets dictated by its expected equilibrium deficit, except for temporary spells (ϵ_m, which may be a process with autoregressive and moving average components) when it attempts exogenously to vary the fiscal/monetary mix. This long-run tendency to go for 'balanced' monetary financing is the result of the intertemporal budget constraint on government, which prevents permanent 'monetary' financing of a deficit. ϕ is the ratio of GDP to financial assets; hence ϕd is the expected rate of injection of financial assets into the economy arising from the government's deficit, and (4) states that this will normally be matched by the rate of monetary injection. Since both d, and such temporary spells, are assumed to be exogenous, the level of M at any time is exogenously determined (by the history of d and these spells). (3) and (4) give rise to the LM curve in the (p, y) domain in Figure 3.1.

Equation (5) is the postulated process driving the exogenous deficit (in the full model, the actual deficit is endogenous, while tax rates and government spending as a fraction of GDP are exogenous); it is treated as a random walk (as are tax rates and government spending in the full model).

(6) is a standard net exports (current balance) equation. (7) then equates changes in financial wealth with this current balance, the change in net foreign assets. This equation is a substantial simplification; the full change in financial wealth would be given by $\Delta\theta = \phi(x+d)-(\Delta p+k\Delta R)$ where the last bracketed term represents valuation effects. The simplification is effected by assuming that inflation and interest rates are in equilibrium where $\Delta p = \Delta m = \phi d$ and $\Delta R = 0$. (7) is used to construct the WW curve in Figure 3.1; this describes those combinations of e and y for which $\Delta\theta = 0$. To its right θ will be falling as x is negative, to its left θ is rising.

Equation (8) is the interest parity condition adjusted for expected exchange rate change, in terms of real interest and exchange rates. This is identically equivalent with the usual nominal formulation (as used, e.g., by Dornbusch, 1976). Note our definition of real interest rate uses the consumption deflator, p, and that of the real exchange rate uses the two countries' consumption deflators converted to a common currency. These deflators do of course include an effect of foreign prices through the prices of imports.

Substituting for r in terms of r_F, e and $\underset{-1}{E}e_{+1}$ allows one to draw the IS and PP curves in the (e, y) domain as in Figure 3.1, in which we have now described all the elements going to make up a full equilibrium (the starred values are equilibrium ones) as illustrated, for the home economy.

The model for the other economy is a mirror image. We use the same coefficients, simply placing an F subscript on all 'home' variables including errors (and withdrawing it on all 'foreign' variables).

Notice however that $\theta_F = -\theta$, $x_F = -x$, and $e_F = -e$. Thus we have additionally for the foreign country:

$$y_F = \delta_\theta \theta - \delta_r r_F + \delta_e e + \delta_F y + \delta_d d_F + \epsilon_{\delta F} \tag{9}$$

$$y_F = \sigma_p(p_F - \underset{-1}{E}p_F) - \sigma_e e + \epsilon_{sF} \tag{10}$$

$$m_F = \mu_y y_F - \mu_\theta \theta - \mu_\rho(\underset{-1}{E}p_{F+1} - p_F + r_F) + p_F + \epsilon_{\mu F} \tag{11}$$

$$\Delta m_F = \phi d_F + \epsilon m_F \tag{12}$$

$$\Delta d_F = \epsilon d_F \tag{13}$$

(1)–(13) comprise the full model.

Solution of this model can conveniently proceed in two steps. First, solve for the expectations, $\underset{-1}{E}p_{+1}$, $\underset{-1}{E}p$, and $\underset{-1}{E}e_{+1}$; these will emerge from the full solution conditional on information at $t-1(\Phi_{-1})$. Second, solve for the impact (first period) effect of the innovations or shocks at t, on all endogenous variables. The full solution for all endogenous variables can then be formed by adding these impact effects to the conditional solution. The first part of the solution gives the path by which the model converges to equilibrium in the absence of further shocks from initial values (as shocked) at $t-1$, the second part tells how shocks will change the initial values at t from those anticipated, to give rise to a new path with the same convergence properties. Our interest therefore segments respectively into convergence properties and impact effects.

The dynamic properties can be derived (for details see Minford et al., 1983) from the second-order difference equation governing the expected variables, which is:

$$\begin{aligned}\underset{-1}{E}Z_{+i+2} - 2\delta_r^{-1}\{\delta_r + \sigma_e(1+\delta_F) \\ + \delta_e + \delta_\theta \phi(\beta_e + \beta_y \sigma_e + \beta_F \sigma_e)\} \underset{-1}{E}Z_{+i+1} \\ - \delta_r^{-1}\{\delta_r + 2\sigma_e(1+\delta_F) + 2\delta_e\} \underset{-1}{E}Z_{+1} = 0 \quad (i \geqslant 0)\end{aligned} \tag{14}$$

If there is a saddle path, then there is one stable root, say λ. The form of the solution for the expected real exchange rate, for example, is:

$$\underset{-1}{E}e_{+i+1} = \lambda \underset{-1}{E}e_{+i} \quad (i \geqslant 0) \tag{15}$$

and for expected inflation in the home country:

$$\underset{-1}{E}\Delta p_{+i+1} = \phi d_{-1} + (1 + \mu_\rho(1-\lambda)^{-1})(K\lambda^i \underset{-1}{E}e) \tag{16}$$

where K is a combination of the model's parameters and ϕd_{-1} is the expected equilibrium inflation rate seen from $t-1$.

The impact of shocks can be evaluated on the simplifying assumption that θ moves little on impact, being the product of a gradual build-up via

Table 3.1. *Impact effects of home policy shocks*

	positive fiscal shock	positive monetary shock
p	?	+
p_F	+	?
e	+	−
r	+	−
r_F	+	?
y	+	+
y_F	?	?

the current balance. On this basis we may reduce our system to four equations:

an IS/PP locus at home and abroad (corresponding to the intersection in the upper quadrant of our diagrams)

and an LM locus at home and abroad (the lower quadrant solution).

We also use (8) to replace r in terms of r_F and e.

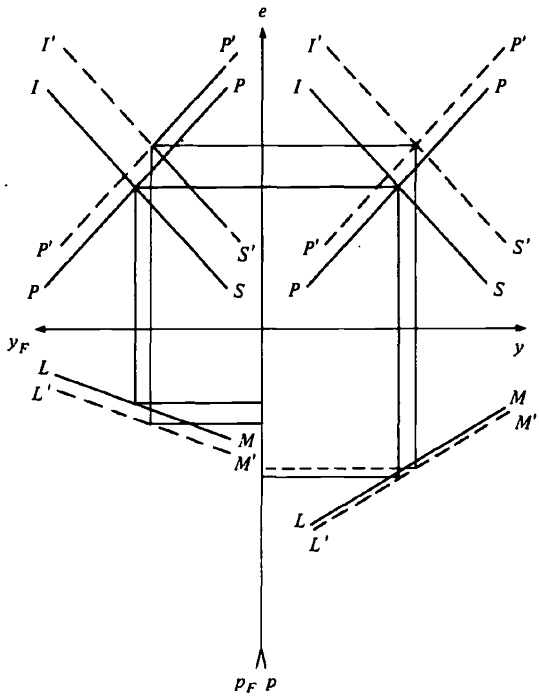
All variables are to be read as the 'unexpected components' of the solution; e.g. 'r' $= r - \underset{-1}{E}r$. The system is then:

$$\begin{bmatrix} -\{\delta_r+\delta_e+\sigma_e(1+\delta_F)\} & -\delta_r & -\sigma_p & \delta_F\sigma_p \\ \mu_y\sigma_e-\mu_\rho & -\mu_\rho & 1+\mu_\rho+\mu_y\sigma_p & 0 \\ \phi_e(1+\delta_F)+\delta_e & -\delta_r & \delta_F\sigma_p & -\sigma_p \\ -\mu_y\sigma_e & -\mu_\rho & 0 & 1+\mu_\rho+\mu_y\sigma_p \end{bmatrix} \begin{bmatrix} e \\ r_F \\ p \\ p_F \end{bmatrix} = \begin{bmatrix} 0 & -\delta_d \\ 1 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \epsilon_m \\ \epsilon_d \end{bmatrix}$$

where we have omitted all shocks other than domestic monetary and fiscal. The effects of foreign monetary and fiscal shocks are symmetric; and those of other shocks are left to the interested reader.

It can readily be established that the determinant is negative. We can then sign the effects of a positive domestic shock as in Table 3.1.

The fiscal shock raises real interest rates worldwide, but *more* domestically, also raising the real exchange rate. There is a rise in domestic output (maybe a rise in home prices); the higher exchange rate raises foreign prices, and the effects on foreign output are ambiguous. Thus expansionary fiscal policy is in this world not clearly a 'friendly' act (not a surprising finding in the light of recent attacks from Europe on President Reagan's budget deficits). Figure 3.2 illustrates the impact effects. The IS curve shifts to the right in the home country along the PP curve. The rise in interest rates shifts the LM curve outwards. The effect on prices is ambiguous.



3.2 Temporary fiscal expansion in the home country – stylised model

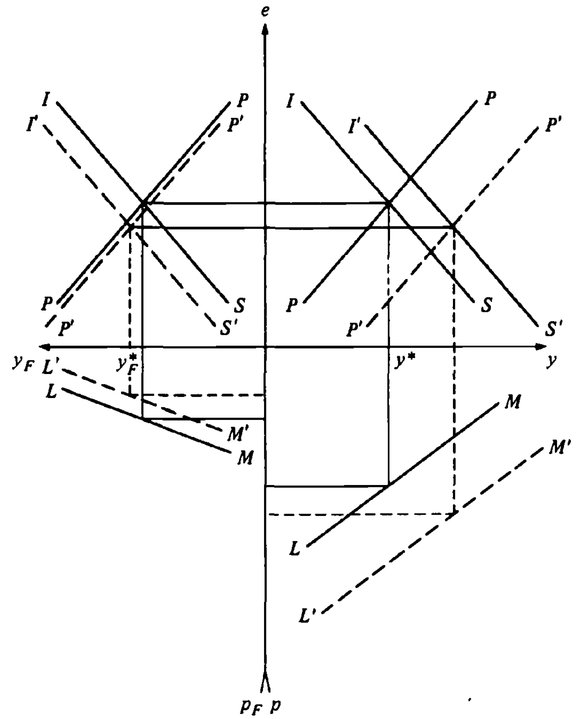
(Figure 3.2 shows them as falling slightly, so that the PP curve shifts to the left.)

In the foreign country there are two responses. First the rise in y shifts the IS curve to the left (expansionary), second the rise in world real interest rates shifts the IS to the right (contractionary). It also shifts the LM curve outwards which raises prices for given y and so shifts the PP curve outwards.

The balance of these forces causes an intersection of IS and PP at lower foreign y_F, corresponding to the higher e.

Monetary expansion has familiar effects at home, lowering interest rates and the exchange rate, and raising prices and output. Foreign interest rates, however, will not necessarily fall, while foreign output and prices may not rise; the exchange rate depreciation (an appreciation from the foreign country's viewpoint) may act to offset the expansionary effects of domestic monetary expansion on the foreign country.

Figure 3.3 illustrates the possible impact effect of a monetary expansion in the home country. At home the LM curve shifts outward. This raises



3.3 Temporary money supply growth in the home economy – stylised model

the price level unexpectedly, therefore the PP curve shifts outwards. The rise in output at home will raise output abroad and the reflected impact back home is to shift the IS curve outwards. The new IS/PP intersection is at a higher output level, and a lower real exchange rate. The nominal exchange rate falls more sharply than the real exchange rate.

Abroad, the fall in the home exchange rate implies generally rising nominal exchange rates. Typically, the real exchange rate rises, prices fall, the PP curve shifts inwards. The rise in home output shifts the IS outwards. The new IS/PP intersection is at a higher output level and a higher real exchange rate.

IV The model in the context of previous work

Before we proceed to summarise the full model, we highlight in this section the major ways in which previous work has differed in its theoretical assumptions and indicate the effects on these properties such differences would appear to make.

The major ways appear to be:

(a) Rational expectations
(b) Wealth effects
(c) Specification of 'wage/price' equations
(d) Degree of capital mobility

(a) If we substitute adaptive (AE) for rational expectations (RE) the effect familiarly will be to impart much longer lags, probably cycles, to the dynamics and possibly instability. This tedious exercise for our simple model is left to the reader. As for impact effects, those of temporary unexpected changes may well be similar because they have little effect on future expectations (in our simple model they would be identical for all shocks under RE and AE because expectations are dated at $t-1$). But this will not be true of permanent unexpected changes, for here the forward expectation has a powerful impact on current interest rates which strongly influence current demand and output. The 'paradoxical' impact effects of our model (see next section) in this case would thus be lost.

(b) The role of wealth (or 'portfolio balance') effects is clearly crucial to our model. It both affects the impact and the subsequent dynamic effects. It is the wealth variables interacting with future expectations that moderate (and can more than offset) the initial expansionary effect of 'locomotive' policies, that impart the oscillations (the 'inventory cycle' effect) and that subsequently provide an engine to drive the model back towards stock equilibrium. Clearly, in this respect the model belongs to the family of work emphasising stock/flow interactions, such as the work of Branson and Teigen (1976) and Kouri (1976) in the external sector, and it embraces the work on the government budget constraint in closed economy models.

