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The International Transmission of Fiscal Policies in Major Industrial Countries

by Paul R. Masson and Malcolm Knight*

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Summary

Expansionary fiscal policies in the United States from 1981 to 1985 and contemporaneous moves to fiscal restraint in the Federal Republic of Germany and Japan constituted an important shift in the pattern of fiscal positions among the largest industrial economies. During this same period, the international economy was characterized by a persistently high level of real interest rates in international financial markets, a sharp rise in the current account deficit of the United States, increased surpluses of Germany and Japan, and sustained appreciation of the real effective exchange rate of the U.S. dollar. In this paper, we examine the extent to which these developments characterizing the international economy may be related to fiscal shifts.

Our analysis emphasizes the basic point that the fiscal changes of recent years constitute major disturbances to net saving and investment flows. Unless changes in the stock of government debt leave net private wealth unaltered, an autonomous increase in a country's fiscal deficit, brought about by tax reductions, requires an inflow of saving from the rest of the world and a rise in the level of world interest rates. In order for the increased flow of foreign saving to enter through the capital account, the current deficit must be pushed into deficit via an appreciation of the real exchange rate. An outward shift in the investment schedule, such as that induced by U.S. tax measures in 1981-82, would be expected to produce similar effects on interest rates, exchange rates and current accounts, at least in the short run.

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We specify an empirical model of saving, investment, and net exports, which we estimate for the United States, Germany, and Japan using data since the early 1960s. Simulations of the model suggest that a permanent increase in the fiscal deficit of 1 percent of capacity output in any one of the three largest industrial countries produces a significant increase in real interest rates and a large initial appreciation in that country's currency. Furthermore, simulations of the investment incentives embodied in U.S. tax changes of 1981-82 (abstracting from their revenue effects) also would have led to higher interest rates and to an appreciation of the U.S. dollar. Simulations of the combined effect of an increase in intended investment in the United States and of observed movements in inflation-adjusted deficits from 1981 to 1985 in the United States, Germany, and Japan suggest that a substantial fraction of observed interest rate and exchange rate movements for the major industrial countries over that period may be related to fiscal policy shifts.

I. Introduction

Recent years have witnessed substantial changes in the pattern of fiscal positions among major industrial countries. From 1981 to 1985, for example, the fiscal deficit of the U.S. federal government is estimated to have risen by 2.8 percent of U.S. GNP, while the deficits of central governments in the Federal Republic of Germany and Japan, both of which have implemented medium-term fiscal restraint programs, declined by about 0.6 percent of their GNPs. A broader measure of government policies, general government fiscal impulses, gives roughly the same pattern: an expansionary shift of 2.5 percent in the United States and contractionary shifts of 4.2 percent in Germany and 2.5 percent in Japan, when cumulated over 1981-85 (International Monetary Fund 1985, Appendix Table 16). It is widely acknowledged that this pattern of fiscal shifts is at least one of the factors responsible for three important developments that have characterized the first five years of the present decade: the persistently high level of real interest rates in international financial markets, the rising current account deficit of the United States and surpluses of Japan and Germany, and the sustained appreciation in the real effective exchange rate of the U.S. dollar. Furthermore, the passage of the Gramm-Rudman-Hollings deficit reduction act in the United States late in 1985 has coincided with a substantial decline in real interest rates and in the value of the U.S. dollar against other major currencies.

Another aspect of the changes in fiscal policies that have occurred in the United States is the more favorable tax treatment of capital, in particular, a substantial acceleration of depreciation allowances. As a result, real nonresidential investment, financed both by U.S. residents and by capital inflows, may have been encouraged in the United States. The investment shift may also have led to appreciation of the dollar and contributed to the substantial current account deficits of the United States in recent years.

The purpose of this paper is first to describe a very simple model of savings and investment--including government dissaving--and then to specify and estimate a somewhat more sophisticated dynamic version of the model for the United States, the Federal Republic of Germany, Japan, and a highly aggregated rest-of-the world sector. Simulation experiments are performed with the empirical model to see the effects of shifts in fiscal policy in major industrial countries on world interest rates, on the pattern of real exchange rates and on current account balances.

In order to isolate the medium-term patterns that are our major interest, we abstract from the portfolio allocation decisions regarding stocks of domestic and foreign assets (Kouri and Porter 1974; Dornbusch 1975; Girton and Henderson 1977; Branson, Halttunen and Masson 1977), and concentrate instead on the intertemporal decisions that determine flows of domestic saving and capital accumulation. Of course, in a fully-articulated macromodel the determinants of both portfolio allocation and saving-investment decisions would be derived consistently from a general maximizing framework. But we emphasize the intertemporal aspect both because its role in the determination of exchange rates has received less attention in the literature and because, prima facie, the fiscal changes referred to above are likely to have resulted in major disturbances to national saving and investment flows. It is obvious that a model which concentrates on the underlying determinants of saving and investment in the largest industrial economies is unlikely to provide much insight into the causes of day-to-day or month-to-month fluctuations in market exchange rates. Nor does it indicate the effects of changes in fiscal policy in smaller countries. Nevertheless, such a model may serve to highlight how shifts in fiscal policy in the largest industrial economies influence private saving and investment behavior both at home and abroad, leading to changes in the level of world interest rates and in the pattern of real exchange rates and current account positions that is sustainable over the medium term.

The analysis of current account and exchange rate movements in terms of saving and investment behavior has a long history in the literature, extending back to the classic work of Laursen and Metzler (1950). 1/ Mundell (1963) discussed these interrelations in some detail, but his analysis was limited by the Keynesian assumption that saving responded only to movements in current income. More recently, following the supply shocks of the 1970s, a number of writers (e.g., Dornbusch and Fischer 1980, Sachs 1981) have emphasized the role of saving and investment decisions, and intertemporal choice generally, in determining the current account positions that are sustainable over the medium term for industrial countries that can borrow or lend freely in an efficient world capital market. Svensson and Razin (1983) develop models based on a rigorous analysis of intertemporal behavior, and Sachs and Wyplosz (1984) study the effects of fiscal policy in a model that takes account of wealth accumulation and forward-looking expectations, but both of these analyses are restricted to the case of a small country facing a given world interest rate. Finally, Frenkel and Razin (1984, 1985a, 1985b)

1/ Metzler (1960, pp. 232-3) anticipated a point that is emphasized by the recent literature when he observed: "I would say that the elasticity of demand [for imports] does not determine the degree to which the balance of trade expands to meet a given deficit; this depends, rather, upon internal conditions such as the slopes of the saving and investment schedules, relative to the slope of the capital outflow...The elasticities of demand for imports govern merely the changes in terms of trade needed to get the balance of trade required for equilibrium."

have integrated intertemporal decisions, fiscal policy, interest rates and terms-of-trade effects in a two-country framework that yields a large number of useful insights. The empirical model described later in this paper is in the spirit of these recent contributions.

The rest of this paper is organized as follows. Section II presents a highly simplified theoretical model that illustrates how a change in fiscal policy in a large country can shift the world level of real interest rates and--via its impact on private saving and investment decisions--alter the pattern of current accounts and real exchange rates. In Section III we specify and estimate a more realistic dynamic model for three major industrial countries. In this model, real exchange rates and interest rates are determined implicitly by conditions of market clearing. The model also allows for country-specific interest rates, cyclical effects, and the possible neutrality of government debt. In Section IV the model is closed to yield the full simultaneous system and the policy simulations are discussed. Section V provides a brief summary of the conclusions.

II. A Simple Model of Government Deficits, the Current Account Balance and the Real Exchange Rate

The starting point of our analysis is the proposition that if there is a disturbance in the domestic saving-investment balance of a large industrial country that maintains a floating exchange rate, the equilibrating mechanism will alter the international allocation of net saving. 1/ For example, unless an autonomous rise in a country's fiscal deficit or private investment leads to a corresponding increase in private saving, that country will have to rely more heavily on saving from abroad (or on a reduction in the amount of domestic saving provided to the rest of the world). In order for the increased saving from abroad to enter through the capital account, the current account must be pushed into deficit. The mechanism by which the current account deficit arises involves an appreciation of the real effective exchange rate and a loss of international competitiveness. Only in this way can the international capital transfer necessitated by the disturbance in the saving-investment balance be "effected."

1/ Our analysis is intended to refer to the largest industrial economies. Furthermore, it specifically excludes cases where a country's initial fiscal position is viewed as unsustainable, either because it implies a continuously rising ratio of government debt to GNP (Masson, 1985) or because the initial outstanding stock of official foreign debt poses significant "sovereign credit risk" problems.

In order to explain this mechanism in the clearest possible way, it is convenient to use a model which does not depend on an elaborate specification of the effects of fiscal policy on the level of real income 1/ and which avoids the complex issue of the effect of international interest rate differentials on exchange rates and capital flows. In addition, we assume flexibility of goods prices, so that we can ignore the effects of changes in the level of the money supply on real magnitudes. The next section, however, presents an empirical model that addresses some of these complications, and is dynamic in the sense that it accounts for accumulations of asset stocks and their feedback onto saving and investment flows.

Consider a model of saving and investment behavior in a world of two large countries: the home country and the rest of the world, ROW (variables followed by an asterisk). All variables, including the exchange rate and the interest rate, are defined in real terms, taking the price of domestic output as the numeraire. Flow variables, such as saving, investment and fiscal deficits, are all defined as ratios of each country's level of capacity output.

The notation of the model is:

ε = the exchange rate (relative price of ROW output in terms of home-country output),

R = the world real interest rate,

S, S^* = flows of private sector saving in the home country and the rest of the world, respectively,

I, I^* = private sector fixed capital formation in the home country and the rest of the world,

N, N^* = the current account balance of the home country and the rest of the world, (surplus = +),

D, D^* = public sector fiscal deficit in the home country and the rest of the world,

For any function $F(x)$, $F_x = \frac{\partial F}{\partial x}$.

1/ This is so even though, as Buiter (1983) has rightly emphasized, both the time path and the steady state effects of shifts in fiscal policy depend crucially on the specific types of public sector spending and tax changes by which they are implemented.

Both private investment and government fiscal deficits are financed by the issue of one-period bonds, and all bonds are viewed as perfect substitutes by private savers. To further simplify the analysis of this section, we assume that market participants expect that the current real exchange rate will persist in the future. 1/ These assumptions ensure that there is a fully integrated world credit market with a single real interest rate, R. 2/

Ex ante saving and investment, expressed as ratios of capacity output, are both assumed to depend on the real interest rate. Because of adjustment costs, real private net investment exhibits lagged adjustment to an optimal capital stock, which in turn depends on the user cost of capital (Gould 1968). Saving is taken here to result from individuals' intertemporal optimization of the utility from consumption (Mussa 1976). For a given rate of time preference and expected future wage income, higher real interest rates will decrease consumption. However, a rise in the real interest rate may either raise or lower real private saving, since current income is increased for households holding positive net claims. Hence the sign of the partial derivative of saving with respect to R is ambiguous. We impose the weaker restriction that if intended saving declines when the interest rate rises, it falls by less than intended investment.