We can illustrate the dynamic behaviour without wealth in our simple model, by setting $\delta_\theta = \mu_\theta = 0$. We may derive the expected final form for e as:

$$\underset{-1}{E}e_{+1} = \left\{1 + \frac{2\sigma_e(1+\delta_F)}{\delta_r}\right\} \underset{-1}{E}e + \frac{\delta_d}{\delta_r} d_{F-1} - \frac{\delta_d}{\delta_r} d_{-1} \tag{18}$$

Imposing boundary conditions, this implies that:

$$\underset{-1}{E}e_{+i} = e^* = \frac{\delta_d d_{-1} - \delta_d d_{F-1}}{2\sigma_e(1+\delta_F)} \quad (i \geqslant 0) \tag{19}$$

The removal of wealth implies the real exchange rate is expected to 'jump' to its new equilibrium, which in turn depends on fiscal policy; in our model it gradually returns to an equilibrium which is independent of fiscal policy. There are of course other ways than through wealth effects to supply both the missing dynamics (e.g. adjustment costs) and to force the equilibrium to that at which there is current account balance (e.g. by letting fiscal policy react to foreign indebtedness, a wealth effect on the government). In our full model, adjustment costs supply further dynamics, but wealth alone enforces the appropriate equilibrium, and indeed this latter process is entirely classical, for it is impossible for rational consumers to spend at rates indefinitely unaltered by foreign debt.

(c) Our wage/price equations give rise to a supply curve similar to the Lucas type; output rises with unanticipated inflation and with a rise in the real exchange rate (the real wage and profits; this parallels the intertemporal substitution element in Lucas). The derivation however appears to be 'Keynesian' in the sense that 'contracts' are emphasised (for a part of the unionised sector) as in Taylor's work (e.g. Taylor, 1979). Clearly therefore it fits uneasily into any 'camp'; in this annual model it behaves like a Lucas equation, in a quarterly model it would behave more like a Taylor equation. Perhaps this illustrates a point; that there is not such a big difference in practice between these two types of model. It seems that the model simulation properties would not be seriously affected by switches of specification within these two families.

Nor is there a qualitative difference in behaviour of the model if we assume non-clearing markets, with some slow 'tatonnement' process towards clearing market equilibrium. If we take for example a standard 'Lipsey-Phillips curve' (Lipsey, 1960) set-up where there is variable (with excess demand) mark-up pricing and the rate of wage change depends on expected inflation and excess demand, i.e.:

$$\Delta p = \alpha \Delta w + (1-\alpha)(\Delta p_F - \Delta s) + \beta y \qquad (20)$$

$$\Delta w = \underset{-1}{E}\Delta p + \gamma y \qquad (21)$$

Where w = nominal wages, s = nominal exchange rate (+ is appreciation), both in logs. Now substitute for Δw into (20) and subtract Δp from both sides to get ($e = p + s - p_F$):

$$0 = -\alpha(p - \underset{-1}{E}p) - (1-\alpha)(\Delta e) + (\beta + \alpha\gamma)\, y \qquad (22)$$

So that

$$y = \frac{\alpha}{b+\alpha\gamma}(p - \underset{-1}{E}p) + \left(\frac{1-\alpha}{\beta+\alpha\gamma}\right)\Delta e = \sigma_p(p - \underset{-1}{E}p) + \sigma_e \Delta e \qquad (23)$$

This is identical to (2) and (10), except that first the σ_p, σ_e here in this Keynesian sticky-price setting may be expected to be larger than those in (2) and (10) ($\beta + \alpha\gamma$ is smaller, or supply is more elastic in the short run) and secondly e enters in first difference form. The last change raises the order of the final form difference equation in expected e to 3rd order; there will now be two stable roots, one unstable for a normal solution, but the resulting change in the dynamic properties cannot be evaluated a priori.

A special case of the non-market clearing set-up is the 'rigid real wage-price mark-up' model beloved of English Keynesians; the source of the rigidity is usually specified as being exogenous, sociological perhaps. Rewrite (20) and (21) as:

$$p = \alpha w + (1-\alpha)(p_F - s) \tag{24}$$

$$\Delta w = \underset{-1}{E}\Delta p - \lambda(w-p)_{-1} \tag{25}$$

i.e. real wages tend to some fixed target. From (24) $(w-p)_{-1} = (1-\alpha/\alpha)e_{-1}$. Differencing (24), and substituting for Δw and $(w-p)_{-1}$, gives:

$$\alpha\Delta p = \alpha \underset{-1}{E}\Delta p - \lambda(1-\alpha)e_{-1} - (1-\alpha)\Delta e$$

or $$\Delta e = -\frac{\alpha}{1-\alpha}(p - \underset{-1}{E}p) - \lambda e_{-1} \tag{26}$$

This model is one in which the real exchange rate is rigid apart from price shocks from which it gradually recovers at the rate λ. The equilibrium domestic *output* level is now forced to be that at which the current account is balanced at *this* rigid real exchange rate. Thus the PP curve in our diagram is horizontal.

It is worth noting that *both* countries could not behave in this way, because the model solution for real variables would then either be indeterminate or non-existent, equations (2) and (10) would in the first case both yield the same, and in the second yield different solutions for e.[1]

This special case does not in fact yield qualitatively different properties from our model. The final form equation for expected e now simply has the root $(1-\lambda)$. Expected inflation solves as before. The impact effects are altered in detail by $\sigma_e \to \infty$ in an obvious enough manner.

The interesting and perhaps surprising result of this analysis is that the behaviour of the model is qualitatively robust in respect of non-market-clearing 'Keynesian' wage/price structures as such. This is *not* a crucial element (unless quite absurd constraints are put on the model – e.g. see footnote 1).

(d) The tight link between real interest rate differentials and the real exchange rate (the real wage) arises from the efficient market assumption (which is equivalent in our model to 'perfect capital mobility'). There seems no point in speculating on the effects of *zero* capital mobility, since under floating rates this would imply that current accounts had to be in permanent balance, a condition which would impose great strains on the model (let alone the 'real world').

To analyse imperfect capital mobility, we may replace in our stylised model (8) ($r = r_F + e - \underset{-1}{E} e_{+1}$). We now have a capital flow equation:

$$\Delta K = k' \Delta (r - r_F + \underset{-1}{E} e_{+1} - e) \tag{27}$$

where for simplicity we leave out the small 'continuing flow' effect of the level of real interest differential (adjusted for expected change in the real exchange rate). Equilibrium in the floating exchange rate market occurs when:

$$x + \Delta K = 0 \tag{28}$$

so that

$$x = -k' \Delta (r - r_F + \underset{-1}{E} e_{+1} - e) \tag{29}$$

Since

$$x = \frac{1}{\phi} \Delta \theta \quad \text{we have that:}$$

$$r - r_F + \underset{-1}{E} e_{+1} - e = -\frac{\theta}{k} \tag{30}$$

which replaces (8) accordingly; $k = k'\phi$ (we set the constant of integration at zero).

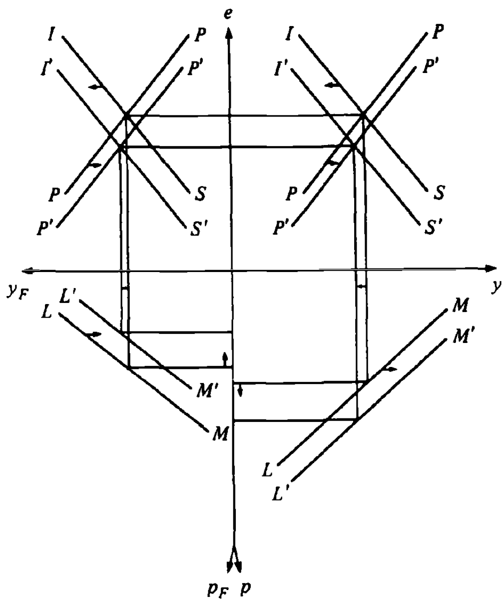
The effect of (30) on the dynamics of the model is qualitatively unimportant. All that happens is that $\delta_\theta + k^{-1} \delta_r$ replaces δ_θ in (14). The stable root will change, but the effect cannot be established a priori; though, if it was positive and remains so, it will be smaller than before (if so imperfect capital mobility is *stabilising* on the rate of convergence).

The impact effects are more complicated however. Suppose we write (30) for this purpose as:

$$r = r_F - \underset{-1}{E} e_{+1} + e - k^{-1} x - k^{-1} \theta_{-1}.$$

We can now reconstruct the impact system as:

$$\begin{bmatrix} 1 & \beta_e + (\beta_y + \beta_F)\sigma_e & 0 & \beta_y \sigma_p & -\beta_F \sigma_p \\ k^{-1}\delta_r & -\delta_r - \delta_e - (1+\delta_F)\sigma_e & -\delta_r & -\sigma_p & \delta_F \sigma_p \\ k^{-1}\mu_\rho & \mu_y \sigma_e - \mu_\rho & -\mu_\rho & 1 + \mu_\rho + \mu_y \sigma_p & 0 \\ 0 & \sigma_e(1+\delta_F) + \delta_e & -\delta_r & \delta_F \sigma_p & -\sigma_p \\ 0 & -\mu_y \sigma_e & -\mu_\rho & 0 & 1 + \mu_\rho + \mu_y \sigma_p \end{bmatrix} \begin{bmatrix} x \\ e \\ r_F \\ p \\ p_F \end{bmatrix} = \begin{bmatrix} 0 \\ -\delta_d \epsilon_\delta \\ \epsilon_m \\ 0 \\ 0 \end{bmatrix} \tag{31}$$



Arrows indicate effects of imperfect capital mobility (i.e. of x deteriorating)

3.4 The effects of imperfect capital mobility under fiscal or monetary expansion

where the dashed lines enclose the previous system. It can be seen that the effects on the determinant are now to render it strictly ambiguous in sign, because of the terms in $k^{-1}\mu_p$ (the terms in $k^{-1}\,\delta_r$ unambiguously make the determinant more negative); this is analogous to the effect of wealth on an IS/LM set up where powerful wealth effects on *money* demand can move output perversely.

We can however handle this ambiguity by noting that (30) has introduced a new shift factor, x, into the home IS and LM curves in our diagram; a fall in x shifts the home IS to the left and the home LM to the right (it has no direct effect on the foreign IS and LM curves, or on either of the PP or WW curves). Therfore we can argue that the solution would be the same except for this effect of x.

Since it is reasonable to suppose that fiscal and monetary expansion shocks cause x to deteriorate (the normal case), the effect of imperfect capital mobility can be investigated using this assumption.

The own country direct effects of lower x (r_F, y_F constant) are to raise prices, p, lower the real exchange rate, e, and raise interest rates, r; the effects on output, y, are ambiguous. In the rest of the world r_F has to move so as to accommodate; assuming that direct foreign output effects because of changing home output are small, this will require a fall in r_F which will shift the foreign IS outwards, LM inwards and PP inwards (another way of looking at this is that the appreciation abroad lowers prices and so, via the Phillips curve, raises output, while lowering the demand for money). This situation is illustrated in Figure 3.4.

Since fiscal expansion had an ambiguous effect – under perfect capital mobility – on prices and raised the real exchange rate, it is not possible to say how imperfect capital mobility will leave the overall effect on them; both prices and the real exchange rate may now fall or rise. However, interest rates will rise, more than under perfect mobility. Further, monetary expansion will under imperfect capital mobility still raise prices (more so than under perfect mobility) and cause the real exchange rate to fall (further than under perfect mobility – the contrary of Bhandari, 1981); interest rates will fall but less than under perfect mobility.

Provided capital is reasonably mobile (as the evidence indicates, as a minimum) it would seem therefore that assuming perfect capital mobility may not seriously distort the picture, at least for monetary shocks; and we also have some idea of the direction of what distortion there is.

In sum, if one had to name the features that are most important to our results that follow, these would be rational expectations and wealth effects; in our context at least non-market clearing and capital mobility, though much has been made of both in the literature, would probably not change the basic picture.

V The full model

As a preliminary to considering the full model, we now examine the principal simplifications of it in our earlier stylised version. First, the impact effects of wealth were neglected. If this assumption is dropped, the analysis becomes generally ambiguous. As is by now familiar from the wealth literature, it is possible for fiscal expansion to be deflationary on output at home on impact, because it provokes a 'financial crisis' effect via wealth; the same applies to monetary expansion (examples are Minford (1980) and Blanchard (1981)). The full model has such wealth effects, though the elasticities on wealth are small (typically 0–0.4). Therefore this is one major way in which the full model differs from the simplified version.

The second major simplification lies in the dating of expected inflation in the real interest rate definition. In the full model this is dated $\underset{t}{E}_{t+1}$, on the grounds that this will in an annual context be a better approximation than $\underset{t-1}{E} p_{t+1}$; the best approximation would be a partial information solution (e.g. Barro, 1981) but we cannot implement that at this stage. The result is that the effect of future events previously unanticipated will have a current impact through nominal interest rates.

Thirdly, financial wealth itself in the full model depends on the current price level and on current interest rates because of their valuation effects; this interaction is omitted in the simplified version.

These three differences can produce 'paradoxical' impact effects. Though the wealth effects in the full model are small, a shock which permanently alters the environment (e.g. a permanent fiscal and monetary expansion) will exert harsh leverage through these three interactions; expected inflation will shift sharply, so altering financial values sharply, which applied to even small wealth coefficients implies a large impact effect, swamping conventional responses.

If we turn last and briefly to the dynamics of the full model, first this has lagged adjustment terms in the IS, LM and PP curves and expected future output enters the PP curve (because of union bargaining), which adds further roots to the characteristic equation. Second, a moving average process is introduced by stock-adjustment in the IS function; investment responds to the rate of change of financial assets, of the real interest rate and of expected output. This 'accelerator' mechanism imparts a short moving average process to the path of the model after impact, resembling an inventory cycle. When financial conditions are changed substantially (e.g. by permanent shifts in the environment), then this inventory cycle becomes a prominent short-run feature.