A crucial question for the analysis of fiscal policy is the extent to which the government bonds issued to finance a fiscal deficit are viewed by the private sector as part of its net wealth. The Ricardo-Barro debt neutrality hypothesis asserts that if individuals and firms anticipate that the government will raise taxes in the future to finance the debt service on the bonds, and that they or their descendants will have to pay those taxes eventually, then there may be little or no difference between financing government spending through tax increases or bond issues (Barro 1974 and Carmichael 1982). In the extreme case where individuals are fully rational, can borrow and lend in perfect capital markets, and

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1/ This highly restrictive assumption is relaxed in Section III.

2/ The relationship between integration of national capital markets and the extent national saving and investment move together has been considered by Feldstein and Horioka (1980) and a number of subsequent authors. Murphy (1984) has shown that if countries do not face a perfectly elastic supply of capital because they have a non-negligible effect on the world rate of interest, then there will be an association between national saving and investment despite perfect capital mobility. Frankel (1985) points out that even for a small country domestic crowding out occurs in response to a fiscal shock unless both capital market integration <u>and</u> goods market integration prevail, the latter condition being equivalent to purchasing power parity.

value their descendants' consumption as highly as their own, bonds issued by the home government are not properly treated as a component of the private sector's net wealth, which will consist only of the capital stock and net claims on foreign residents. In this case a rise in the fiscal deficit (i.e., an increase in public sector dissaving) would be exactly offset by a higher flow of saving by the private sector. Holdings of bonds issued by foreign governments would still be part of wealth because the taxes to service them are levied on foreign residents. 1/

Most economists would now concede that changes in public sector saving are likely to be at least partially offset by alterations in private saving behavior. However there are a number of reasons for expecting that, in practice, households would not make a full offset of any change in their holdings of bonds to take account of future taxes: they may think that they can avoid these taxes, they may not value their descendants' welfare equally with their own, and they certainly face significant capital market imperfections (see Buiter and Tobin 1979 for a more complete discussion).

One way of modelling the lack of full offset is to stipulate that the private sector has a higher discount rate than the borrowing government; for instance, a fixed probability of death, p, will cause the private sector's discount rate to be higher than the government's by that amount (Blanchard 1985). In Blanchard's model, private consumption depends on the sum of financial wealth and the discounted present value (using discount rate $r + p$) of future wage income net of taxes. The government, on the other hand, faces an intertemporal budget constraint in which future taxes are discounted at rate r: given a path for government spending, higher initial levels of government debt must be offset by higher future taxes, discounted at rate r. This budget constraint can be used to calculate a net financial wealth variable, which deducts from private sector holdings of government bonds the discounted value of future taxes relevant to households alive today. If taxes and real interest rates are expected to remain constant in the future, then the proportion of government bond holdings that is considered net wealth by the private sector will be unity minus the ratio of the government's discount rate to the private sector's. We will call this proportion ϕ; it should lie between zero and unity. 2/ A value of $\phi < 1$ implies that

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1/ It is assumed that governments levy taxes on their own residents only, and that taxes are lump-sum, so that they modify neither the return to labor nor that to capital.

2/ In general, ϕ need not be constant, and will depend on the expected paths of taxes and interest rates. Let H be human wealth and W financial wealth, defined as follows (Blanchard 1985, p. 239):
(To be continued on page 9)

the private sector only treats a corresponding fraction of its acquisition of government debt as an increment to its net worth, with the rest reflecting the present discounted value of future tax liabilities.

2/ (Continued from page 8)

$$H(t) = \int_t^{\infty} [Y(s) - T(s)] e^{-\int_t^s (r(v)+p)dv} ds$$

$$\equiv \Pi(Y - T; r + p)$$

$$W(t) = B(t) + C(t)$$

where Y is non-interest income, T lump-sum taxes, B government bonds, C other forms of financial wealth, and Π the present-value operator (Blanchard and Summers 1984, p. 317). The government's budget constraint in integral form is

$$B(t) = \int_t^{\infty} [T(s) - G(s)] e^{-\int_t^s r(v)dv} ds$$

$$\equiv \Pi(T - G; r).$$

Using the government's budget constraint, we can express H in terms of current holdings of government debt and future government spending, not taxes:

$$H = \Pi(Y; r + p) - \Pi(T; r + p)$$

$$= \Pi(Y; r + p) - (1 - \phi)\Pi(G; r) - (1 - \phi)B$$

where

$$\phi = 1 - \Pi(T; r + p)/\Pi(T; r)$$

We can now define new measures of human and financial wealth as follows:

$$\bar{H} = \Pi(Y; r + p) - (1 - \phi)\Pi(G; r)$$

$$\bar{W} = \phi B + C$$

If r(s), T(s) and G(s) are constant for $t < s < \infty$, then

$$\phi = 1 - r/(r + p)$$

$$\bar{H} = \Pi(Y - G; r + p).$$

Measured private saving equals the private sector's total net asset accumulation, including its acquisition of government debt. Thus, total private saving S equals the change in private net wealth plus $(1 - \phi)$ times the government deficit D (i.e., the increase in the outstanding stock of government debt):

$$(1) \quad S = S(R) + (1 - \phi)D$$

where S(R) is the (interest-sensitive) component of saving that the private sector undertakes in order to accumulate wealth, and $(1 - \phi)D$ is the component reflecting the private sector's response to public sector dissaving.

It is assumed that since net exports of goods and services N (the current account surplus) respond to the price of the home good relative to the foreign good, the home country's current account tends toward deficit when its currency appreciates in real terms (ε falls) and vice versa when the home currency depreciates. The response of the current account balance to the real exchange rate embodies expenditure switching by both home and foreign consumers: a rise in the relative price of domestic output leads to lower demand for home goods by both foreigners and domestic residents. 1/

Macroeconomic equilibrium in the home country occurs when ex ante private saving minus private domestic investment and the government's fiscal deficit equal the current account surplus:

$$(2) \quad S - I(R) - D = N(\varepsilon)$$

Substituting (1) into (2) yields the following modification of the equilibrium condition: 2/

1/ Since a change in the real exchange rate has a valuation effect as well as a volume effect on N, our prior that $N_\varepsilon > 0$ entails the assumption that the Marshall-Lerner condition is fulfilled. Specifically, $N_\varepsilon > 0$ requires that $\delta\eta_\varepsilon + \mu_\varepsilon > 1$ where η_ε is the elasticity of the volume of home-country gross exports (X) with respect to ε, μ_ε is the absolute value of the corresponding elasticity of ROW gross exports X*, and $\delta = X/\varepsilon X^*$ is the initial ratio of home to foreign exports, expressed in a common numeraire.

2/ The relevant modification is that S(R) is only the interest-sensitive component of private saving, and ϕD represents the net effect of government fiscal policy on <u>total</u> (private plus public) national saving, given the value of the Ricardian equivalence parameter ϕ.

(3) $S(R) - I(R) - \phi D = N(\varepsilon)$

The restrictions on the partial derivatives of the behavioral functions of equation (3) are:

$N_\varepsilon > 0 \qquad I_R < 0 \qquad (S_R - I_R) > 0 \qquad 1 > \phi > 0$

An analogous saving-investment equilibrium holds for the rest of the world:

(4) $S^*(R) - I^*(R) - \phi^* D^* = N^*(\varepsilon)$

with the restrictions

$I_R^* < 0 \qquad (S_R^* - I_R^*) > 0 \qquad 1 > \phi^* > 0$

Equations (1) and (2) clearly do not constitute two independent conditions for macroeconomic equilibrium. This is because, in a two-country world, the home country's current account surplus must equal the deficit of the rest of the world, so that

(5) $N^*(\varepsilon) = -N(\varepsilon)$

This identity serves to emphasize the fact, already noted above, that the partial derivative N_ε subsumes the responses of both home-country and rest-of-the-world residents to changes in international competitiveness. Finally, assuming a 'pure' float, real private capital transfers from the rest of the world to the home country (i.e., the use of foreign savings by the home country) must always equal N*.

The simple model (3)-(5) determines three endogenous variables: the world real interest rate, R; the real exchange rate, ε; and the current account balance, $N = -N^*$, prevailing between the home country and the rest of the world. The only exogenous variables are the public sector fiscal deficits at home and abroad, D and D*.

The total differential of the system (3)-(5) is:

(6) $$\begin{bmatrix} (S_R - I_R) & -N_\varepsilon \\ (S_R^* - I_R^*) & N_\varepsilon \end{bmatrix} \begin{bmatrix} dR \\ d\varepsilon \end{bmatrix} = \begin{bmatrix} \phi dD \\ \phi^* dD^* \end{bmatrix}$$

The determinant of the coefficient matrix, Λ, is

$$(7) \quad \Lambda = N_\varepsilon(S_R - I_R) + N_\varepsilon(S_R^* - I_R^*)$$

which, given our assumptions about the partial derivatives, is unambiguously positive.

Suppose that, starting from a balanced current account position, the government of either the home country or the foreign country increases its fiscal deficit by some amount dD. The system (6) gives the following effects on the endogenous variables:

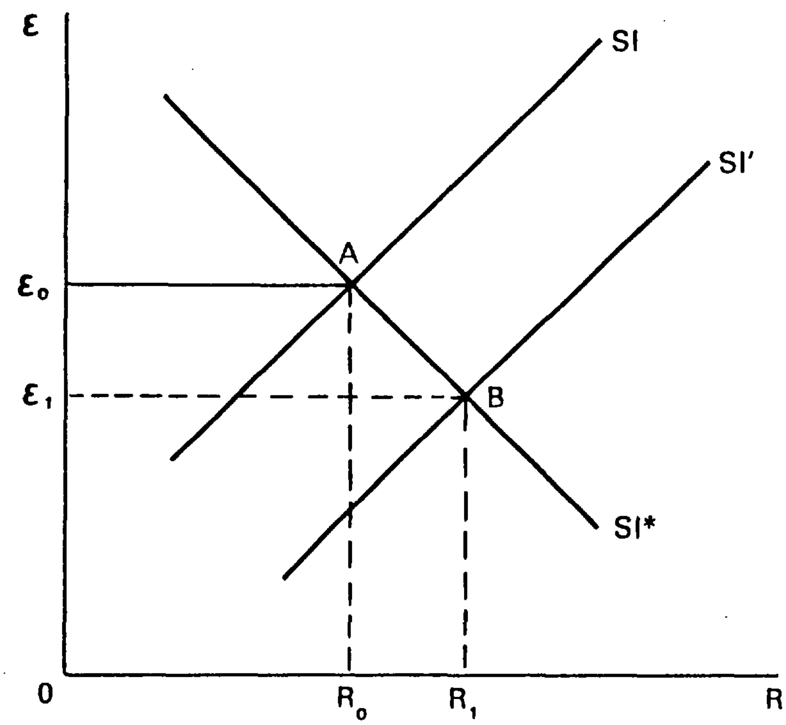
$$(8) \quad \begin{array}{ll} \dfrac{dR}{dD} = \dfrac{\phi N_\varepsilon}{\Lambda} > 0 & \dfrac{dR}{dD^*} = \dfrac{\phi^* N_\varepsilon}{\Lambda} > 0 \\ \dfrac{d\varepsilon}{dD} = \dfrac{\phi(I_R^* - S_R^*)}{\Lambda} < 0 & \dfrac{d\varepsilon}{dD^*} = \dfrac{\phi^*(S_R - I_R)}{\Lambda} > 0 \\ \dfrac{dN}{dD} = \dfrac{\phi N_\varepsilon(I_R^* - S_R^*)}{\Lambda} < 0 & \dfrac{dN}{dD^*} = \dfrac{\phi^* N_\varepsilon(S_R - I_R)}{\Lambda} > 0 \end{array}$$