To introduce these features into the analytic version would have made it unduly complicated for a 'classroom model'. We therefore leave them at this descriptive account and proceed to examine the behaviour of the full model.

This is a very large model for rational expectations solution. There are 160 equations and 45 expectational variables. Experience of estimating and solving the UK model, which is just over one tenth the size but is by now fully operative in forecasting and policy analysis, has taught us that the coefficients used must be tightly circumscribed by prior restrictions if the model is to be capable of generating a 'proper' solution – i.e. one that lies within a plausible distance from the equilibrium path. The coefficients that give most trouble in this respect are the wealth coefficients; at this stage we have been unable to find a specification within which free estimation of these gives proper solutions. The reason seems to be that *total* wealth (w) is highly collinear with time and its coefficient correspondingly hard to identify, while financial wealth (θ) is extremely dependent on the volatile valuation effect which we have had great difficulty in estimating (revalued series do not appear to exist for most OECD countries). These coefficients

Table 3.2. *Impact effects of US fiscal and monetary shocks*

	fiscal expansion shock		monetary expansion shock	
	2-country model	full model	2-country model	full model
p	?	–	+	+
p_F	+	+	?	+
e	+	+	–	–
r	+	+	–	–
r_F	+	+	?	–
y	+	0	+	+
y_F	?	–	?	+

are largely imposed therefore in the current version, at values that imply small impact effects (as assumed in our previous formal discussion).

The annual data, at the level of aggregation we were using failed also to generate sensible current account balance equations. The coefficients of these have accordingly been taken from Beenstock and Minford (1976), who estimated a comprehensive set of trade elasticities of plausible size on a consistent basis. The long-run elasticities on 'competitiveness', which were estimated via polynomial distributed lags of long duration (up to six years) have been applied here to the *expected* deviation from purchasing power parity over the five years ahead, rather than the lagged values of this deviation.

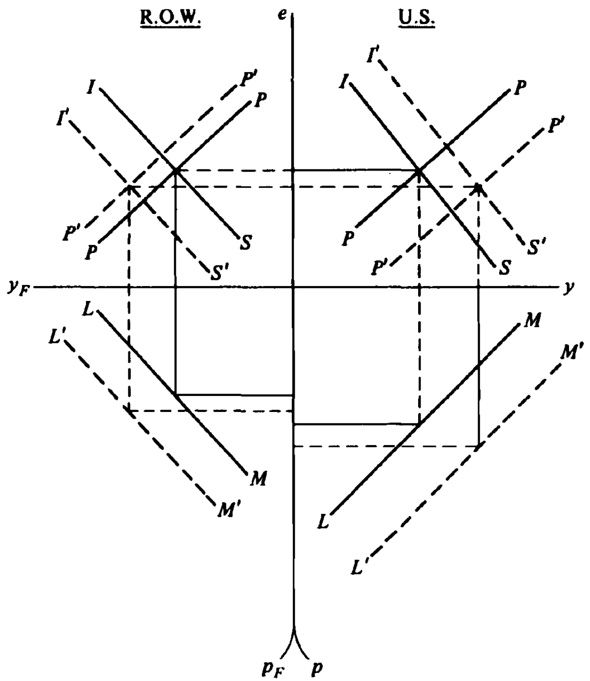
The other coefficients are generally freely estimated subject to these imposed values.

VI US policy simulations with the full model

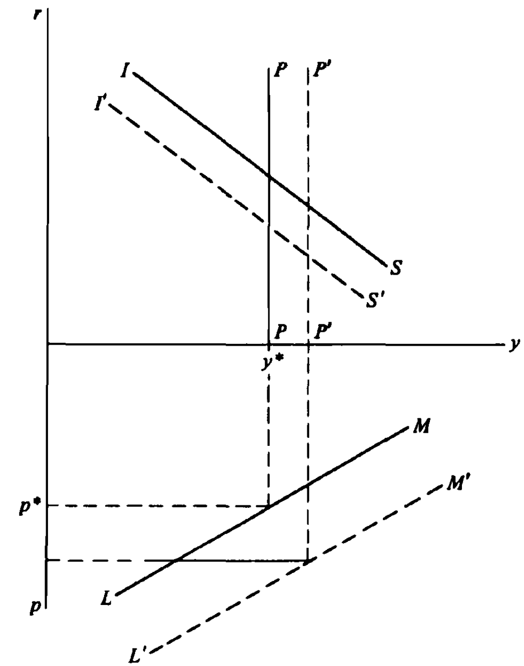
A once-for-all rise in the US money supply

We begin with that simulation standby – a monetary shock, i.e. an unanticipated once-for-all rise in the money supply. Table 3.2 compares the signs of the full model impact effect with those of the stylised model; they are different only in pinning down ambiguous signs, in a plausible enough manner (as foreign income and prices *rise*, foreign real interest rates *fall*).

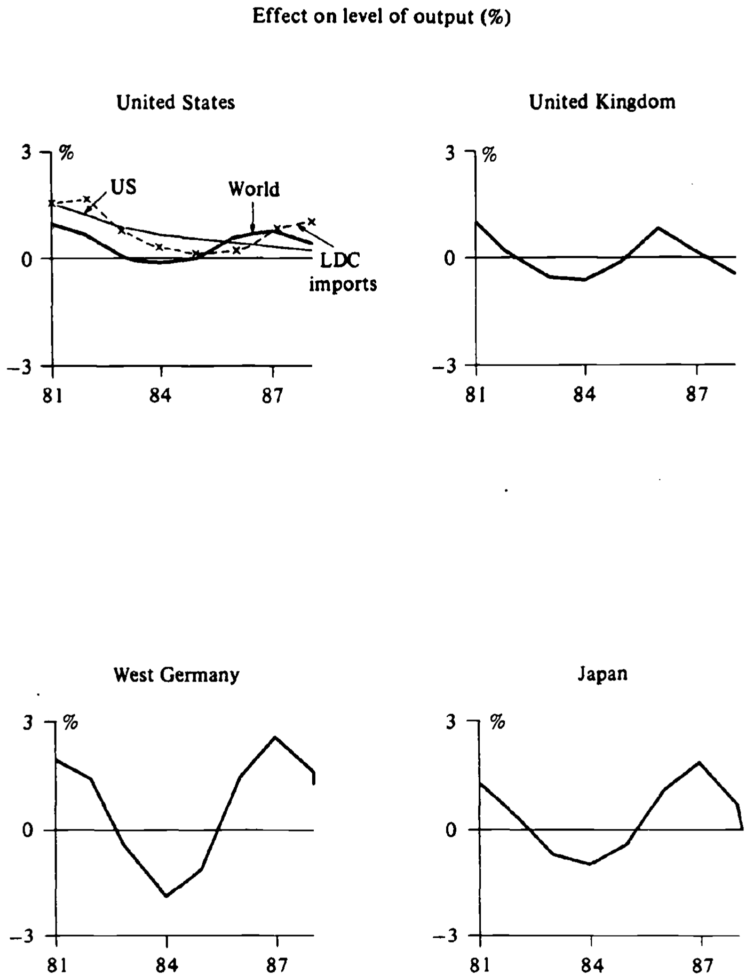
Figure 3.5 illustrates the model's behaviour for a two-country world. There is a powerful real interest rate effect in the model. As world real interest rates fall, the US 'IS' curve shifts to the right; this shift is less than that of the PP curve so the real exchange rate falls. In the rest of the



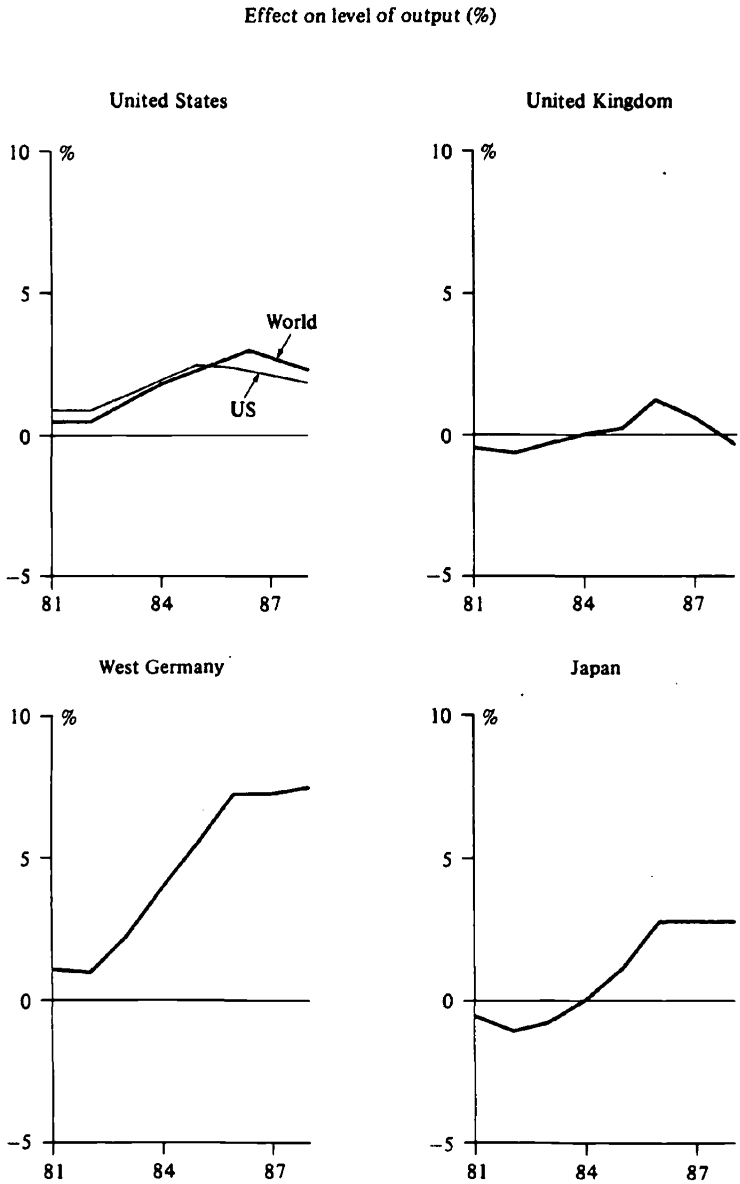
3.5 US monetary expansion – full model



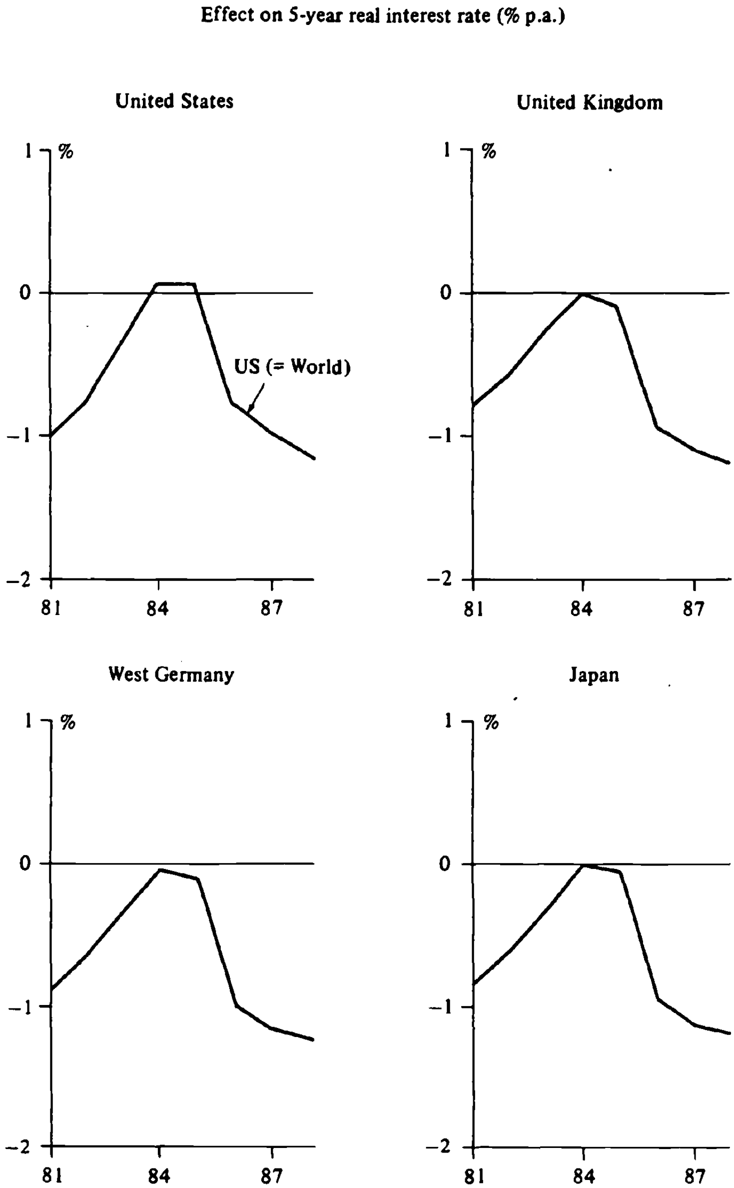
3.6 US monetary expansion – world effects – full model



3.7 Rise in US money supply by 2% (once for all from 1981)



3.7 (continued)