Assuming that the private sector treats some fraction ($\phi > 0$) of domestic government bonds as a component of its net worth, an increase in the home country's fiscal deficit, dD, will raise the world interest rate, cause the domestic currency to appreciate in real terms, and induce a deterioration of the home country's current account balance, financed by a transfer of capital from the rest of the world. These results have a simple intuitive rationale. When an increase in the home country's public sector budget deficit disturbs the domestic saving-investment balance, the excess demand for saving must be financed by an inflow of capital from the rest of the world. In order for this capital transfer to be effected, the home country's current account must move into deficit, and this movement is accomplished by a real appreciation of the domestic currency in the foreign exchange market. However, other things equal an increase in public sector dissaving by the home country creates an imbalance between global saving and investment, necessitating a rise in the <u>world</u> real interest rate to restore equilibrium. 1/

1/ It is often argued that an increase in the home country's fiscal deficit will induce a capital inflow because it tends to raise domestic interest rates "relative to foreign rates." It is certainly probable that an increase in the home country's fiscal deficit will raise its (To be continued on page 13)

FIGURE 1

EQUILIBRIUM REAL INTEREST RATE
AND REAL EXCHANGE RATE



Analogous results hold for the case of an increase of the public sector fiscal deficit, dD*, in the rest of the world: provided $\phi^* > 0$, a more expansionary fiscal policy in the rest of the world will also raise the world interest rate but will cause the home currency to depreciate and induce a current account movement in the opposite direction to that referred to above. 1/

It should be reiterated, however, that these results hold for deficit shifts in each country only if the relevant value of $\phi \neq 0$, implying that full Ricardian equivalence does not hold. In general, the value of ϕ depends, among other things, on the life expectancies of households (Blanchard 1985) and on private sector expectations about the specific types of future tax and spending measures that the government will introduce in order to achieve its desired stance of fiscal policy. Thus the values of ϕ may differ significantly, not only across countries but over time, as views change about likely future fiscal policies.

Shifts in private investment will have effects that are qualitatively similar to an increase in government dissaving, but they will be larger (unless $\phi = 1$) because investment shifts produce no direct offset on the part of private saving. Therefore an autonomous increase in private investment in the home country will tend to raise interest rates, at home and abroad, and to appreciate the home currency. Higher interest rates will reduce investment in both economies, including the foreign economy which did not benefit from the positive investment shift.

The implications of the preceding analysis for the world real interest rate and the real exchange rate between the two countries are illustrated in Figure 1. In the figure, the vertical axis is the real price of the currency of the rest of the world in terms of home currency, while the horizontal axis is the world real interest rate. The SI curve is the locus of combinations of the interest rate and the real exchange rate which, for given public sector fiscal positions, equates the ex ante home-country private saving and investment balance with the ex ante current

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1/ (Continued from page 12) real interest rate relative to that prevailing abroad, either because domestic and foreign financial assets are not viewed by wealth-holders as perfect substitutes, or because investors expect a real exchange rate depreciation. However, even if interest rates are assumed equal at home and abroad, as in the simple model discussed here, the new equilibrium will involve an appreciation of the home currency as a result of an increase in its fiscal deficit. It will also be true that interest rates in both countries will be higher.

1/ Also note that a one unit increase in the ROW fiscal deficit would increase the world interest rate by the same amount as a one unit increase in the domestic deficit only if $\phi = \phi^*$.

account balance. This curve slopes upward on our assumption that a rise in the interest rate causes desired investment to fall relative to intended saving, leading to an improvement in the home country's current account balance in real terms. Such an improvement requires a depreciation of the home currency (a rise in ε) to equate the ex ante current account balance to the new desired pattern of saving and investment. For analogous reasons, the rest-of-the-world's saving-investment balance curve, SI*, slopes downward in ε-R space.

The nature of the interest rate and exchange rate movements that result from an autonomous shift in one country's fiscal position or in ex ante investment will obviously depend on the responsiveness of the real interest rate and exchange rate to a disturbance in the world market for saving, or to a disequilibrium in the world goods market. Figure 1 illustrates the effect of either an expansionary fiscal policy in the home country or an exogenous increase in the desire to invest. Either of these shocks must shift the SI curve to the right: at a given exchange rate and current account the increased demand for private saving can only be brought about through a rise in the real interest rate which "crowds out" private investment relative to desired saving. The new equilibrium, B, will involve a real appreciation of the home currency and a higher world interest rate. Not described is the nature of the path to equilibrium. If there is lagged adjustment of trade flows to real exchange rates, or if saving and investment flows embody gradual movements toward desired stocks of wealth and physical capital, respectively, then the dynamic adjustment path of the real interest rate to R_1 and the real exchange rate to ε_1 is likely to be quite complex. The issue of the path of adjustment after a fiscal shock is clearly an important empirical question, and it will be considered at greater length in Section IV.

III. An Empirical Model for the United States, the Federal Republic of Germany and Japan

The model described in the preceding section is too simple to capture such real-world complications as cyclical variations (which tend to cause common movements in the historical data), or the accumulation of real and financial assets resulting from flows of net saving, investment, and payments to foreigners. A more fully specified model would also ensure that in the steady state asset supplies and demands are equilibrated and that each outstanding stock settles down to some proportion of output. Finally, to be useful as an explanation of recent developments in exchange rates and current account balances the model should be extended to a multi-country context. In this section we specify and estimate a model that takes account of these complexities.

The empirical model includes equations for private saving, private investment, and the non-oil merchandise exports and imports of the United States, the Federal Republic of Germany, and Japan. The rest of the world is captured in a rudimentary way through an aggregate function explaining total ROW saving minus investment. For each of the three countries there are equations linking fiscal deficits to the increase in outstanding government debt, net investment to the change in the real capital stock, and imports and exports--via an identity equating the current balance to net merchandise exports plus the balance on services--to the change in claims on foreigners. In addition, the model implicitly determines the level of the real effective exchange rate of each of the three countries as the rate that makes the supply of private saving, minus the demands for saving from net private domestic investment and the government deficit, equal to net exports. (The real effective exchange rate of the remaining countries as a group is thus residually determined, as are its net exports.) The model retains the assumption of a single integrated world capital market with perfect substitutability among the claims on capital in the three countries. However, to the extent that the real bilateral value of the U.S. dollar is expected to depreciate (appreciate) in terms of the deutsche mark and the yen, real interest rates in Germany and Japan will be lower (higher) than the rate in the United States by an amount equal to the expected rate of dollar depreciation (appreciation).

a. Specification

We now set out the structural equations for each country in the model. In what follows, the subscript i is incremented over the list of countries (US, GE, JA) unless otherwise noted.

Our model is similar in spirit to that of Metzler (1951) in focussing on the interaction of saving and wealth. It also resembles a more recent theoretical model (Dornbusch 1975), though it ignores portfolio balance considerations treated there. We assume that private saving adjusts to close the gap between the private sector's desired wealth and its actual holdings at the beginning of each period. Desired wealth is a function of the domestic real interest rate and permanent income (here proxied by the current level of income). Consistently with the model of the preceding section (and also to avoid problems of heteroscedasticity and spurious correlations among trended variables) we deflate real private saving and real wealth in each country by a measure of capacity output (see Appendix for the sources of data). The income variable, which appears in the equation because it helps to explain target wealth, therefore has the form of a gap between actual and capacity output (see Artus 1977 for methodology).

Given the stringency of the assumptions (discussed in the preceding section) that are required in order for autonomous shifts in public sector saving to be fully offset by induced movements in private saving, we treat the validity of Ricardo-Barro debt neutrality as essentially an empirical hypothesis to be decided by the data. Thus our empirical model retains the assumption that the private sector's perceived net wealth may include any proportion ϕ of government debt, with ϕ to be dictated by the data.

The equation for private saving in each country, i, embodies the hypothesis that the change in private sector real wealth, as a proportion of capacity output, YC_i, is equal to a fraction of the gap between the private sector's end-of-period target real wealth, W_i^*, and lagged wealth,

$$\Delta(W_i/YC_i) = a_i[W_i^*/YC_i - W_i(-1)/YC_i(-1)] \qquad \text{where } W_i^* = W_i^*(Y_i,R_i),$$

that is, target wealth is a function of domestic real income and the domestic real interest rate. Wealth is composed of some proportion, ϕ_i, of the real stock of government debt, B_i, plus the real net capital stock K_i, and real net claims on foreigners, F_i: 1/

$$W_i = \phi_i B_i + K_i + F_i$$

In the empirical model we retain the assumption of Section II that there is a single world capital market, but we no longer impose the assumption of static expectations of the real exchange rate. The real

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1/ Published data on the real capital stock are calculated by cumulating real gross investment and subtracting physical depreciation; we have not attempted to measure the market value of the capital stock, as valued, for instance, in the stock market. To calculate real government debt, we cumulate nominal deficits and divide by the GDP deflator; accounting for valuation changes requires knowledge of the maturity structure of the government debt. Under the assumption made here that all government debt takes the form of indexed one-period bonds, there are no valuation effects of changes in the real interest rate on the real stock of government debt. This would not be the case either for multi-period, nominal debt or for government liabilities in the form of money. Finally, real net claims on foreigners are obtained by cumulating current account surpluses and dividing by the GDP deflator. There is an implicit assumption that net claims on foreigners remain constant in terms of domestic output as real exchange rates change, and we ignore such valuation effects. The sensitivity of the results to valuation effects on the stocks of government debt and net claims on foreigners is discussed in Section IV.

interest rate on (private and government) bonds valued in units of U.S. output is R_{US}. However, since the real value of the U.S. dollar can change in terms of the other two currencies over the holding period, real interest rates in Germany and Japan are given by:

$$R_i = R_{US} - ERDOT_i \qquad i = GE, JA$$

where $ERDOT_i$ is the market's anticipated rate of appreciation in the real exchange rate of currency i vis-à-vis the U.S. dollar. 1/

Saving data are calculated such that private saving equals the difference between after-tax disposable income and consumption; that is, the private sector's acquisition of assets including government debt. Thus, based on the arguments of Section II above, we define private saving as the change in net wealth plus $(1-\phi)$ times the real government deficit (DEF, equal to ΔB):

$$S_i = \Delta W_i + (1-\phi_i)DEF_i$$

This is the specification of the flow of private savings that is required for consistency with the equation that defines the stock of private sector wealth (above). It emphasizes that if households are rational, not all of private saving serves the purpose of acquiring net wealth; individuals increase their saving by some fraction $(1-\phi)$ of the government deficit in order to accumulate the assets needed to pay future taxes that will be levied by the government to service the additional debt. Combining this identity with the wealth adjustment equation given above, we obtain

$$S_i/YC_i = a_i[W_i^*/YC_i - W_i(-1)/YC_i(-1)] + (1-\phi_i)DEF_i/YC_i$$
$$+ (n_i/(1+n_i))W_i(-1)/YC_i(-1)$$

where n is the growth rate of capacity output. After substituting for W and W* and grouping terms, the equation that is to be estimated takes the form

1/ In the estimation work that follows, the $ERDOT_i$ are effectively treated as exogenous variables. However, the simulation model has been used to study the effects of making exchange rate expectations endogenous.

(9) $S_i/YC_i = b0_i + b1_iR_i + b2_iGAP_i + b3_i[\phi_iB_i(-1) + K_i(-1) + F_i(-1)]/YC_i(-1)$

$+ (1-\phi_i)DEF_i/YC_i$

where $b3_i = (n_i/(1+n_i) - a_i)$ and $b0_i$, $b1_i$ and $b2_i$ depend on the W* function as well as the speed of adjustment a_i. GAP is defined as the ratio of actual to capacity output, minus unity: GAP = Y/YC - 1.

The current account balance, which is the difference between total national saving (S_i - DEF_i) and private investment, is given by:

$$N_i = S_i - I_i - DEF_i$$

Combining the three preceding equations it is clear that if Ricardian equivalence holds (Barro 1974), then $\phi = 0$ and private saving increases one-for-one with the government deficit, leaving (public plus private) net national saving unchanged. In this case the current account balance would also be unaffected by changes in fiscal policy, provided of course that investment (considered below) was not directly affected. In the other polar case, $\phi = 1$, all of the increased government debt would be considered part of private net wealth, so that there would be no automatic increase in private saving to allow for future tax liabilities. Here the current account balance would change by an amount that would depend on endogenous movements in interest rates and exchange rates. Of course, our model also admits of intermediate cases where $0 < \phi < 1$; in these cases full Ricardian equivalence would not hold, and there would be some direct, but incomplete, positive response of private saving to increases in government deficits.

The investment equation assumes lagged adjustment of the real (net) capital stock divided by capacity output, where the desired capital stock depends on expected output and the domestic real interest rate, and expected output is assumed to be equal to actual output:

$$\Delta(K_i/YC_i) = c_i[K_i^*/YC_i - K_i(-1)/YC_i(-1)]$$

where $K_i^* = K_i^*(Y_i, R_i)$. The interest rate affects the desired stock through the user cost of capital, which also depends on tax considerations, which though not made explicit here, are considered more fully below. The investment equation has the familiar accelerator property: an increase in output, relative to capacity output, tends to increase investment. We assume that the K* function is homogeneous in Y, and we write the investment equation in terms of the output gap. After grouping terms, the estimating equation takes the form:

(10) $I_i/YC_i = f0_i + f1_iR_i + f2_iGAP_i + f3_iK_i(-1)/YC_i(-1)$

where $f3_i = (n_i/(1+n_i) - c_i)$.

The equations that determine flows of merchandise trade are modelled in a manner similar to those of the IMF's World Trade Model (see Spencer 1984 for the latest version of that model). Non-oil merchandise export volumes, XV, are assumed to depend on foreign demand, here proxied by the foreign output gap, GAPF = YF/YCF - 1, and on the real effective exchange rate, REEX (defined as the ratio of normalized unit labor costs in the home country to those in foreign countries, so an increase in REEX indicates a real appreciation). In addition, the ratio of exports to the home country's capacity output, YC, may vary with a time trend (T), for instance, as a result of a gradual expansion of trade flows, relative to output, over the post-World War II period. Non-oil merchandise import volumes, MV, are assumed to depend on the country's output gap and its real effective exchange rate, and again may exhibit a time trend when divided by capacity output. In addition, we allow for slow adjustment of volumes to activity and exchange rate changes. The estimating equations take the form:

(11) $XV_i/YC_i = g0_i + g1_iT + g2_iGAPF_i + g3_iREEX_i + g4_iXV_i(-1)/YC_i(-1)$

(12) $MV_i/YC_i = h0_i + h1_iT + h2_iGAP_i + h3_iREEX_i + h4_iMV_i(-1)/YC_i(-1)$

Finally, we also include in the model an equation explaining the aggregate saving (minus investment) of the rest of the world. In the absence of data on the fiscal positions and wealth stocks of those countries, we simply make this net saving variable (also equal to the current account position of the rest of the world, NROW) a function of their real interest rate (RROW), proxied by an average of rates prevailing in the United States, Germany, and Japan:

(13) $NROW/YCROW = k_0 + k_1\ RROW$

Equations (9)-(13) above constitute the model that is to be estimated. Data sources are described in the Appendix, but some explanation here is warranted. The basic data for saving, investment, and current account flows are at an annual frequency and come from the national accounts of the country concerned. Data on asset stocks are cumulated from these flow data using whatever information is available concerning a benchmark stock figure. The capital stock is just the cumulation of the flow of net private real investment. As for the real value of government debt, a correction has been made to national accounts fiscal deficits for the portion of nominal interest payments that corresponds to compensation for inflation (see Jump 1980). The calculation was performed in the following fashion: nominal deficits were cumulated from a benchmark stock for government debt, and this series was deflated by the GDP deflator to get the real debt stock. The adjusted real deficit was defined as the first difference of this stock. A similar correction could be made to the published current account balance (Sachs 1981), but it is clear that flows of investment income do not correspond solely to payments of interest on financial assets fixed in nominal terms. Also included are dividends on shares and earnings from foreign direct investment. In the absence of detailed data on the nature of the claims acquired, we assumed that all claims on foreigners correspond to real claims, and no correction was made to the current account. Real net claims on foreigners were simply calculated as the sum of past real current account surpluses. Finally, real net private sector saving was calculated residually, in order to make it consistent with the other flow data, as the sum of the real current balance, real net private investment and the corrected real government deficit. It thus embodies a partial correction for inflation, to the extent that assets acquired take the form of claims on government.

b. Estimation

The equations for each country were estimated over the longest time period for which annual data were available, in most cases from 1961 to 1983. The equations were estimated in blocks using nonlinear three-stage least squares. Since real interest rates, real exchange rates, and output gaps are endogenous to the full model, they were not treated as being predetermined in each block; instruments used included the lagged asset stocks, government deficits, and capacity output. Saving and investment equations were estimated jointly for the three countries, along with the net saving function for the rest of the world. Estimates are presented in Table 1. Import and export equations were also estimated jointly for the three countries; results are reported in Table 2. Joint estimation by blocks allowed appropriate restrictions, discussed below, to be imposed across equations. It also permitted efficiency gains by allowing for correlation among the shocks facing the same sectors in different countries. Joint estimation of all the equations together was not feasible owing to computer limitations.

For the results reported here, two assumptions were employed in the estimation and simulation work. The saving equation for each country embodies a nonlinear restriction on the coefficients, since ϕ appears in both the definition of wealth and the coefficient applied to the budget deficit. We initially estimated ϕ separately for each country. In all three cases its value was significantly different from zero, indicating

Table 1. Coefficient Estimates for Investment and Saving Equations, 1/
Three-Stage Least Squares, 1966-1983

(t-ratios in brackets)

	Saving Equations						
Parameter (Associated Variable)	b_0 (Constant)	b_1 2/ (R)	b_2 (GAP)	b_3 (W(-1))	ϕ 2/ (B,DEF)	R^2	S.E.E.
United States	.2181 (8.85)	-.0707 (1.68)	.257 (16.59)	-.0776 (6.00)	.4252 (10.32)	.629	.0076
Germany	.4274 (13.94)	-.0707 (1.68)	.157 (5.91)	-.1322 (10.40)	.4252 (10.32)	.806	.0071
Japan	.2678 (8.80)	-.0707 (1.68)	.202 (5.16)	-.0513 (3.67)	.4252 (10.32)	.153	.0127

	Investment Equations					
Parameter (Associated Variable)	f_0 (Constant)	f_1 (R)	f_2 (GAP)	f_3 (K(-1))	R^2	S.E.E.
United States	.2838 (8.41)	-.1713 (2.90)	.327 (15.84)	-.1208 (6.30)	.888	.0069
Germany	.4647 (4.58)	-.2155 (1.33)	.342 (4.94)	-.1477 (3.51)	.621	.0139
Japan	.4045 (10.97)	-.1233 (2.55)	.338 (9.09)	-.1174 (6.95)	.858	.0087

	Rest of World Saving Minus Investment			
Parameter (Associated Variable)	k_0 (Constant)	k_1 (RROW)	R^2	S.E.E.
	.00415 (9.77)	.0401 (3.06)	.249	.0014

System log likelihood: 412.6 System R^2: .969 Weighted S.E.E.: .0102

1/ For the form of the equations, see equations (9), (10), and (13) in the text, respectively. All variables are expressed as decimal fractions or as ratios to capacity output.
2/ Constrained to the same value for all three countries.

Table 2. Coefficient Estimates for Export and Import Volume Equations, 1/
Three-Stage Least Squares, 1961-1983

(t-ratios in brackets)

Parameter (Associated Variable)	g_0 (Constant)	g_1 (T)	g_2 (GAPF)	g_3 (REEX)	g_4 (XV(-1))	R^2	S.E.E.
	Export Volume Equations						
United States	.0825 (8.67)	.00055 (2.99)	.150 (6.36)	-.03548 (7.59)	.3988 (4.35)	.974	.0025
Germany	.0227 (1.39)	.00097 (1.25)	.206 (4.86)	-.00535 2/	.9086 (8.04)	.959	.0079
Japan	.0663 (5.28)	.00258 (4.89)	-.012 (.42)	-.05200 (4.35)	.4797 (11.62)	.971	.0047

Parameter (Associated Variable)	h_0 (Constant)	h_1 (T)	h_2 (GAP)	h_3 (REEX)	h_4 (MV(-1))	R^2	S.E.E.
	Import Volume Equations						
United States	.0021 (.20)	.00144 (4.49)	.058 (3.98)	.01015 (1.76)	.3940 (3.23)	.904	.0040
Germany	-.0017 (2.52)	.00180 (4.13)	.137 (3.22)	.04867 3/	.5840 (4.80)	.955	.0068
Japan	-.0278 (1.98)	.00106 (3.74)	.085 (4.60)	.05271 (3.70)	.3384 (3.12)	.826	.0057

System log likelihood: 520.9 System R^2: .989 Weighted S.E.E.: .0055

1/ For the form of the equations, see equations (11) and (12) in the text, respectively. All variables are expressed as decimal fractions or as ratios to capacity output, except time T which is incremented by one each year, and the real effective exchange rate which is an index number, 1980 = 1.

2/ Constrained to equal the average of the export price elasticities cited for Germany in Helliwell-Padmore (1985), in the long run.

3/ Constrained to equal the average of the import price elasticities cited for Germany in Goldstein-Khan (1985), in the long run.

that full Ricardian equivalence (and thus debt neutrality) does not hold. Further, the unrestricted estimate yielded a lower value of ϕ for the United States (0.25) than for Germany and Japan (about 0.6).