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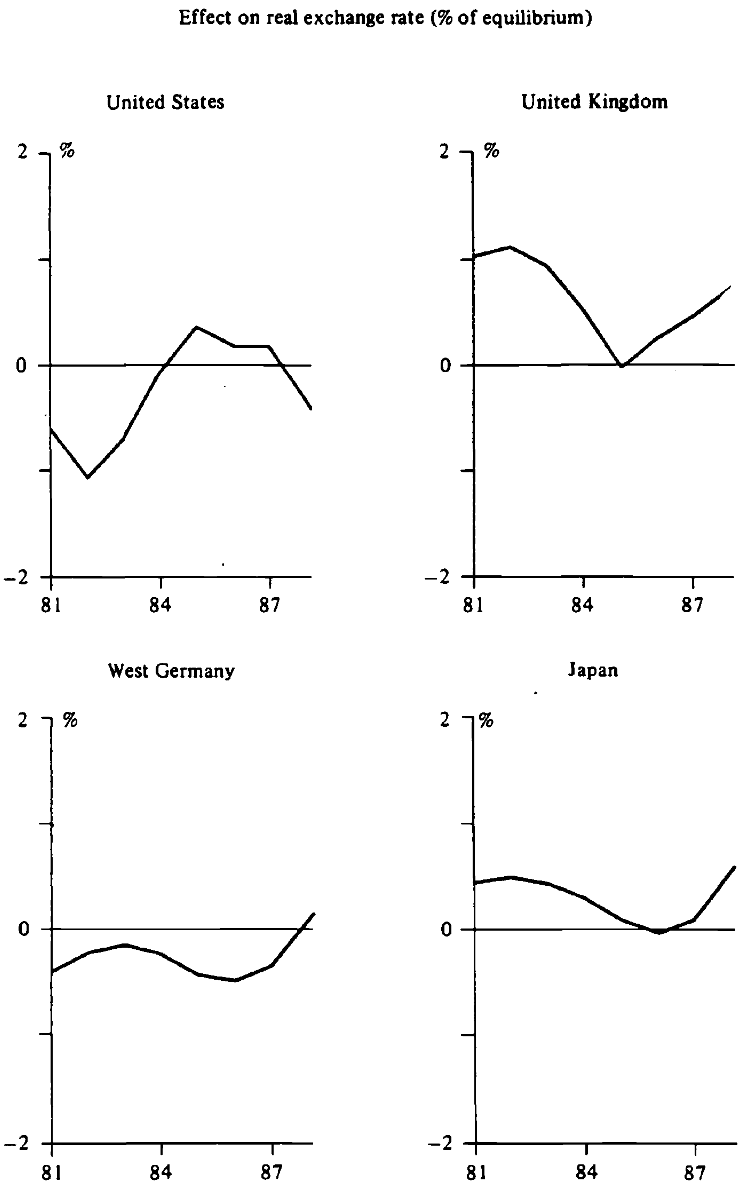


3.7 (continued)

world, wealth falls as prices rise causing the LM curve to shift out. This is the principal difference from the stylised model, shown in Figure 3.3 (even though real interest rates fall, causing the LM curve to shift *in*, this shift is more than offset). As prices rise, the PP curve shifts out in turn. The world real interest rate effect on the IS curve is sufficiently large for the shift to dominate the PP curve's.

At the world level, the simulation offers no real puzzles. Figure 3.6 illustrates the aggregate world picture. At the world level, the Phillips curve is vertical, because we have no intertemporal substitution built into supply (at least at present; this may well have resulted from an admitted failure to investigate this so far). When US (and so world) money supply rises, the LM curve shifts out; this shift out is dampened by the fall in world interest rates (rising money demand) and exaggerated by the fall in world real bonds (lowering it), but the overall effect of outward shift is not altered. The consequent rise in prices shifts the Phillips curve outwards along the IS curve; real interest rates fall and output rises.

We now turn to the numbers produced by a 2% once-for-all money supply increase. Figure 3.7 shows effects for selected countries on output, real interest rates, prices and the real exchange rates. The basic flavour of the simulation is given by this diagram. World output rises by 1.3% (US by 1.8%) on impact – a large effect for only a 2% money supply increase. World (and US) real interest rates fall 1%. World and US prices rise, as does the US real exchange rate (while others fall on average).

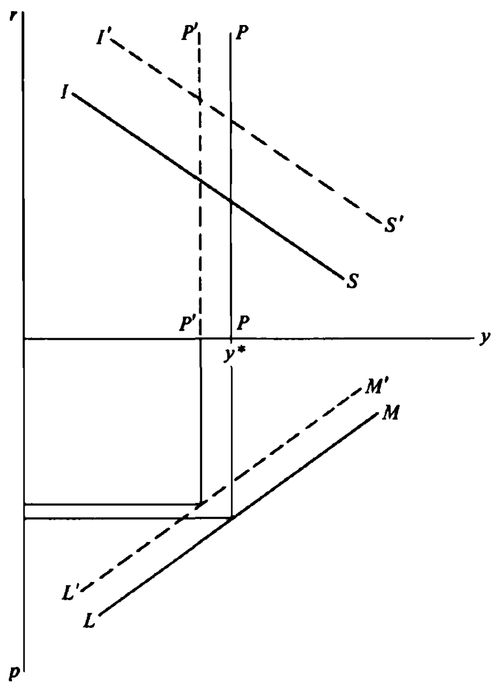
These are the impact effects, already discussed qualitatively. Figure 3.7 also shows the dynamic path back to equilibrium. This turns out (rather unusually among the model's simulations) to have a strong cyclical component; the result is that it moves fairly rapidly back to equilibrium (in about 3 years) but then begins to depart again. More typical model dynamics are the monotonic convergence at about 25% per year exhibited in the fiscal simulation, to which we now turn.

US fiscal expansion

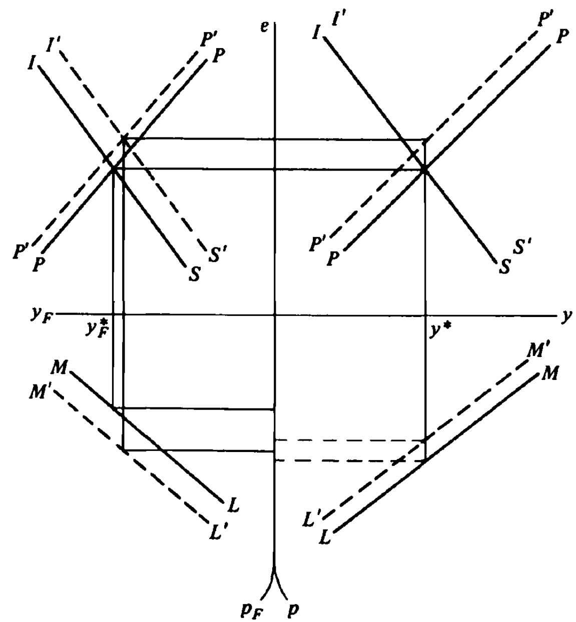
We study next a temporary rise (for one year only) in the US budget deficit – financed by bonds (i.e. the money supply is held constant).

Referring to Table 3.2, we can see that the impact effects in the full model tally closely with those of the stylised model, with one exception; output in the US is unaffected (crowding out is 100%). Output abroad *falls* instead of rising as conventional theories would indicate; this settles an ambiguous result in the stylised model. US prices also fall in the full model, while they may go either way in the stylised version.

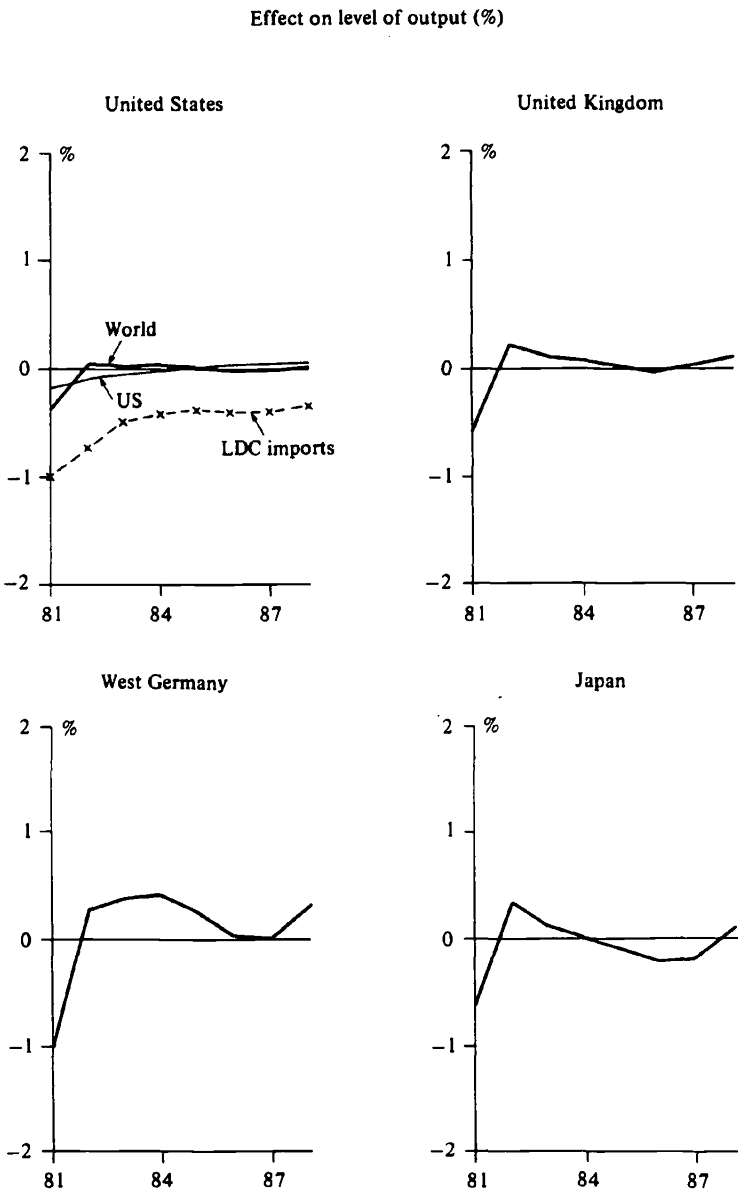
These output effects can be explained using Figure 3.8 which shows the