Of course, one would expect ϕ to differ not only over time but across countries, because individual households form expectations about the specific types of tax and spending measures that their government is most likely to implement in altering its fiscal position. Each household can then form views about whether, for example, an expected reduction in public consumption is a close substitute for its own expenditure and whether it is likely to have to share the burden of future tax increases. Nevertheless, allowing ϕ to differ across countries produces some simulation results that do not have a very transparent explanation. 1/ Thus our first simplification in this preliminary analysis was to constrain ϕ to have the same value in all three countries. This restriction was accepted by the data, on the basis of a likelihood ratio test, at the 2.5 percent level. The estimated common value of ϕ is significantly different from both zero and unity. The value of 0.43 yielded by our sample implies that neither Ricardo-Barro debt neutrality nor the full inclusion of government bonds in private net wealth is warranted on the basis of the data and is consistent with earlier estimates based on consumption functions (see Kochin 1974, Tanner 1979, Buiter and Tobin 1979, and Seater 1982).

In view of the well-known difficulties of isolating a statistically robust effect of the real interest rate on saving, our second simplification was to constrain this coefficient to be the same for the three countries. Our estimate implies a small negative response of saving to an increase in the interest rate, suggesting that the income effect slightly outweighs the substitution effect. 2/ The equations for net investment are similar in the three countries; in all cases, investment

1/ In particular, they yielded the implausible result that fiscal contraction in Germany and Japan would lead to larger falls in the general level of interest rates than an equal contraction (expressed as a ratio to capacity output) in the United States.

2/ This empirical result is generally regarded as counterintuitive. In a recent paper, however, Bernheim and Shoven (1985) present evidence that during the past few years net contributions to pension funds, which make up a large proportion of total private saving in the United States, have tended to fall as real interest rates increased. This implies a negative relation between real interest rates and private saving in the United States. The negative relation occurs because roughly 70 percent of pension fund assets are in "defined-benefit" plans for which, other things equal, a rise in real interest rates allows firms to finance the benefits stipulated by the plan with a lower level of corporate contributions.

responds positively to the output gap and negatively to the real interest rate. Coefficient f3 implies a similar, rather slow, speed of adjustment to the desired capital stock in all three countries. The effect of the real interest rate on investment is larger than that on saving; consequently, saving minus investment in each of these countries responds positively to the interest rate. Saving minus investment in the rest of the world also responds positively to an increase in the real interest rate, proxied here as a weighted average of real rates in the United States, Germany, and Japan.

The trade volume equations (for non-oil merchandise exports and imports relative to capacity output) depend on economic activity, the country's real exchange rate, and a time trend. Historically, exports and imports have increased as a proportion of output over time, owing to the secular effects of the postwar liberalization of trade and increased specialization to exploit comparative advantage. For the three largest industrial countries there is a positive and statistically significant trend effect on trade volumes over and above the increase in capacity output. There are also significant cyclical effects, as measured by foreign and domestic gap variables in export and import equations, respectively. Export volumes respond negatively and imports positively to an appreciation of the real effective exchange rate (an increase in REEX). However, data for Germany had difficulty capturing these effects and we imposed a long-run elasticity of imports equal to 0.28 (at sample means), which is an average of estimates for Germany presented in Helliwell and Padmore (1985, p. 1148); and a long-run elasticity of exports equal to 0.79, the average of estimates for German total exports (Goldstein and Khan 1985, p. 1079). 1/ For both exports and imports, lags in adjustment to relative price and activity changes seem to be present.

IV. Simulated Effects of Shifts in Fiscal Policies

In order to gauge the effects of shifts in fiscal policies on the level of world interest rates and on the pattern of current accounts and real exchange rates, we must specify the equations that close the system; the complete model is presented in Table 3. First, we include an identity that relates the current account balance to non-oil merchandise exports minus non-oil merchandise imports, plus investment income (which we proxy by the real interest rate multiplied by the stock of real net foreign assets), plus other net exports of goods and services (oil trade, other services and unilateral transfers). The model solves for the values of the endogenous variables that make this definition consistent with the other way of expressing the current balance; namely, private saving minus private investment minus the government fiscal deficit.

1/ Speeds of adjustment of exports and imports, g_4 and h_4 respectively, are nevertheless estimated for Germany.

This dual identity is given as equation (7) in Table 3. Though the model is fully simultaneous, it is useful to think of the role of the real exchange rate as making these two definitions equal, given real interest rates and output gaps in each of the countries.

We also include a simple production function relationship (equation 10) between the capital stock and capacity output. We do not include the labor force explicitly, but rather include a trend term which captures both population growth and technical progress. On the basis of sample averages for the growth of the capital stock and output, we impose a plausible number for this growth rate, 3 percent per year, and make it common to all countries so that we can compare steady state solutions of the model. We also arbitrarily impose a common Cobb-Douglas production function (differing, however, by a scale factor), with a share of capital equal to one third.

In the theoretical model of Section II, the world rate of interest brings about equality of world saving and world investment; the distribution of saving and investment between countries helps determine the real exchange rate between their currencies. The equality of world saving and investment is equivalent to the condition that current account balances sum to zero globally, and in the simulation model we add the equation, (equation 14 in Table 3) that enforces this condition for the United States, Japan, Germany, and the remaining countries taken as a group. In the data this condition also holds, as we have calculated residually the rest-of-world current balance, expressed in real U.S. dollar terms; e80•GE and e80•JA are just base period (1980) dollar exchange rates of the deutsche mark and the yen.

The model is classical in that saving and investment determine real interest rates; monetary influences on real interest rates and real exchange rates are intentionally neglected. Furthermore, the Keynesian adjustment mechanism, whereby shifts in savings and investment bring about changes to aggregate output, is also ignored; in simulation, the GAP variable is taken as exogenous to the model. As already noted, under floating exchange rates perfect substitutability between domestic and foreign assets does not require that real interest rates be equal at home and abroad: the two real rates will differ by the expected rate of change of the real exchange rate, which we call ERDOT. The simulation model includes the equations that relate real interest rates in Germany and Japan to that in the United States and to the expected real appreciation or depreciation of the deutsche mark or the yen relative to the dollar. In the simulations reported below these expected rates of change, $ERDOT_i$, are treated as exogenous.

Table 3 summarizes the equations of the full simulation model, including all identities; the coefficients used are those given in Tables 1 and 2. To begin the simulations a baseline was created with

Table 3. Equations of the Simulation Model

For i = US, Germany (GE), and Japan (JA):

(1) $S_i/YC_i = b0_i + b1_iR_i + b2_iGAP_i + b3_iW_i(-1)/YC_i(-1) + (1 - \phi_i)DEF_i/YC_i$

(2) $I_i/YC_i = f0_i + f1_iR_i + f2_iGAP_i + f3_iK_i(-1)/YC_i(-1)$

(3) $W_i = \phi_iB_i + K_i + F_i$

(4) $XV_i/YC_i = g0_i + g1_iT + g2_iGAPF_i + g3_iREEX_i + g4_iXV_i(-1)/YC_i(-1)$

(5) $MV_i/YC_i = h0_i + h1_iT + h2_iGAP_i + h3_iREEX_i + h4_iMV_i(-1)/YC_i(-1)$

(6) $K_i = K_i(-1) + I_i$

(7) $N_i = S_i - I_i - DEF_i = XV_i - MV_i + R_i\ F_i(-1) + RES_i$

(8) $B_i = B_i(-1) + DEF_i$

(9) $F_i = F_i(-1) + N_i$

(10) $LN(YC_i) = j0_i + j1_iT\ LN(1+n_i) + (1-j1_i)LN(K_i)$

For i = GE and JA:

(11) $R_i = RUS - ERDOT_i$

For the rest of the world (ROW):

(12) $NROW/YCROW = k0 + k1 \cdot RROW$

(13) $RROW = w1\ RUS + w2\ RGE + w3\ RJA$

(14) $NROW = -(NUS + NGE/e80 \cdot GE + NJA/e80 \cdot JA)$

residuals added back to the equations so that the model replicated historical data. For convenience, it was further assumed that from 1983 onward the values of variables were consistent with a steady state for the economy: in the baseline, ratios of real flows and stocks divided by capacity output are constant, as are real interest rates and real exchange rates. The baseline thus embodies the simplifying assumption that the secular growth in the relative importance of international trade comes to an end, so that there is no trend growth in exports and imports relative to capacity output.

Our first set of experiments assumes independent reductions of the fiscal deficit by 1 percent of real capacity output in each of the three countries separately, beginning in 1985. We calculate the effects of these hypothetical changes on the steady state of the model, using a non-dynamic version of it, as well as on the dynamic path of the endogenous variables. As detailed above, the dynamics of the model arise from lagged adjustment of the capital stock and of private net wealth to their desired levels, as well as the gradual accumulation of government debt owing to the (assumed exogenous) fiscal deficit. In addition, there is slow adjustment of trade flows and the gradual accumulation of net claims on, or liabilities to, foreigners.

Tables 4, 5, and 6 present separate simulation results for deficit reduction programs in the United States, Germany and Japan, respectively. Stock and flow variables are scaled by capacity output so that induced changes in them can be compared directly with the autonomous shock to the fiscal deficit, and also so that the simulation results are comparable across countries. It should be stressed here that it is the total deficit (inclusive of real interest payments) that is being changed in these simulations; thus (unless n_i=0) the model does not produce explosive growth in the ratio of the debt stock to capacity output, as would be the case if the primary deficit were increased autonomously and interest payments were allowed to grow without bound. Our experiments should therefore be viewed as changing the steady-state stock of bonds, with offsetting changes to taxes, so that the government's intertemporal budget constraint is satisfied. Chart 1 compares the paths of real exchange rates and real interest rates in the three simulations, and Chart 2 plots the current account balance and private investment, both as ratios to capacity output.

A permanent fiscal deficit reduction of 1 percent of capacity output in the United States produces a substantial decline in U.S. real interest rates, from 6.8 percent in our baseline to 4.1 percent in the new steady state, a fall of 2.7 percentage points (Table 4). Since interest parity holds for real interest rates in the model and expected real exchange rate changes are assumed exogenous, foreign rates (not reported) also move by the same amount. Private saving declines by almost half of the

Table 4. Simulation of a U.S. Fiscal Deficit Reduction Equal to 1 Percent of Capacity Output, Starting in 1985: Deviations from Baseline

(As percent of baseline capacity output)

Year	U.S. Variables S	I	N	K	F	W	REEX 1/	R 2/
1985	-0.48	0.24	0.28	0.24	0.28	0.10	-5.57	-1.40
1986	-0.47	0.24	0.29	0.48	0.57	0.21	-3.30	-1.51
1987	-0.46	0.24	0.30	0.71	0.85	0.32	-3.26	-1.61
1988	-0.45	0.24	0.31	0.93	1.13	0.43	-3.22	-1.71
1989	-0.45	0.24	0.31	1.14	1.41	0.55	-3.18	-1.79
1990	-0.44	0.24	0.32	1.34	1.69	0.67	-3.14	-1.88
1991	-0.44	0.24	0.32	1.54	1.96	0.79	-3.10	-1.95
1995	-0.43	0.22	0.34	2.25	3.04	1.25	-2.92	-2.20
1999	-0.43	0.21	0.36	2.82	4.06	1.67	-2.72	-2.34
Long-run	-0.48	0.13	0.39	4.48	12.96	3.32	0.52	-2.72

Year	German Variables S	I	K	W	Japanese Variables S	I	K	W
1985	0.10	0.30	0.30	0.10	0.10	0.18	0.18	0.10
1986	0.11	0.30	0.60	0.21	0.11	0.18	0.35	0.21
1987	0.12	0.30	0.87	0.33	0.12	0.18	0.52	0.32
1988	0.13	0.29	1.14	0.45	0.13	0.18	0.68	0.44
1989	0.13	0.29	1.40	0.57	0.13	0.18	0.84	0.56
1990	0.14	0.28	1.63	0.69	0.14	0.18	0.99	0.68
1991	0.14	0.27	1.86	0.81	0.14	0.18	1.14	0.80
1995	0.14	0.25	2.65	1.27	0.15	0.17	1.69	1.28
1999	0.14	0.23	3.28	1.67	0.16	0.16	2.14	1.74
Long-run	0.09	0.15	4.87	2.87	0.12	0.11	3.54	3.89

1/ Percentage deviation from baseline.
2/ Deviation from baseline, in percentage points.