3.8 US deficit rise – world effects – full model

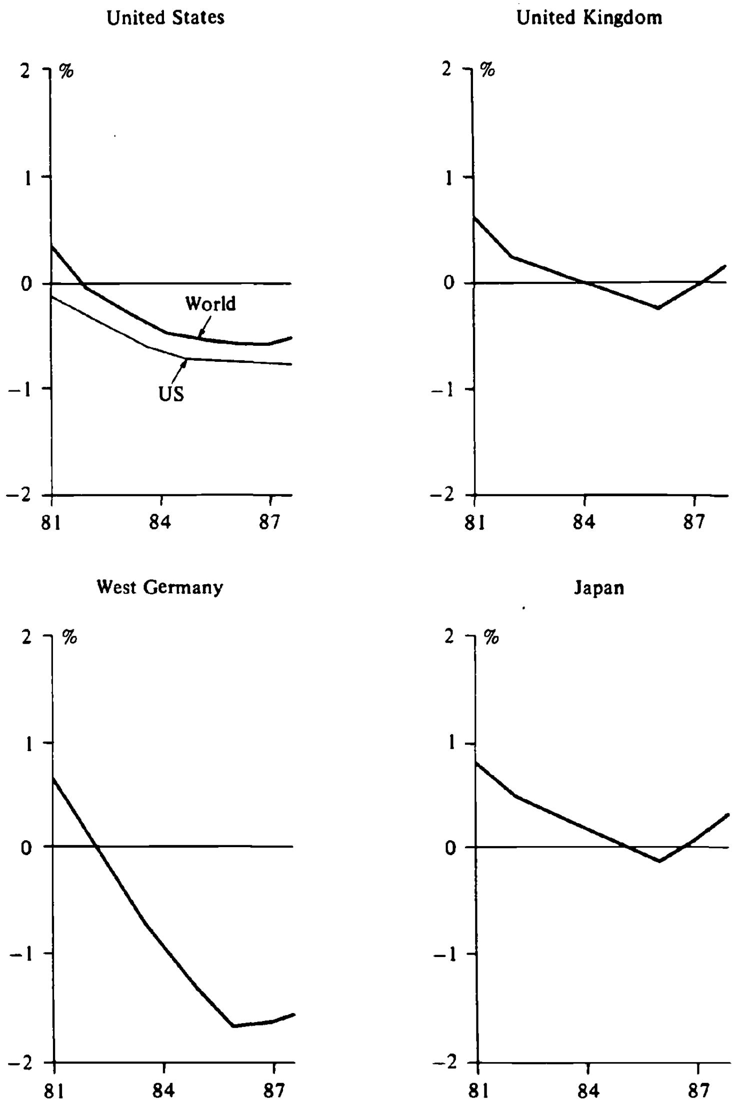


3.9 US deficits rise – full model

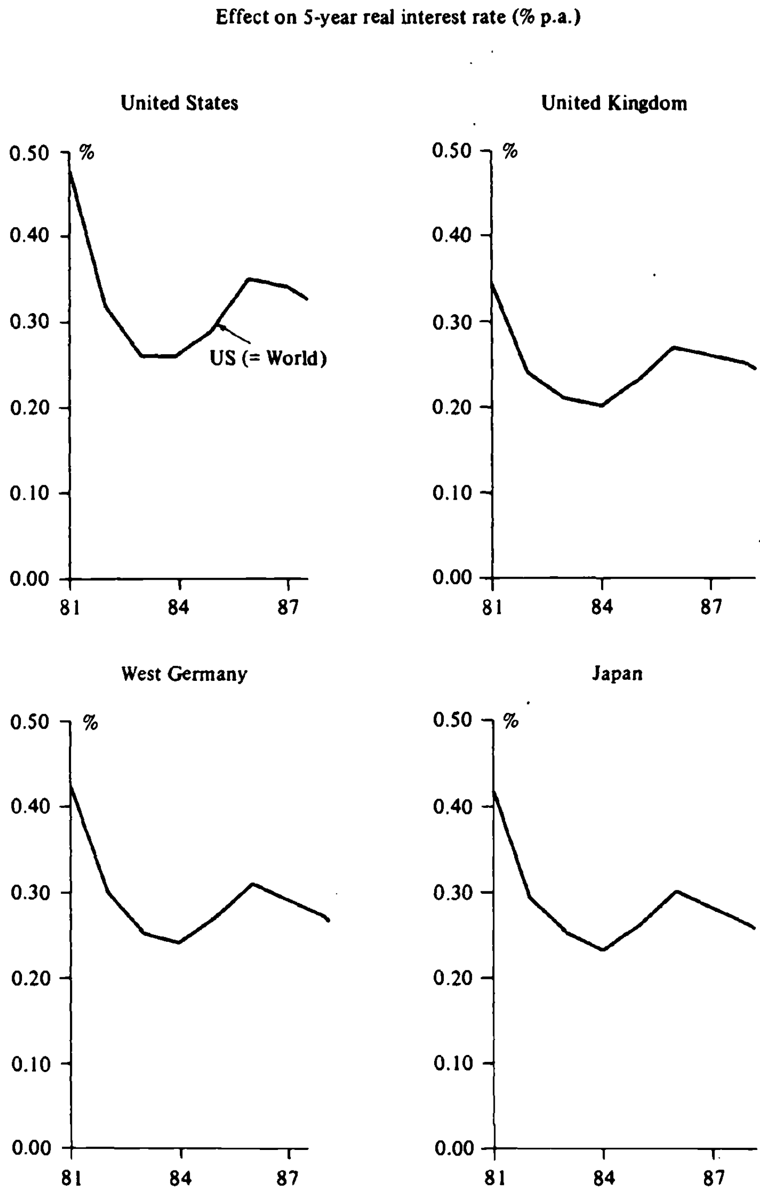


3.10 US deficit rise (by 1% of GDP, for 1981 only)

Effect on price level (%)

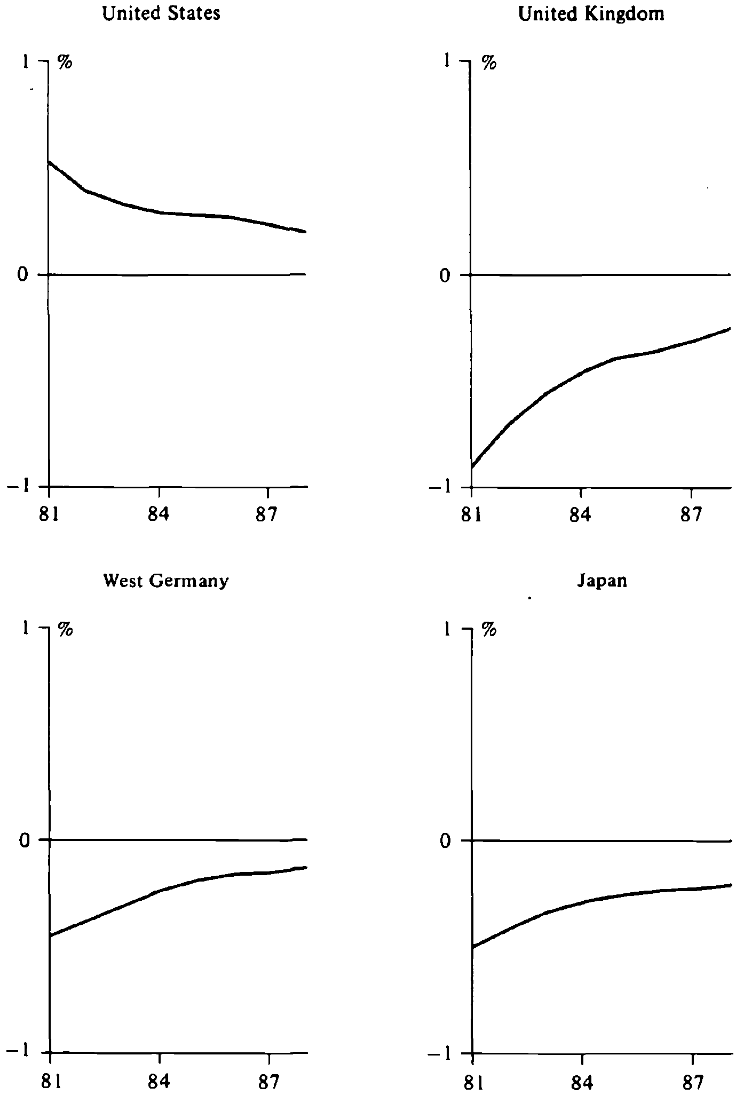


3.10 (continued)



3.10 (continued)

Effect on real exchange rate % of equilibrium)



3.10 (continued)

world picture. The fiscal expansion raises real interest rates, conventionally enough as the IS curve shifts to the right; this lowers demand for money shifting the LM curve outwards but the rise in bonds (and so wealth) associated with the higher deficit more than offsets this effect, on money demand, so that the net effect is for the LM curve to shift inwards, lowering prices for given output. The PP curve therefore shifts to the *left*, and output falls.

This is none other than the result first introduced by Blinder and Solow (1973), whereby wealth effects of bond financing may be greater on the LM curve than on the IS curve, so that more than 100% crowding out occurs. (They associated this result with instability, but that does not in general occur in a rational expectations context).

The two-country effect in the simulation is illustrated in Figure 3.9. It resembles the earlier diagram (Figure 3.2) except that now the rise in world real interest rates has a bigger negative impact on both IS curves.

The actual numbers are illustrated for the same variables as before in Figure 3.10, for a 1-year rise in the US deficit of about 1% of US GDP. It can be seen that there is a contraction on impact both on world and (very slight) US GDP. There is also a sizeable contraction (1%) in LDC's import volumes because of the effect on their debt interest of higher world real interest rates. These real rates in turn rise by 0.5% at the long end (and 1.1% at the short end). This is a substantial effect and it can be seen that *international* crowding out (especially the LDC's) is fairly significant.

The US real exchange rate appreciates by 0.5%, about the same as the US real long rate of interest. When one reflects that the actual US budget deficit has risen from 1% of GDP in 1979 to 2½% in 1980 and 1981, 4% in 1982 and 6% in 1983, and that at present there is no viable plan to reduce it, the scale of the effect on world real interest rates and on the US real exchange rate of recent US fiscal policies is suggested – approximately 6 times the impact effects of this stimulation. Being a longer-lasting fiscal change, these effects would last correspondingly longer – in fact in a simulation of the same shock lasting 5 years, real world interest rates stayed over 1% higher for 9 years.

When we turn to the dynamic path on this temporary shock, there is little cyclical component. Convergence is monotonic and proceeds at about 25% per year. The recovery of non-US output in year 2 reflects the strong stock-adjustment effect of higher real interest rates; in year 2 this 'unwinds' giving rise to the moving average process discussed earlier. (From the output supply side, this unwinding is permitted by the positive effects on supply of expected future output and of the lagged real exchange rate – see equation 15, Table 3A.1a, in Appendix 3A.)

To sum up, this fiscal simulation indicates that US fiscal expansion does

Table 3.3. *Recent world events (% or % p.a.)*

	1978	1979	1980	1981	1982	1983
Growth in GDP						
US	4.7	2.4	−0.3	3.0	−1.7	3.4
OECD	3.9	3.2	1.2	2.0	−0.5	2.2
Inflation (CPI)						
US	7.6	11.3	13.5	10.4	6.2	3.2
Industrial Countries	7.2	9.1	11.9	9.9	7.5	5.1
Real Short-Term Interest Rates*						
US	−0.4	−1.3	−1.9	3.7	4.5	5.4
Fiscal and Monetary Policies						
US Federal Deficit (calendar year) as % of US GNP	2.0	1.1	2.6	2.5	4.3	5.8
US growth in M1**	7.3	7.6	9.1	5.1	4.8	9.0
Industrial Countries growth in Ml**	10.8	9.6	6.6	6.0	6.7	9.5

* Treasury Bill Rate (3 months) minus average inflation rate (this assumes that over such a short-time horizon expected and actual inflation are equal, probably not a bad approximation).
** IFS definition.

not 'stimulate' the world or the US economy but mainly causes higher world real interest rates and a US real appreciation. The crowding-out that results from higher real interest rates has a particular impact on LDC's and other major debtors.

Some notes on recent events and policy implications

Based on these simulations, we can hazard an outline of the reasons for the 1980–2 world recession and the 1983 recovery; we have not yet been able to use the model formally to track these events but an informal discussion is possible.

The salient features of the world economy since 1978 can be crudely summarised. World output fell between 1979 and 1982 in a prolonged 'double-bottomed' recession. It then began – at the end of 1982 – a fairly normal recovery, rapid (as typically occurs) in the US and sluggish elsewhere (except for the UK whose recovery began, like its recession, earlier than most and had gathered some strength by end 1982). World real interest rates, having been very low for most of the 1970s, rose sharply in 1980 and have remained high ever since. Inflation rose to a peak in 1980 of over 10% and has since then fallen rapidly, reaching 3% in the US in 1983 and 5% in the world.

On the policy side, the US deficit has grown substantially as a fraction of GDP; allowing for plausible 'cyclical adjustment' does not change that picture. If one takes at face value the determination of the Federal Reserve Board to hold inflation at 3% or so, then given that the deficit is being financed by nominal bonds of average maturity, '(prospective) inflation accounting' does not change the picture significantly either. From the rational expectations viewpoint, we need to know how much of this deficit change was unanticipated; my suggestion would be that it was unanticipated in 1979 but that by the end of 1980 the expectation of sustained high deficits under Reagan's policies had become dominant.

US monetary growth, which is essentially independent of the President in the USA, began to be curbed in 1980 when it reached 9.1%; this has to be seen against a rise in inflation to 13.5% (we can think of inflation as reflecting largely the *expected* monetary growth in the previous year). It would have been reasonable to expect the Fed to allow much faster M1 growth given the 'needs of trade'. Hence I would suggest that there was a substantial unexpected fall in M1 growth. In 1981, M1 growth fell sharply to 5.1%; again inflation at 10.4% in 1981 suggests that much of this fall was unanticipated. The same but to a lesser extent was true of 1982 (the low average M1 figure conceals a very low figure early in the year but a much higher figure in the second half). Thus there may have been three successive negative monetary shocks in a row. The 1983 figure by contrast indicates a strong positive monetary shock; M1 grew by 9% against inflation of 3%.

According to this interpretation, the rise in world real interest rates in 1980 was the result of the rise in the US deficit *and* the unexpected fall in US M1 growth. That world real rates have *stayed* so high and appear set to continue that way is due to the *sustained* high deficits (for negative monetary shocks gave way to a positive shock in 1983).

The pattern of growth is to be explained not at all by *fiscal* shifts; these were positive in 1980 (and again in 1982) but did not prevent recession in 1980 and continued recession in 1982. Indeed according to the model they may have somewhat *worsened* the recession (partly by precipitating the LDC debt crisis).

Rather, the recession, its 'double-bottom' and long duration, are plainly due to the succession of negative monetary shocks, inspired in turn by the Fed's determination to get inflation back down to rates last seen in the 1960s. The recovery process would have occurred anyway in 1983 according to the model, provided there was no *further* negative shock then. It has however been speeded up by a fairly strong positive monetary shock (related, it seems, to the Fed's fears for the collapse of the international monetary system under a major default).

Last, the inflation story can be interpreted as the successive downgearing of expected monetary growth, as the Fed's determination and stamina progressively became apparent. In the US there were no announcements of long-term targets, only one year ones; this lack of long-term commitments was encouraged by the political system – for example, mid-term elections to Congress and the Fed Chairman, Paul Volcker's own reappointment date in 1983 – but it no doubt partly contributed to the downward-ratchet pattern of expectations. A 'sharp enduring shock' administered in 1980 and backed by a complete political commitment would, if possible, have – according to the model – precipitated a bigger recession in 1980 (it was actually quite mild) but one that would have ended more quickly and brought inflation down more rapidly.

In view of the propensity for many economists to cite 'oil factors' as major causal agents over this period, I should stress that it enters the story here not at all. Oil is 'just another input commodity' in this model; its price is a relative price and energy technology is just one source of technological change. Clearly, shocks to tastes and technology matter at the micro level and if sufficiently correlated across industries *may* matter at the business cycle level. I feel free to refer to such correlated shocks as sources of macro shock (this would undoubtedly be the case for the 1973 oil shock); but in this recent episode there is no compelling reason to do so.

The role of non-US policies in this account has similarly been neglected. However, there is clear evidence (in industrial countries' M1 growth for example) of these reacting to US monetary policies in an imitative manner; to account for and allow for this part of the story is however beyond the scope of this paper. It does not appear to alter its basic outlines.

Should US fiscal policy have moved 'in line' with tight money? This has been the main flashpoint of recent US-rest of world policy interchange. The rest of the world has not welcomed the effect of US government borrowing in pushing up real interest rates worldwide. (The logic of tight money has separately been accepted as necessary for anti-inflation policy). This complaint, in the light of the model's interpretation, has two dimensions. First, there is the dislike of shocks in themselves; uncertainty is increased – a stable fiscal policy is to be preferred to an unstable. Second, in so far as the rest of the world is a net debtor to the US (which it is),[2] it suffers a rise in its real debt burden; there is therefore a transfer effect.

Shocks are as unwelcome in the US as elsewhere; the fact that a new government felt it necessary to impose one reveals its judgement that the need offset the unwelcome effects. Governments, like private agents, optimise in response to changed circumstances. One can only speculate on whether it was truly in the US interest for taxes to be deferred in this way; the optimal tax pattern over time is discussed in Barro (1974), who argues from the transactions costs of changing tax rates that they should be constant. If this is so, then the issue revolves around whether government spending projections are for such falls that future tax rates will *fall*, making it optimal to *lower* them now.

As far as transfer effects are concerned, such possibilities are inherent in the signing of debt with short-term maturities; the debt was voluntary so no complaint is possible. Nevertheless, a severe transfer effect on LDCs has turned out to be particularly disruptive – and *did* force a shift in US monetary policy in 1982 (to avoid monetary collapse). In its own interest, the US needs to take these effects into account, legitimate as it is to cause them.

A few things the model does imply are:

(a) the more *predictability* in government policy the better; shocks and uncertainty cause costs. Therefore, if the US shift to higher deficits was *not* internally justified, it imposed costs on the world by disturbing plans and in particular raised the variance of output.
(b) planned 'reflation' or 'locomotive' policies will have their principal effects on inflation and, if fiscal and bond-financed, on real interest rates; they will not speed up recovery or end recession.
(c) there are a number of ways in which international feed-back rules for monetary and fiscal policy could 'work' to reduce the variance of world output (as discussed by Minford and Peel, 1983, chapter 3); but it is not at all obvious what *values* should be given to the feedback coefficients to improve the stability of the model relative to its present tolerable rate of convergence.
(d) governments also can optimise individually with respect to world capital market conditions by borrowing less at times of high real interest rates; if they do, the response of world real rates to higher US borrowing would of course be smaller and so too would the disturbance to world output.

To sum up, with respect to US policies, the rest of the world does not appear to have a case for them to change, other than to point out the *effects* which the US authorities may not have taken into account in designing them. A world government might take a different view of what US policy should be; but then we do not have one – and if we did, the rest of the world would not be free either!

Table 3A.1a. *Structure of the non-US country models*

(Equation listed with ' ≡ ' are identities or approximations to them)

$$(1)\ \log m/\theta = a_1 + a_2 . R_s + a_3 \log w + a_4(PEXPL - R_L) + a_5 T + a_6 \log(M/\theta)_{-1} + a_{36} PEXPL^2$$

$$(2)\ \log g/\theta = a_7 + a_8(PEXPL - R_L) + a_9 \log w + a_{10} T + a_{11} \log(g/\theta)_{-1} + a_{37} PEXPL^2$$

$$(3)\ \log c = a_{12} + a_{14}(PEXPL - R_L) + a_{15} \log w + a_{16} T + a_{17} \log(y/y^*) + a_{18} \log c_{-1} + a_{38} PEXPL^2$$

$$(4)\ y \equiv c + \Delta g + eg + x \text{ vol} + a_{13} \cdot g_{-1}$$

$$(5)\ w \equiv \theta + g$$

$$(6)\ \theta \equiv eg - ty + x \text{ val} + \theta_{-1}\left[1 + a_{40} \cdot \left(R_L - a_{41} \frac{\Delta R_L}{R_{L_{-1}}}\right) - \Delta P/P_{-1}\right]$$

$$(7)\ x \text{ vol}/y^* = a_{26}(a_{20} ERXRL + a_{21} \log WT + a_{22} \log WBC + a_{23} \log y + a_{24} \log y^* + a_{25})$$

$$(8)\ \frac{x \text{ val}}{y^*} = \frac{x \text{ vol}}{y^*} + a_{26} a_{27} RXR + Z$$

$$(9)\ r_L = (RXR - ERXRL)/5 + r_{FL}$$

$$(10)\ r_S = (RXR - ERXR) + r_{FS}$$

$$(11)\ R_S \equiv r_S + PEXP$$

$$(12)\ R_L \equiv r_L + PEXPL$$

$$(13)\ \log M = a_{30} \Delta \log M_{-1} + a_{31} \log(y/y^*)_{-1} + a_{32} \Delta \log P + a_{33} DMT + \log M_{-1}$$

$$(14)\ \log P \equiv \log P_{-1} + \Delta \log M - \Delta \log m$$

$$(15)\ RXR = a_{28} RXR_{-1} - [DA - Z + a_{28} Z_{-1} - a_{34}(\log(y/y^*) - a_{28} QEXPL_{-1})]/a_{29}$$

$$(16)\ r_{FL_i} = (r_{WL} - c_1 c_{i+1} r_{Li})/(1 - c_1 c_{i+1}) \quad i = 2, 9$$

$$(17)\ r_{FS_i} = (r_{WS} - c_1 c_{i+1} r_{S_i})/(1 - c_1 c_{i+1}) \quad i = 2, 9$$

Appendix A. Listing of the Liverpool multilateral macroeconomic model

PIERRE-RICHARD AGÉNOR

The Liverpool multilateral macro-model is a large, non-linear rational expectations model linking together the nine major OECD countries.[3] Each country model has a structure resembling the Liverpool Model of the UK economy, described in Minford et al. (1984). The model is closed by trade and price equations for the rest of the world, divided into three blocks: other industrial, oil-producing, and non-oil developing countries. In this appendix, we briefly summarise the model's main features and provide a complete listing of the equations and coefficients currently in use.

Table 3A.1b. *Structure of the US model*

$$(1)\ \log m = a_1 + a_2 r_S + a_3 \log(y/y^*) + a_4 \log\theta + a_5 T + a_6 \log m_{-1}$$

$$(2)\ g = y - c - eg - x\ \text{vol} + (1 - a_{13}) g_{-1}$$

$$(3)\ \log c = a_{12} + a_{14} \log(PEXPL - R_L) + a_{15} \log(w) + a_{16} T + a_{17} \log(y/y^*) + a_{18} \log c_{-1}$$

$$(4)\ \log y = \log y^* + a_{28}(RXR - a_{29} + a_{34} T) + a_{36} \log(y/y^*)_{-1}$$

$$(5)\ w \equiv \theta + g$$

$$(6)\ \theta \equiv eg - t.y + x\ \text{val} + \theta_{-1}\left[1 + a_{40}\left(R_L - a_{41}\frac{\Delta R_L}{R_{L_{-1}}} - \frac{\Delta P}{P_{-1}}\right)\right]$$

$$(7)\ \frac{x\ \text{vol}}{y^*} = \left[\frac{x\ \text{val}}{y^*} - a_{26} a_{27} RXR - Z\right]$$

$$(8)\ \frac{x\ \text{val}}{y^*} = -\left[a_{37} \sum_{i=2}^{9} c_{i+1} \frac{x\ \text{val}_i}{y_i^*} + a_{38} \sum_{i=10}^{12} c_{i+1} \frac{x\ \text{val}_i}{x\ \text{vol}_i}\right]$$

$$(9)\ r_L = \left(r_S + \sum_{i=1}^{4} Er_{S_{+i}}\right)\Big/5$$

$$(10)\ r_S = (1/a_8)[a_7 + a_9 \log w + a_{10} T + a_{11} \log(g/\theta_{-1}) - \log(g/\theta)]$$

$$(11)\ R_S \equiv r_S + PEXP$$

$$(12)\ R_L \equiv r_L + PEXPL$$

$$(13)\ \log M = a_{30} \Delta \log M_{-1} + a_{31} \log(y/y^*)_{-1} + a_{32} \Delta \log P + a_{33} DMT + \log M_{-1}$$

$$(14)\ \log P \equiv \log P_{-1} + \Delta \log M - \Delta \log m$$

$$(15)\ RXR = -\frac{1}{1 - c_2} \sum_{i=2}^{9} c_{i+1} RXR_i$$

The basic structure for each non-US country model is set out in table 3A.1a; variables definitions appear in table 3A.3.

Equations (1) and (2) consist of an inter-related set of private sector portfolio demands for stocks of money, government bonds (inclusive of net foreign assets) and durable goods. In equation (1), the demand for real money balances is related to the stock of financial assets, short-term nominal interest rates, total wealth, long-term real interest rates and the variance of inflation forecasting errors (measured as the squared value of the long-run expected inflation rate). Equation (2) relates the stock of goods demanded (including fixed capital, consumer durables, and inventories) to the stock of financial assets, long-term real interest rates, total wealth and price variability, which is now a proximate determinant of the risk on goods. Equation (3) relates non-durable consumption to total wealth, real long-term interest rates and price variability, a proxy for real wage risk. Equation (4) is the GDP identity. Equation (5) defines total wealth as the sum of goods and financial assets. Equation (6) defines the

Table 3A.1c. *Equations for the rest of the world and the common bloc*

Rest of the world

(1) $\log x \text{ vol} = b_1 \log WT$

(2) $\log P = \sum_{i=0}^{4} b_{2+i} \log WBC_{-i} + \log PI + b_{13}$

(INDBLOC and OILBLOC)

(3a) $\log IMP = \sum_{i=0}^{4} b_{7+i} \log (x \text{ vol}_{-i} P_{-i}) - \log PW$

(LDCBLOC)

(3b) $\log IMP = \sum_{i=0}^{4} b_{7+i} [\log (x \text{ vol}_{-i} P_{-i}) - DEF_{-i} r_{WL_{-i}}] - \log PW$

(4) $x \text{ val} = b_{12}(P . x \text{ vol} - PW . IMP)/P$

Common bloc

(5) $\log WT = c_1 \left(\sum_{i=1}^{9} c_{1+i} . \log (y_i) \right) + \sum_{i=10}^{12} c_{1+i} \log (x \text{ vol}_i) + V$

(6) $\log WBC = \sum_{i=1}^{9} c_{1+i} . \log (y_i / y_i^*)$

(7) $r_{WL} = r_{USL}$

(8) $r_{WS} = r_{USS}$

(9) $\log PI = \sum_{i=1}^{9} c_{1+i} \log (P_i)$

(10) $\log PW = \sum_{i=10}^{12} c_{1+i} \log (P_i) + c_{14} \log PI$

change in private sector financial wealth as equal to changes in its counterparts, public sector debt and net foreign assets (via the budget deficit and the current balance in volume terms), plus valuation effects due to changes in prices and interest rates. Equation (7) relates the current account in volume terms (excluding terms of trade effects) to the expected (5 years ahead) 'real exchange rate' (defined as the domestic price level relative to the foreign price level converted into domestic currency), world trade, the world business cycle and the deviation of output from its trend; terms of trade effects are included in equation (8). Equations (9) and (10) describe the term structure of interest rates, in an open economy under perfect capital mobility and 'efficient' financial markets; the (real) exchange rate and (real) interest rates are supposed to move until the expected return on foreign and domestic bonds is the same. In equations (11) and (12), real and nominal interest rates are forced into consistency by the Fisher identities. Equation (13) is the nominal money supply equation. Equation (14) determines the inflation rate through the nominal-real money identity.

Table 3A.2a. *Country coefficients*

Parameters (a_i)	US	Canada	Japan	Germany	France	Italy	Belgium	Holland	UK
1	1.6867	8.0655	19.66	−4.5361	6.1758	45.5831	−0.67	−3.775	12.02
2	0.0	−0.75	−1.5	−1.5	−1.5	−1.8523	0.0	−1.968	−1.32
3	0.6826	−1.8	−2.0	1.5	−2.2	−5.0604	0.004	0.0	−1.41
4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0009	0.1564	0.091	−0.0956	0.175	0.213	0.0062	0.052	0.0425
6	0.5869	0.7771	0.615	0.5177	0.2415	0.3719	0.5	0.201	0.0
7	6.1063	7.4895	23.439	0.3912	7.4552	41.7192	1.8068	5.855	11.46
8	0.5	1.5	1.5	2.5	2.5	3.435	0.690	0.6942	1.04
9	−1.0	−2.5	−2.5	0.5	−2.0	−4.175	−0.2839	−1.0	−1.2
10	0.0362	0.1425	0.2052	−0.04	0.147	0.159	0.025	0.017	0.0456
11	0.6793	0.6281	0.6103	0.5325	0.4275	0.603	0.3476	0.352	0.46
12	0.0	−0.132	0.0	0.0	−1.255	−0.54	−0.4	0.0	0.0
13	0.074	0.068	0.0901	0.071	0.071	0.0581	0.045	0.05	0.084
14	0.5	0.75	0.8	1.1984	1.0	0.15	0.69	0.3	0.0
15	0.35	0.3167	0.4093	0.5421	0.7045	0.28	0.1212	0.883	0.38
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.424	0.0	0.3364	0.2979	0.0	0.0	0.2068	0.473	0.18
18	0.64	0.6354	0.5453	0.2854	0.35	0.76	0.7878	0.312	0.53
19	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
20	−2.8	−1.5	−4.5	−2.6	−2.9	−2.8	−3.7	−2.1	−2.6
21	1.15	0.73	0.2	1.07	1.02	1.3	0.83	0.93	1.2
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