Table 5. Simulation of a German Fiscal Deficit Reduction Equal to 1 Percent of Capacity Output, Starting in 1985: Deviations from Baseline

(As percent of baseline capacity output)

Year	German Variables							
	S	I	N	K	F	W	REEX 1/	R 2/
1985	-0.54	0.09	0.36	0.09	0.36	0.03	-7.90	-0.43
1986	-0.54	0.09	0.37	0.18	0.72	0.07	-2.83	-0.47
1987	-0.54	0.09	0.37	0.27	1.07	0.10	-2.67	-0.50
1988	-0.54	0.09	0.37	0.35	1.41	0.14	-2.53	-0.53
1989	-0.53	0.09	0.38	0.43	1.74	0.18	-2.40	-0.56
1990	-0.53	0.09	0.38	0.50	2.07	0.21	-2.28	-0.58
1991	-0.53	0.09	0.38	0.58	2.39	0.25	-2.17	-0.60
1995	-0.53	0.08	0.39	0.82	3.61	0.40	-1.80	-0.68
1999	-0.53	0.07	0.39	1.01	4.71	0.52	-1.53	-0.74
Long-run	-0.55	0.05	0.41	1.50	13.50	0.88	0.37	-0.84

Year	U.S. Variables				Japanese Variables			
	S	I	K	W	S	I	K	W
1985	0.03	0.07	0.07	0.03	0.03	0.05	0.05	0.03
1986	0.03	0.07	0.15	0.06	0.03	0.05	0.11	0.06
1987	0.04	0.07	0.22	0.10	0.04	0.05	0.16	0.10
1988	0.04	0.07	0.29	0.13	0.04	0.06	0.21	0.14
1989	0.04	0.07	0.35	0.17	0.04	0.06	0.26	0.17
1990	0.04	0.07	0.42	0.21	0.04	0.06	0.31	0.21
1991	0.04	0.07	0.48	0.24	0.04	0.05	0.35	0.25
1995	0.04	0.07	0.69	0.39	0.05	0.05	0.52	0.40
1999	0.05	0.07	0.87	0.52	0.05	0.05	0.66	0.54
Long-run	0.03	0.04	1.38	1.03	0.04	0.03	1.09	1.20

1/ Percentage deviation from baseline.
2/ Deviation from baseline, in percentage points.

Table 6. Simulation of a Japanese Fiscal Deficit Reduction Equal to 1 Percent of Capacity Output, Starting in 1985: Deviations from Baseline

(As percent of baseline capacity output)

Year	Japanese Variables							
	S	I	N	K	F	W	REEX 1/	R 2/
1985	-0.54	0.07	0.40	0.07	0.40	0.04	-3.31	-0.55
1986	-0.53	0.07	0.40	0.14	0.78	0.08	-2.02	-0.59
1987	-0.53	0.07	0.40	0.20	1.16	0.13	-1.91	-0.63
1988	-0.53	0.07	0.40	0.27	1.53	0.17	-1.81	-0.67
1989	-0.52	0.07	0.41	0.33	1.89	0.22	-1.72	-0.70
1990	-0.52	0.07	0.41	0.45	2.25	0.26	-1.63	-0.73
1991	-0.52	0.07	0.41	0.50	2.59	0.31	-1.54	-0.76
1995	-0.52	0.07	0.42	0.66	3.89	0.50	-1.22	-0.86
1999	-0.51	0.06	0.42	0.83	5.07	0.68	-0.93	-0.93
Long-run	-0.53	0.04	0.43	1.38	14.31	1.51	1.75	-1.06

	U.S. Variables				German Variables			
	S	I	K	W	S	I	K	W
1985	0.04	0.09	0.09	0.04	0.04	0.12	0.12	0.04
1986	0.04	0.09	0.19	0.08	0.04	0.12	0.23	0.08
1987	0.05	0.09	0.28	0.12	0.05	0.12	0.34	0.13
1988	0.05	0.09	0.36	0.17	0.05	0.11	0.44	0.17
1989	0.05	0.09	0.44	0.21	0.05	0.11	0.54	0.22
1990	0.05	0.09	0.53	0.26	0.05	0.11	1.64	0.27
1991	0.05	0.09	0.60	0.31	0.05	0.11	1.73	0.32
1995	0.06	0.09	0.88	0.49	0.06	0.10	1.03	0.54
1999	0.06	0.08	1.10	0.65	0.05	0.09	1.28	0.65
Long-run	0.04	0.05	1.75	1.29	0.03	0.06	1.90	1.12

1/ Percentage deviation from baseline.
2/ Deviation from baseline, in percentage points.

CHART 1

SIMULATED CHANGES IN REAL EXCHANGE RATES AND REAL INTEREST RATES IN RESPONSE TO A FISCAL DEFICIT REDUCTION, STARTING IN 1985, EQUAL TO 1 PERCENT OF CAPACITY OUTPUT IN THE COUNTRY CONCERNED

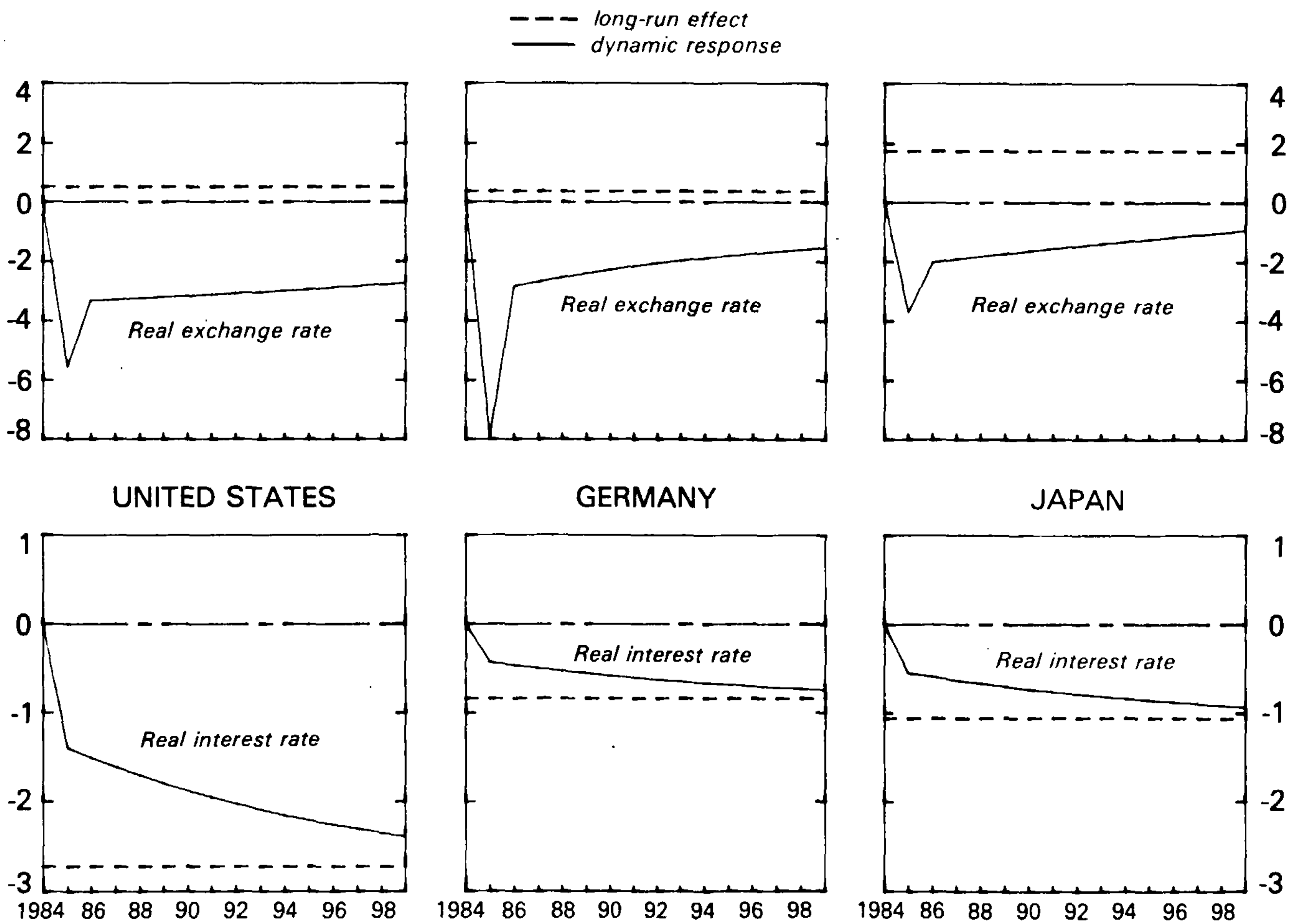
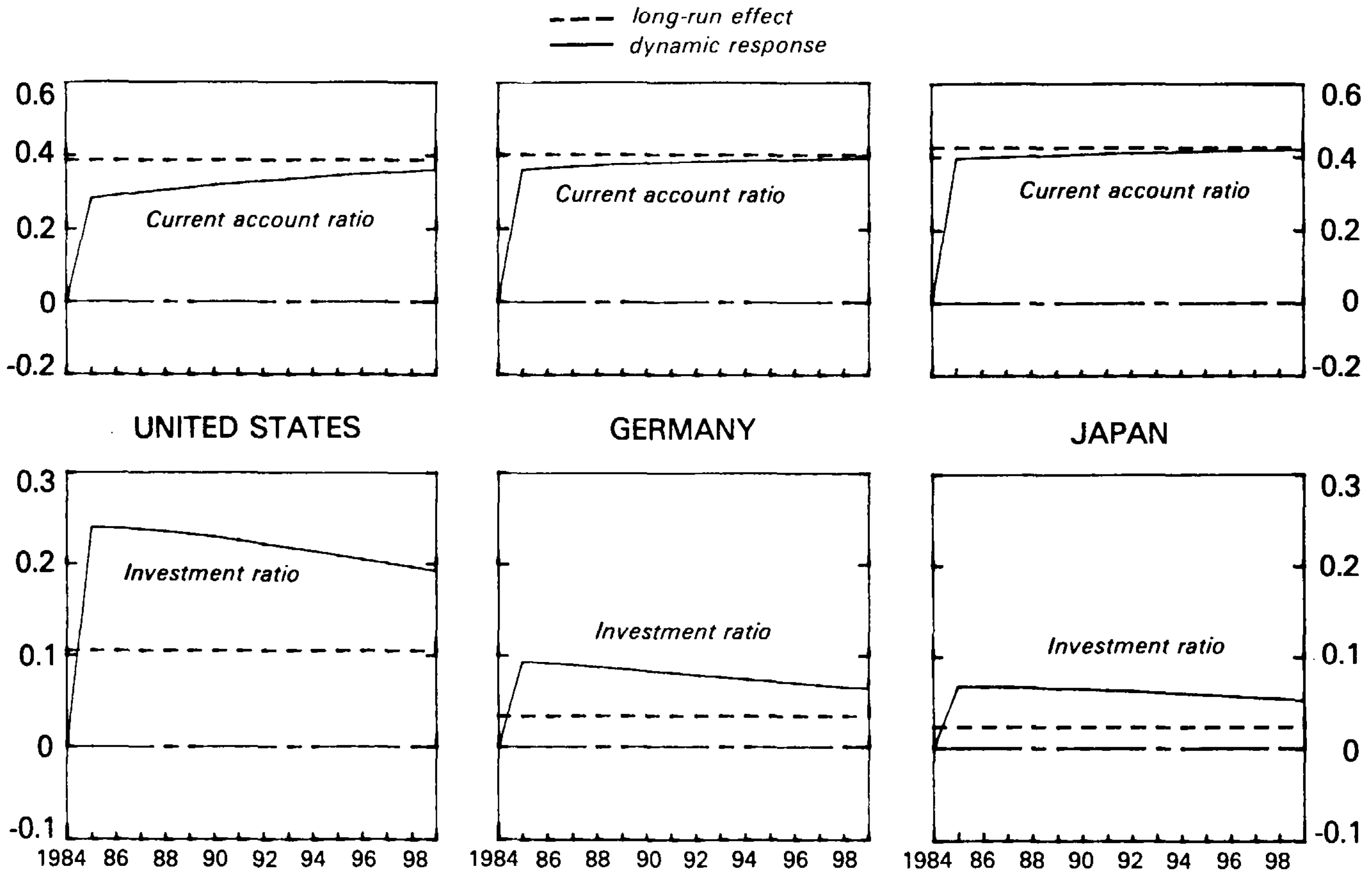


CHART 2

SIMULATED CHANGES IN CURRENT BALANCES AND PRIVATE INVESTMENT AS PERCENTAGES OF CAPACITY OUTPUT, IN RESPONSE TO A FISCAL DEFICIT REDUCTION, STARTING IN 1985, EQUAL TO 1 PERCENT OF CAPACITY OUTPUT IN THE COUNTRY CONCERNED



reduction in government dissaving, mainly owing to the direct offset of $(1-\phi)$ multiplied by the fiscal deficit--equal to 0.57 percent of capacity output. The effect on saving changes over time in response to two contrary forces: as the interest rate declines, target wealth increases, raising saving, but as wealth accumulation proceeds the positive effect on saving diminishes. Investment rises strongly, both on impact and in the long run, but not by enough to offset the increase in national saving resulting from the lower fiscal deficit. Consequently, the current account improves by an amount that expands over time to about 4/10 of 1 percent of capacity output and the net foreign claim position of the United States eventually rises by 13 percent of capacity output. As a result, net wealth of the U.S. private sector increases, both in the short run and in the long run, despite a fall in the government debt component--only a fraction of which (0.43) is part of wealth.

The real effective exchange rate displays interesting dynamics (Chart 1). It depreciates substantially on impact--in the case of a U.S. deficit reduction, the real effective exchange rate of the dollar depreciates by almost 6 percent--as the increase in net national saving, to be consistent with a corresponding excess of exports over imports, requires an improvement in competitiveness of that amount. However, the real exchange rate appreciates thereafter, and the improvement in competitiveness becomes attenuated as lags in the response of import and export volumes work themselves out; in addition, as the U.S. accumulates claims on foreigners its investment income account also improves, requiring less of a surplus on merchandise trade. By showing that the steady-state change in the real exchange rate may actually be in a direction opposite to the impact effects given by the simple model of Section II, the simulation model illustrates the importance of taking into account the effects of alternative policies on the rates of wealth and capital accumulation. It also demonstrates that overshooting of real exchange rates can occur not only in response to monetary shocks in the presence of sticky prices as in Dornbusch (1976), but also as the result of real shocks when there is slow adjustment of trade flows, a point emphasized in theoretical work by Dornbusch and Fischer (1980) and Frenkel and Rodriguez (1982).

The U.S. deficit reduction has consequences for the rest of the world through changes in other countries' exchange rates and interest rates. The decline in the latter stimulates investment and increases the equilibrium capital stock in Germany and Japan (Table 4). Private saving increases in both countries (though only slightly) and as a result the current account balance (here equal to changes in private saving minus investment, as the fiscal position has not changed) worsens in both countries in the short and medium run. The current balance of the rest of the world (not reported) also worsens as a result of the shock.

Given, among other assumptions, a common value of ϕ for the three countries, fiscal deficit reductions in Germany and Japan produce broadly similar patterns for the variables of interest (Tables 5 and 6). However, effects on domestic (and world) interest rates are smaller in response to a fiscal deficit reduction equivalent to 1 percent of capacity output. In contrast, the current account effects are considerably larger than for the United States, owing mainly to a smaller stimulus to private investment. It is also interesting to note that for Germany and Japan, as well as the United States, the long-run effect on the real exchange rate is opposite to its short-run effect. In the long run the real exchange rate appreciates in response to a shift to fiscal restraint because the resulting increase in the net foreign claims position improves the services account sufficiently that it must be offset by an appreciation, in order for net foreign claims to settle down to a constant proportion of capacity output (or of wealth). It need not necessarily be the case, however, that appreciation is the long-run outcome. For a given positive net claim position, the services account will tend toward deficit as interest rates decline. Thus it is possible that the services balance will deteriorate and the real exchange rate depreciate in the long run. Obviously, the sign of this long-run effect is dependent on a number of parameters, including investment and saving elasticities, whether the country is a net creditor or debtor, and the "economic size" of the country (see Sachs and Wyplosz 1984).

Equilibrium interest rates and exchange rates will also be affected by any measures that change the level of desired private saving or investment. Examples are changes in the perceived productivity of capital, tax incentives for saving, and provisions affecting the user cost of capital for given levels of interest rates. We will only consider the latter here: in 1981 and 1982, the United States implemented substantial changes to the tax treatment of depreciation that tended to lower the user cost of capital for nonresidential investment while a decline in personal tax rates increased the cost of capital for residential investment. These changes are embodied in the Economic Recovery Tax Act of 1981 (ERTA) and in the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA). Hooper (1984) cites estimates that as a result of these changes, the cost of capital relevant to investment in producers' durable equipment and structures fell by 1 percentage point and 3 percentage points, respectively (see also Brayton and Clark, 1985). On the other hand, the cost of capital for rental housing increased by an estimated 1/2 percentage point, and for owner-occupied housing, by 1 percentage point (Hooper 1984, p. 14). Averaged together, using shares in 1983 investment as weights, these changes yield a decrease in the cost of capital for overall investment equal to 1.25 percentage points.

The estimates cited above calculate the user cost of capital in the following way (see Brayton and Clark, 1985, p. 5):

(14) $C = [(1-t)R_n + \delta - \pi]D,$

where t = tax rate (corporate or personal)

R_n = nominal interest rate

δ = rate of economic depreciation

π = rate of change of the price of the investment good

D = a factor that depends on the tax treatment of depreciation and investment tax credits; for housing, D is equal to unity.

ERTA/TEFRA lowered the value of D for business investment and lowered the value of t for individuals. In order to simulate the effects of these changes on investment, we first calculate the changes in the interest rate, for given rates of inflation, that would have produced the same change in the user cost of capital. From equation (14) above, these changes are approximately

$$dR_n = \frac{1}{D(1-t)} dC$$

where t = .46 for corporations and t = .19 for individuals. 1/ If we average these implied changes in the real interest rate using investment shares, the same effect as the tax changes would have been produced through a real interest rate decrease of 2.0 percentage points. Table 7 presents the result of simulating the model in such a way that this change is embodied in the equation for U.S. investment; in particular, the constant term in that equation is decreased by 0.02 times the coefficient of the interest rate in that equation (with sign reversed). However, effects on government revenue are ignored here: the deficit is assumed unchanged in this simulation.

As would be expected, the decline in the user cost of capital stimulates investment in the United States and leads to a current account deficit there. In long-run equilibrium, both the U.S. capital stock and external indebtedness are permanently higher. The dynamics

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1/ The figures behind the calculations in Brayton and Clark (1985) were obtained directly from Flint Brayton.

Table 7. Simulation of U.S. Tax Changes Affecting the Cost of Capital, Starting in 1982: Deviations from Baseline

(As percent of baseline capacity output)

Year	S	I	N	K	F	W	REEX 1/	R 2/
1982	-0.08	0.15	-0.23	0.15	-0.23	-0.08	5.1	1.14
1983	-0.07	0.14	-0.21	0.28	-0.42	-0.14	2.2	1.10
1984	-0.05	0.14	-0.19	0.42	-0.61	-0.19	1.9	1.06
1985	-0.04	0.14	-0.18	0.55	-0.77	-0.23	1.5	1.02
1986	-0.03	0.13	-0.17	0.66	-0.92	-0.25	1.3	0.99
1990	0.00	0.12	-0.12	1.17	-1.43	-0.26	0.4	0.83
Long run	0.02	0.08	-0.06	2.59	-2.00	0.59	-0.6	0.42

	German Variables				Japanese Variables			
	S	I	K	W	S	I	K	W
1982	-0.08	-0.25	-0.25	-0.08	-0.08	-0.14	-0.14	-0.08
1983	-0.08	-0.22	-0.45	-0.16	-0.08	-0.13	-0.27	-0.16
1984	-0.08	-0.19	-0.63	-0.24	-0.08	-0.11	-0.37	-0.23
1985	-0.08	-0.16	-0.78	-0.31	-0.07	-0.10	-0.46	-0.30
1986	-0.07	-0.14	-0.90	-0.37	-0.07	-0.09	-0.54	-0.36
1990	-0.05	-0.07	-1.22	-0.60	-0.06	-0.05	-0.78	-0.60
Long run	-0.01	-0.02	-0.75	-0.44	-0.02	-0.02	-0.55	-0.60

1/ Percentage deviation from baseline.
2/ Deviation from baseline, in percentage points.

of adjustment produce an initial substantial rise in the real exchange rate of the dollar, and an increase in world real interest rates in excess of 1 percentage point. In long-run equilibrium, real interest rates are higher than in the baseline, but the exchange value of the dollar is close to its initial equilibrium. Higher interest rates discourage capital formation in the other countries, which are assumed not to benefit from greater investment incentives. Despite increased claims on the United States, wealth in Germany and Japan is lower than in the baseline.