23	−0.94	−1.68	−1.65	−1.06	0.64	−1.91	−1.5	−1.25	−3.1
24	0.0	0.79	0.71	−0.56	0.95	0.24	0.2	−0.07	0.0
25	0.0	0.0	0.08	0.0	0.0	0.0	0.029	0.0	0.0
26	2.2831	0.29	0.17	0.281	0.2	0.21	0.53	0.56	0.27
27	0.976	0.25	0.0	1.0	0.0	0.0	0.0	0.0	0.7
28	0.0965	0.88	0.88	0.88	0.88	0.528	0.9861	0.9	0.88
29	1.8566	0.2845	1.8571	1.8571	1.4783	0.4144	1.2188	0.6863	1.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
34	0.0238	0.9725	0.2	0.1539	0.2515	1.9112	0.0	0.3022	0.4
35	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
36	0.7759	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1
37	2.2831	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.85
38	0.9776	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.33
39	2.95	6.66	10.8	8.67	6.66	2.48	1.71	2.49	2.2
40	0.95	0.95	0.9	0.95	0.95	0.95	0.95	0.95	0.95
41	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.5
42	2.95	6.66	10.8	8.67	6.66	2.48	1.71	2.49	2.2
43	−0.0336	−0.0942	−0.0845	−0.1625	−0.0942	−0.0149	−0.0607	−0.045	0.0075

Table 3A.2b. *Coefficients for the rest of the world*

Parameters	INDBLOC b_i	OILBLOC b_i	LDCBLOC b_i	COMMON BLOC c_i
1	0.403	0.428	0.39	0.616
2	0.0	0.0	0.37	0.438
3	0.0	0.0	0.44	0.047
4	0.0	0.0	0.42	0.141
5	0.0	0.0	0.44	0.12
6	0.0	0.0	0.31	0.096
7	0.3	0.1	0.5	0.05
8	0.4	0.2	0.3	0.018
9	0.3	0.3	0.2	0.024
10	0.0	0.2	0.0	0.066
11	0.0	0.2	0.0	0.128
12	0.029	0.029	0.029	0.137
13	1.4402	0.4774	3.7945	0.119
14	—	—	—	0.616
15	—	—	—	1.5818

Equation (15) relates real exchange rate changes to actual and one year ahead expected deviation of output from its trend. Finally, equations (16) and (17) relate foreign interest rates to (country-adjusted) world interest rates.

The US model, described in table 3A.1b, is specified in a slightly different way, in order to capture the role of this country in the world economy and to ensure consistency of exchange rate and trade relationships. Equations (1), (3), (5), (6), (11), (12), (13) and (14) are unchanged. The stock of goods demanded (equation 2) is now determined through the GDP identity. Real output (equation 4) depends on the real exchange rate and the lagged (one period) value of output deviation from its trend. The US trade balance (including terms of trade, equation 8) is inversely related to a weighted measure of the rest of the world trade balances. Equation (8) in table 3A.1a is now inverted to determine the trade balance excluding terms of trade adjustments. The US short-term real interest rate (equation 10) is determined by inverting the goods equation. The long-term real interest rate is calculated as the average value of the current and four-years ahead expected short-term interest rate (equation 9). Finally, the US real exchange rate (equation 15) is inversely related to a weighted measure of other main industrial countries' real exchange rates.

Equations for the rest of the world (other industrial, 'INDBLOC', oil-producing, 'OILBLOC', and non-oil developing countries, 'LDCBLOC')

Table 3A.3. *World model definitions*

log	natural logarithm.
*	long-run value of variable.
$E_{-j}(X_{+i})$	rational expectation formed at time $t-j$ on information available, of X at time $t+i$.
T	time (years).
R_L, r_L	nominal, real long-run interest rate.
R_S, r_S	nominal, real short-run interest rate.
W	total private sector wealth (1975 prices).
θ	financial assets (1975 prices).
g	goods (1975 prices).
m	money (1975 prices).
M	nominal money supply.
eg	government spending (1975 prices).
P	price level of domestic goods (1975 = 100).
PI	price index, industrialized countries (1975 = 100).
PW	price index, world.
x val	trade balance including terms of trade effects (1975 prices).
x vol	trade balance excluding terms of trade effects (1975 prices); exports volume for the rest of the world.
c	non-durable consumption (1975 prices).
RXR	real exchange rate (log deviation from 1975 = 100).
y	gross domestic product, average estimate (1975 prices).
(y/y^*)	output deviation from trend.
WT	volume of world trade.
WBC	world business cycle.
r_{FS}	foreign real short-run interest rate.
r_{FL}	foreign real long-run interest rate.
r_{WS}	world real short-run interest rate.
r_{WL}	world real long-run interest rate.
t	overall tax rate.
DMT	(expected) long-run growth rate of nominal money supply.
$QEXP$	$E[(y/y^*)_{+1}]$
$QEXPL$	$E[(y/y^*)_{+2}]$
$PEXP$	$E\Delta \log P_{+1}$
$PEXPL$	$E\left[\left(\sum_{i=1}^{5} \Delta \log P_{+i}\right)/5\right]$
$ERXR$	$E[RXR_{+1}]$
$ERXRL$	$E[RXR_{+5}]$
IMP	imports volume (1975 prices).
DA, Z	dummy variables.
DEF	foreign debt, non-oil developing countries

are given in the upper part of table 3A.1c. Export volumes (equation 1) are related to world trade. Equation (2) relates price changes to world economic activity and inflation in industrialized countries. Imports volume for INDBLOC and OILBLOC countries (equation 3a) depends on export capacity and world prices; for non-oil developing countries, export capacity is defined net of interest payments on foreign debt (equation 3b). Equation (4) defines the trade balance, in volume terms.

In the 'COMMON' bloc (lower part of table 3A.1c) indices of world trade and world economic activity are defined as weighted measures of output and exports in the industrialized countries (equations 5 and 6). World interest rates, defined in equations (7) and (8), are set equal to US interest rates. Finally, equations (9) and (10) define the industrialized and world price indices.

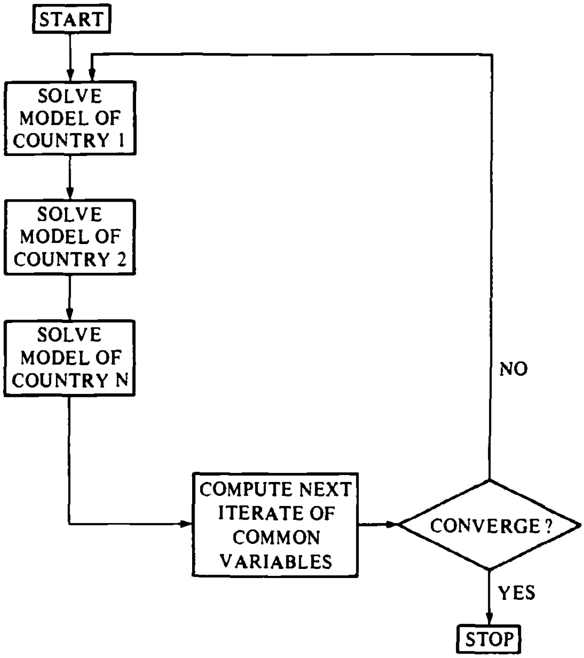
The country coefficients currently in use are given in table 3A.2a and the coefficients for the rest of the world and common bloc equations are given in table 3A.2b. Some of these parameters are based on preliminary econometric estimates using limited information methods, some have been imposed on the basis of previous work when satisfactory estimates could not be obtained. Efforts continue to improve the quality of parameter estimates.

Appendix B. The solution and simulation of the model

SATWANT MARWAHA

1. Introduction

This note outlines the basic approach used for solution of a large-scale Rational Expectation model, and is an extension of the methodology in Matthews et al. (1981). The extension is just a complement to the above and makes the solution techniques more efficient computationally. The extension has involved two additions, which are: (1) Instead of solving the complete model simultaneously, we solve it in country blocks, i.e. imposing a 'block diagonal' structure; this is basically taking advantage of the fact that the interdependence between the country models is not great, except indirectly. (2) Two more model solution techniques have been introduced, namely modified Powell Hybrid method (see Garbow et al., 1980, Powell, 1970, and Walsh, 1975) and a modified Levenberg-Marquardt (see More, 1977, Powell, 1970 and Walsh, 1975). These techniques both involve the calculation of a Jacobian, hence the use of (1) lets these be implemented without being too costly.



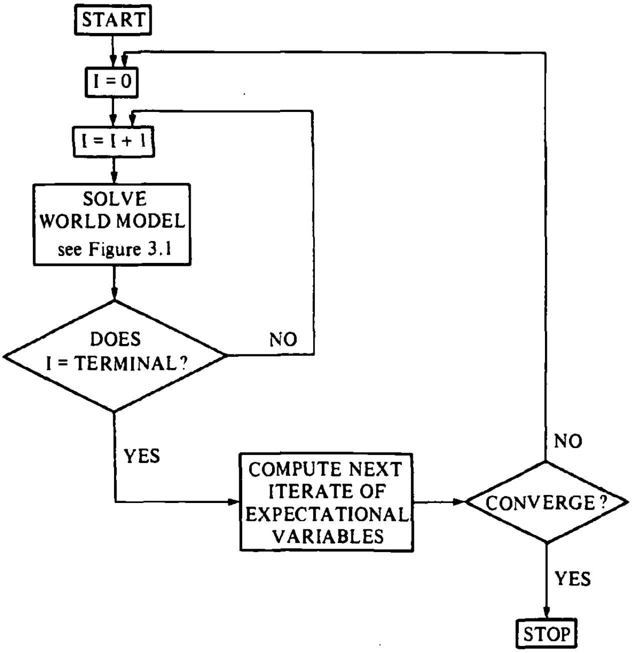
3.11 Iteration structure for period 1, given expectational variable iterate

2. The rational expectation solution

This has been described in Matthews et al. (1981) and as can be seen in Figure 3.12, this arrangement is a Jacobi type iteration for the solution of expectational variables, given that the complete model has been solved, using earlier iterates. The terminal is chosen to be greater than the expectational horizon (and as a guide the terminal is twice the expectational horizon).

3. The complete model solution

This solution is illustrated in Figure 3.11. There are two levels of solution, the first being the solution of the country model and the second being the solution of the common variables. The solution techniques for the country model are described below, and it can be seen that the second level of solution is similar to one described in (2); that it is a Jacobi type iteration of blocks of equations.



3.12 Iteration structure for expectational variables

4. Solution of non-linear set of equations

The technique of Gauss-Seidel (GS) is usually used for solution of most econometric models.

The advantage of GS is its simplicity and cheapness in terms of time, but GS is unreliable in the presence of strong non-linearities, hence the following two techniques can be employed.

The first is the modified Powell Hybrid method; its main characteristics involve the change in the model iterate being the convex combination of the Newton and scaled gradients, and the updating of the Jacobian by rank-1 method of Broyden. The Jacobian is approximated by forward differences at the initial point, and is not recalculated until rank-1 method fails to converge.

The second is the modified Levenberg-Marquardt and its main characteristics are the use of implicitly scaled variables and an optimal choice of the change in the model iterate.

The above two techniques give a good performance in finding solutions, and are not too costly, as is usually feared with such techniques which calculate Jacobians.

5. Conclusion

The solution techniques for a large model described above are the ones currently used in RATEXP mark 4, and as can be seen from Figures 3.11 and 3.12, other techniques can be used to achieve the same results or even improve on the current version; for example, the solution of the country models in Figure 3.1 could be rational solution, and then the common iterates be performed.

NOTES

* I am grateful to the ESRC for the financial support of this paper under Grant B 00220004. The current paper draws on Minford et al. (1983); my debt to my previous co-authors, Chris Ioannidis and Satwant Marwaha (who wrote Appendix B), is considerable. Eric Nowell carried out the simulations reported here; Richard Agénor has assisted recently in model development and wrote Appendix A, the model listing. I am grateful for helpful comments to Willem Buiter, Matthew Canzoneri, Michael Emerson, Richard Marston and Jeffrey Sachs, as well as to a number of other participants at this conference.

1 Some English Keynesians (such as the Cambridge Economic Policy Group) however would argue that this behaviour was general; international co-ordination of real wages would be needed to resolve inconsistency, and controls could be introduced to fix one variable and so resolve indeterminacy. Finally, co-ordinated demand expansion (locomotive policies) could then be used to raise world output, given no supply constraints.

2 Net overseas assets of the US banking system at end-1981 were about £138 billion.

3 The United States, Canada, Japan, Germany, France, Italy, Belgium, the Netherlands, and the United Kingdom.

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COMMENT MICHAEL EMERSON

I much appreciate Patrick Minford's fearless contributions to economic policy debate, especially in some of the no-go areas where many dare not tread. Passing on from macro financial policy in the UK, the micro-economics of unemployment and, recently I believe, the organisation of local government services in the city of Liverpool, Professor Minford here has a go at the major issues of macro financial policy at the world level. In all these fields Professor Minford widens the range of debate among economists and politicians – certainly in the UK. This means that he will not always be carrying everyone's agreement before him, but that is hardly surprising in the circumstances.

Professor Minford's paper is divided into three main parts, and I will comment on each in turn:

- design of the author's multi-country model
- results offered by the model
- some less formal interpretation of recent events in the world economy.

A limitation in the paper is that the links between these three parts are none too strong. The applied model is only partly estimated econometrically and not fully tested – as the author himself clearly says. So the link between the theory and the results is not fully supported. In addition the model could not be used to simulate recent experience, which breaks the link between the model and the author's comments on recent events.

Design of the Minford model

Setting aside for the moment the author's choice of a monetarist, rational expectations and neo-classical form to his model, there is a general question of multi-country model design posed here. Can compact models do better than the juggernaut multi-country models which have been built elsewhere – for example the LINK project, and the somewhat smaller Japanese EPA and US Federal Reserve Board MCM models?

In principle I think we should be rather sympathetic to multi-country modelling that gives priority to stripping the individual country models down to essentials, and exploring the uncertain international properties of a system of national economies which themselves on their own have familiar characteristics. In particular, valuable perspective may be gained by consolidating various regional or sectoral economies, for example Western Europe, and primary commodity producing countries. This may help better see the wood for the trees.

As regards the behavioural properties of the Minford model in comparison with its opposite Keynesian counterpart, I was rather puzzled by the author's plea for the opposition to stand up and show the colour of its money. Examples of multi-country models with a Keynesian income-expenditure structure exist, for example the 1980 vintage of the OECD Interlink model. In this particular model a US fiscal expansion of 1% of GDP would have an output impact multiplier of about 2 on the US in the second year, and of about 0.35 on the rest of the OECD area. The impact on inflation would be small. Monetary policy shocks would typically not give plausible results or indeed be feasible for the model system. Real balance and wealth effects would be largely absent, and the exchange rate would not be endogenised.

In relation to all this, then, Minford is staking out the ground at the opposite end of the spectrum. Fiscal policy generates 100% crowding-out, but monetary policy is very potent.

Results

For a more detailed presentation of his model the author refers us to his 1983 source, which is the proceedings of the 1981 Leuven conference on multi-country exchange rate modelling.[1] The disclaimers in the present paper – about the imposition of some parameters and the experimental stage of the project – also appear in the Leuven paper. A question therefore is how far this project is really advancing in proving its viability in terms of standard econometric tests?

As regards the model's main properties, I shall comment in turn on its response to monetary and fiscal shocks.

US monetary expansion. A 2% increase in US money supply gives a massive, almost equivalent impact of US output in year 1: Even more striking is its $1\frac{1}{2}$% impact on world output. For the US the impact on output remains substantially positive for 5 to 6 years, whereas for inflation the impact gradually builds up, especially over 3 to 4 years. For the rest of the world the impact on the price level is eventually +4%, against +2% for US. I find the higher inflationary impact on the rest of the world odd.

I have looked for some other evidence worth citing. The Japanese EPA model, in a simulation under flexible exchange rates, suggests an impact on the US's own GDP about $\frac{1}{4}$ as powerful as Minford in years 1 and 2. For the rest of the world (Europe in particular) the output impact is very small indeed, indeed negative for Germany to read from Oudiz & Sachs' paper; this is because the exchange rate impact is to appreciate the DM.

Another source is Michael Bruno's[2] reduced-form analysis which for Europe offers a little encouragement for Minford, with US money supply appearing with a coefficient of 0.2 (with weak statistical significance) in explaining European output fluctuations. But by comparison Minford's monetary policy results remain very strong indeed.

US fiscal expansion. Minford argues that the US fiscal stimulation does not stimulate the US or the world. The mechanisms that gives this result are as follows:

Step 1, the US fiscal shock pushes out the IS curve, giving higher output and a higher interest rate; so far so good.

Step 2, this lifts the US real exchange rate, cuts US prices and so pushes the supply curve inwards to the left, so we ride up the IS curve, back to a lower level of output more than offsetting the initial stimulus.

This is where the acid tests arise for the Minford model. All depends upon:

- the amplitude of the interest rate's reaction to the output increase,
- the amplitude of the exchange rate reaction to the interest rate rise,
- the extent to which domestic prices also will be pushed upwards, especially in non-tradeable sectors, with the initial upturn of activity, perhaps offsetting the exchange rate effect on prices and therefore activity,
- or, if prices are reduced, the amplitude of the positive wealth effect as a result of this disinflation.

These are the places in the argument where the size of key parameter values determine the sign of the outcome. These key parameters are given in an Annex to the paper, but without indication of how they score on the usual tests of empirical significance. I feel that the conclusion that a US fiscal policy has a perverse impact on the US itself in the first year after the shock implausible. Since Minford's parameters, we know, are not fully estimated and rest in some degree on a priori assumptions, we are entitled to express such views.

Observations on recent events

Minford argues that the fiscal shift in US did not do anything for the current US expansion – it was all money. The 1983 recovery would have happened anyway with just the monetary boost. I believe that this is an implausible extreme interpretation. In my view fiscal policy did contribute to the US expansion. Without it in the US the expansion would have been slower. However, for the rest of the world the US fiscal deficit has had serious adverse effects. The 1982 cyclical relapse in Europe can be traced to the collapse of world trade that year, in turn substantially but not exclusively linked to the debt crisis in Latin America, in turn substantially accounted for by US fiscal policy.

More generally the US financial policy mix (monetary, exchange rate, budgetary) has temporarily redistributed world output (+ in US, – in Europe) and world inflation (– in US, + in Europe), and this has kept European policy on the defensive. If US policies had been less distorted, European policies would have been different, and OECD output would have been more evenly distributed. OECD output (according to the OECD Economic Outlook of June 1984) is expected to rise at an annual average rate of about 3% in 1983–85, with the US at 4% and Europe at 2%. With a less eccentric US policy it might have been the same with a more even distribution, or possibly a bit higher in total, say with the US at 3½% and Europe at 3%. Thus I am quite sympathetic to Minford's conclusions along these lines.

Finally, there are a few pieces of surrealism in the author's conclusions. On oil shocks, Minford feels 'no compelling reason to refer to them as a macro shock'. On US policies, because they are chosen constitutionally by the powers that be, they are necessarily optimal, and 'the rest of the world does not appear to have a case for them to change'. On LDC debt, this was taken on voluntarily and so 'no complaint is possible'.

I imagine Minford says these things with tongue in the cheek. I think I am familiar with the reasoning that leads him to these conclusions. I won't argue about this. I completely disagree, and also feel that their gratuitous delivery at the end of the paper will lead readers not to take the author's overall arguments are seriously as he would like.

NOTES

1 Minford, A. P. L., C. Ioannidis and S. Marwaha (1983). 'Rational Expectations in a Multilateral Macro-Model', in P. de Grauwe and T. Peeters (eds.), *Exchange Rates in Multicountry Econometric Models*. Macmillan.
2 Paper in M. Emerson (ed.), *Europe's Stagflation*. Oxford University Press, 1984.

COMMENT RICHARD C. MARSTON

Minford offers what he terms a 'new classical interpretation' of the effects of monetary and fiscal policy in a multicountry setting. His interpretation includes several provocative conclusions which will be examined below.

Before doing so, I should point out that Minford deserves considerable credit for estimating such a large and sophisticated econometric model on which his analysis is based. Estimation of a model for nine countries is too large a task for most individual researchers, and simulation of such a large model under rational expectations has generally been beyond the capability of even large organizations.

Minford's model contains three features which distinguish it from many, though not all, large-scale econometric models. First, aggregate supply is a function of price surprises so that changes in the money supply, for example, have only transitory effects. The specification of aggregate supply is not based on a Lucas-type confusion between local and general prices, but instead on a contract lag in the labor market, although (as explained later) the contract model is different from those found in the open economy literature. The second distinguishing feature of the model is rational expectations. Expectations of inflation and the depreciation of the currency are generated rationally by the rest of the model. With uncovered interest parity also assumed, the path of future inflation and real depreciation are tied together because UIP links real interest rates and the expected depreciation of the real exchange rate. The third feature of the model is the presence of relatively large wealth effects on the aggregate demand or IS equation and in the demand for money equation.

Given a model with these three features, Minford has generated a set of simulations with surprising results, the most surprising of which is the following: a temporary debt-financed increase in government spending in the United States actually lowers output in the United States and raises output (at least in some later periods) in Germany, the United Kingdom and Japan. This is 'crowding out' with a vengeance.

What I would like to do is to focus on aspects of the model that lead to some of these results. The first two features of the model, the aggregate supply function and rational expectations, are by now almost standard in *non*-empirical work, at least, on the open economy. Models with aggregate supply based on contract lags and with rational expectations, in fact, exhibit behavior very similar to that found in a textbook Keynesian model, at least in response to the temporary, unanticipated shocks considered in this paper.

The actual specification of aggregate supply used in the paper, however, includes a lagged dependent variable. In the simulations, this variable appears to be very important. The monetary simulation illustrated in Figure 3.7 suggests that a once-for-all increase in the money supply has output effects seven years and beyond. That's an implausibly long lag for a model based on labor contracts, and is certainly not in the spirit of the 'new classical' literature. The source of the long lag can be traced, I believe, to the large coefficient of lagged output in the US aggregate supply equation (see equation 4 of table 1b in Appendix 3A), although there may be other factors in this complex model helping to account for such prolonged effects.

While discussing the supply equation, I would also like to question the way in which external influences are modelled. In any model used to study international transmission effects, the modelling of the real exchange rate is obviously important. In equation (2) and Figure 3.1, aggregate supply is a function of the current real exchange rate, but not the lagged real exchange rate or the unanticipated change in that exchange rate. The exchange rate enters because imported materials are a second variable input (besides labor) in the production process. This specification of aggregate supply neglects a second channel for real exchange rates to influence aggregate supply. If domestic products are distinct from foreign products, as they are in Minford's model, then producers will respond to a different real wage than will labor. Labor will respond to a real wage deflated by a general price level based on foreign as well as domestic goods. Because of this interplay between the two real wages, aggregate supply is a function of the real exchange rate just as in Minford's specification. However, in a contract model, the real exchange rate enters not currently, but with a lag. Or, if there is wide indexation, the real exchange rate enters as a price surprise. (See Marston, 1984). Since indexation varies widely across countries, the way in which the real exchange rate enters the aggregate supply equation will also vary across countries. And perhaps in no country will the real exchange rate enter exclusively, or even primarily, as a current variable.

I can be a little more specific about the aggregate supply curve in the present context. It's probable that the aggregate supply curve for the United States is close to being vertical (in real exchange rate/output space), while it is negatively sloped (as shown in Figure 3.1) for the rest of the world. It may be close to vertical for the United States for two reasons: (1) The most important imported material, oil, is priced in dollars rather than in foreign currency (as specified in the model). The dollar price isn't exactly constant, but it is much less sensitive to the exchange rate than the franc or mark price, for example. (2) Wages are not highly indexed in the United States, nor is the US consumer price index very sensitive to the exchange rate. So aggregate supply should not be very sensitive to unanticipated changes in foreign prices or the real exchange rate. In contrast, the rest of the world must face oil priced in dollars and, in some European countries at least, wages are highly indexed. (See Branson and Rotemberg (1980)). So we should see a considerable asymmetry in aggregate supply behavior, part of which cannot be captured by the current empirical specification of the model.

Let me turn now to the crowding out effect. The feature which so distinguishes Minford's model from many others, and which to a large extent accounts for his striking results, is the role of wealth in the aggregate demand and money demand equations. Friedman (1972) argued that government spending financed with government debt would be powerless to raise output. Indeed, a rise in government spending might actually lower output. This could occur because the issue of debt raises private wealth, and so raises the demand for money, shifting the LM curve (in interest rate, output space) to the left. That same issue of debt also raises aggregate demand, shifting the IS curve to the right (thus adding to the stimulative effect of higher government spending). If the wealth effect on the demand for money is strong enough, then output can actually fall. (Blinder and Solow (1973), showed that this case of falling output was unstable, but it is not clear whether or not their results would remain the same under rational expectations).

Critics of Friedman's position might take two alternative approaches. Some economists, of whom Barro (1974) is perhaps the most influential, would argue in terms of Ricardian equivalence. The debt issue should have no effect on private wealth since individuals would anticipate the future taxes needed to service the debt. Other economists would take a different tack. They would accept the argument that government debt adds to wealth, as Minford does, but argue that changes in wealth have little effect on the demand for money. According to this view, money is a dominated asset in portfolios, held strictly for transactions purposes. A rise in wealth, if the level of transactions is constant, has no effect on money demand. This latter view is quite persuasive if by money we mean currency and checkable deposits, especially if those deposits pay non-market rates of interest (as they do in many countries). There are near-monies such as Eurocurrency deposits which clearly dominate money holdings for purposes of short term investment. Having phrased the argument that way, it should be clear that the influence of wealth on the demand for money should depend upon the institutional and legal constraints on the banking system, and thus should vary widely from country to country.

According to Minford, the effect of wealth on the demand for money is extremely difficult to estimate. In his model for the United Kingdom (reported in Minford (1984)), the wealth parameters in both the aggregate demand and money demand equations were quite unstable, and were sensitive to the statistical technique used to estimate them. Evidently the same thing is true of the multicountry model, since in this model the wealth parameters were ultimately imposed rather than estimated. But since the parameters were not estimated, it is hard to assess the reliability of the stimulation results. What we need is a sensitivity analysis which would indicate how the crowding out (and other results) are affected when the wealth elasticities are varied around their present values.

There is one final point that I would like to raise about wealth effects. Not only should the wealth elasticities differ across countries, but so also should the sensitivity of changes in wealth to changes in exchange rates. The currency composition of wealth can vary substantially from country to country. So also can the sensitivity of the national price levels used to deflate wealth. The net effect of a change in the exchange rate on real wealth depends opon the balance between these two forces, asset denomination and price sensitivity. Minford's model doesn't seem to take the currency composition into account at all. Given the importance of the wealth effects, it is clearly essential to do so.

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