As cited above, since 1981 there have been major changes in fiscal positions in the United States, Germany, and Japan, and our next set of simulation experiments imposes those changes on the model. Table 8 presents results of simulating model with exogenous values for fiscal deficits that differ from their baseline values by the amount that inflation-corrected general government deficits, DEF, changed relative to 1981. These figures, given in column 1 of Table 8, indicate a large move in the United States to fiscal expansion in 1982, and to fiscal contraction in Germany and (starting in 1984) in Japan. As can be seen from that table, the model implies that those fiscal changes would have produced a sustained real effective appreciation of the U.S. dollar, a comparable depreciation of the deutsche mark, and a modest, and delayed, depreciation of the yen. The model simulation implies a substantial deterioration of the U.S. current account--by some 1 percent of U.S. capacity output--and large improvements of current account positions in Germany and Japan, as ratios to their capacity outputs. Furthermore, the pattern of fiscal deficit is simulated to produce a rise in world interest rates by 4 percentage points in 1982, a further rise in 1983, and a net decline in 1984-85.

The path of interest rates and exchange rates will in principle depend on the form that expectations of exchange rates and interest rates take, and whether movements in those variables, by affecting the current valuation of wealth, are allowed to affect saving behavior. The model as it stands assumes that exchange rate expectations are exogenous; hence, given the convenient assumptions of perfect asset substitutability and flexible prices, real interest rate movements are equalized internationally. It also values asset stocks in such a way that relative price changes are not allowed to affect the real value of wealth. Knight and Masson (1985) show that loosening these assumptions does not make a major difference to either the qualitative or quantitative results of simulating the model's response to fiscal deficit shocks. A version of the model where expectations of exchange rates and interest rates are formed "rationally" (that is, where they are consistent with the model's predictions), where beginning-of-period stocks of real government debt are revalued as a function of changes in the real interest rate, and real net foreign claims are revalued as a function of changes in the real effective

Table 8. Simulation of Deficit Changes in the United States, Germany, and Japan for the Period 1982-1985: Deviations from Baseline

(As percent of baseline capacity output)

Country/ Date	DEF	S	I	N	REER 1/	R 2/
United States						
1982	2.88	0.37	-0.69	-0.82	16.6	4.02
1983	3.64	1.73	-0.82	-1.10	13.6	5.05
1984	2.71	1.31	-0.48	-0.92	6.3	3.47
1985	3.38	1.68	-0.49	-1.21	12.0	3.72
Germany						
1982	-0.63	-0.65	-0.87	0.85	-15.2	4.02
1983	-1.30	-1.12	-1.01	1.19	-10.6	5.05
1984	-1.54	-1.15	-0.58	0.97	-2.1	3.47
1985	-2.20	-1.55	-0.59	1.24	-9.2	3.72
Japan						
1982	0.37	-0.08	-0.50	0.05	0.1	4.02
1983	0.33	-0.18	-0.60	0.09	0.2	5.05
1984	-0.62	-0.61	-0.36	0.37	-2.0	3.47
1985	-1.68	-1.24	-0.37	0.81	-4.7	3.72

1/ Percentage deviation from baseline.
2/ Deviation from baseline, in percentage points.

exchange rate, gives very similar results for most variables, including exchange rates, at least when the fiscal changes occur all at once, at the beginning of the simulation period. The major difference is that interest rates in the three countries are uncoupled, so that a country implementing a fiscal expansion has real interest rates that are higher than elsewhere, and conversely for countries implementing fiscal contraction. With a path of deficit changes that grows over time, rational expectations of financial variables would likely bring forward the effects on exchange rates and interest rates, but, on the basis of our previous results, would be unlikely to change their magnitudes greatly.

In Table 9, we combine the effects of the decrease in the user cost of capital in the United States with the pattern of deficit changes that was simulated in Table 8. The results indicate substantial movements in exchange rates relative to baseline among the three countries, and an increase in interest rates that reaches 6 percentage points in 1983. This increase more than offsets the effect of investment incentives in the United States, and U.S. investment declines relative to baseline.

The issue of how much of the dollar's strength can be attributed to fiscal policy shifts, and the extent to which such fiscal changes also explain high real interest rates both in the United States and elsewhere, has been addressed in several recent papers. Blanchard and Summers (1984) consider a number of explanations for high real interest rates, among them fiscal deficits. They argue that even though the U.S. deficit shows an increase of 3.9 percentage points of GNP over the period 1978-85, 1/ fiscal contraction in other countries implies an increase of only 0.8 percentage points for the six largest OECD countries (Blanchard and Summers 1984, p. 298). Adjusting deficits for inflation and for cyclical position and allowing for anticipated future deficits leads them to conclude: "on balance, therefore, we find no evidence that fiscal policy in the OECD as a whole is responsible, through its effect on saving, for high long real rates." (Blanchard and Summers 1984, p. 302).

Another recent paper examines the consequences of the "Mundell-Reagan mix of fiscal expansion and monetary contraction" (Sachs 1985, p. 119), in particular its effect on the U.S. dollar. Simulations of a small global macroeconomic model, as well as other evidence presented by Sachs, tends to support the view that the U.S. monetary/fiscal policy mix--even accompanied by fiscal contraction in the rest of the OECD--goes a long way toward explaining developments in financial and exchange markets in the last few years. The model simulation assumes "a sustained U.S. debt-financed fiscal expansion of 4 percent of GNP; a sustained ROECD [rest

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1/ Figures for 1984-85 were taken from OECD estimates.

Table 9. Simulation of Deficit Changes in the United States, Germany, and Japan for the Period 1982-1985, and U.S. Tax Changes Affecting the Cost of Capital, Starting in 1982: Deviations from Baseline

(As percent of baseline capacity output)

Country/ Date	DEF	S	I	N	REER 1/	R 2/
United States						
1982	2.88	1.29	-0.54	-1.05	21.3	5.16
1983	3.64	1.66	-0.67	-1.31	15.4	6.14
1984	2.71	1.25	-0.34	-1.11	7.6	4.52
1985	3.38	1.64	-0.35	-1.39	12.9	4.73
Germany						
1982	-0.63	-0.74	-1.12	1.01	-18.0	5.16
1983	-1.30	-1.20	-1.23	1.32	-0.4	6.14
1984	-1.54	-1.23	-0.77	1.07	-1.7	4.52
1985	-2.20	-1.62	-0.75	1.32	-8.6	4.73
Japan						
1982	0.37	-0.16	-0.64	0.11	-0.3	5.16
1983	0.33	-0.26	-0.72	0.13	0.2	6.14
1984	-0.62	-0.69	-0.48	0.41	-1.8	4.52
1985	-1.68	-1.31	-0.47	0.84	-4.4	4.73

1/ Percentage deviation from baseline.
2/ Deviation from baseline, in percentage points.

of the OECD area] fiscal contraction of 2 percent of ROECD GNP; a substantial tightening of U.S. monetary policy; and no change in ROECD monetary policy... The dollar appreciates by 39.4 percent relative to the ECU, and U.S. short-term real interest rates rise by 8.0 percentage points relative to abroad." (Sachs 1985, p. 174).

Our results imply effects on the exchange rate of the dollar and on real interest rates that are somewhat smaller than those of Sachs. When inflation-adjusted deficit changes are simulated in the three countries in combination with tax-induced changes in the user cost of capital in the United States, the peak dollar appreciation relative to baseline is 21 percent in real effective terms, and the peak real interest rate increase is 6 percentage points. Since we do not take account of the tightening of U.S. monetary policy in 1980-81, we do not expect to account fully for the rise in interest rates and in the value of the dollar that was observed in the first half of the 1980s. However, our model does seem to explain a substantial portion of observed movements. From its trough in 1980 to the peak of early 1985, the dollar appreciated by 57 percent, of which 37 percent from the end of 1981; real short-term interest rates were about 4 percentage points higher, and long-term rates about 8 percentage points higher, than in 1980 (International Monetary Fund, 1985, pp. 8 and 18). Furthermore, our results cannot be said to support the view of Blanchard and Summers that there is no link between fiscal policies and high real interest rates, or by implication, with the pattern of exchange rates cited above. All in all, if one accepts the size of the fiscal shifts assumed by the simulation, then the view that fiscal policy changes help to explain the direction and rough order of magnitude of the net movements in real interest rates and real exchange rates of the three largest industrial countries in the 1980s receives strong support.

V. Summary and Conclusions

In order to offer a comprehensive explanation of the relation between the real exchange rate and the balance of payments, it is necessary to evaluate three interrelated mechanisms: the effect of changes in competitiveness on the current account; the impact of shifts in interest rates, expectations and other factors on international asset portfolios; and the effect of autonomous changes in the saving-investment balance on the level of desired capital transfers among countries. Both the qualitative and quantitative aspects of the first mechanism have been thoroughly investigated over the last 20 years and are well understood. The theoretical aspects of the second mechanism have been analyzed extensively since the mid-1970s, with the development of portfolio balance models of exchange rate determination. Although the problems of specifying the determinants of exchange rate expectations have led to intractable empirical difficulties, these models have provided many important insights into the process of exchange rate determination. The purpose of this paper has been to suggest that the final mechanism, saving-investment shifts, may also yield important insights into the behavior of real exchange rates, particularly at times that are dominated by major autonomous disturbances in the medium-term flows of national saving and investment, or in preferences regarding net international capital transfers. A number of points are worth noting in the context of this argument.

First, as Section II has served to show, the theoretical underpinnings of the latter mechanism are to be found in the neoclassical theory of international capital transfers. In focusing on the response of real capital movements to disturbances in national saving-investment balances, this explanation implies quite a different set of causal linkages between the exchange rate and the current account than does the more popular explanation based on the responsiveness of import and export demands to autonomous changes in relative prices. At times when economic developments are dominated by large autonomous changes in national saving and investment balances--particularly those induced by shifts in public sector fiscal positions--the exchange rate and current account effects of such disturbances may be expected to exert an overriding influence on the level of the real exchange rate.

The empirical model described in Sections III and IV tends to confirm the view that the directions and orders of magnitude of movements in real exchange rates and real interest rates in major industrial countries are related to shifts in fiscal positions in the manner we have described. Our estimated saving equations imply that changes in fiscal deficits are not offset one-for-one by changes in private saving; consequently, these fiscal shifts require equilibrating movements in the pattern of real exchange rates, and, to the extent that the global balance between saving and investment has altered, in the level of real interest rates. The magnitude of the resulting exchange rate and interest rate movements depends on a number of factors; the model includes estimated investment functions and merchandise trade equations for the three major industrial countries as well as an equation explaining aggregate saving (net of investment) by the rest of the world. Simulated changes in fiscal deficits equal to 1 percent of a country's capacity GDP--well within historical experience--produce, in our model, sizable movements in these interest rates and exchange rates. The model predicts that the exchange rate movements are largest when the fiscal change is first implemented, and are later reversed as trade flows adjust gradually to relative prices and as asset stocks--physical capital, government debt, and claims on foreigners--move over time to their new equilibrium levels. The eventual equilibrium change of the real exchange rate in response to a fiscal contraction may involve either an appreciation or a depreciation, depending on the ultimate effect of the shock on the balance on investment earnings from abroad.

In an attempt to compare these movements with recent experience, we subjected the model to fiscal policy shifts broadly similar to those that have occurred in three major industrial countries from 1981 to 1985, namely a move to fiscal expansion in the United States and fiscal restraint in the Federal Republic of Germany and in Japan, as well as tax measures that have had the effect of lowering the cost of capital in the United States. The size of the simulated response of exchange rates and of real interest rates is a sizable fraction of the changes observed over that period. However, it is clear that other factors not captured by the model, such as cyclical effects, uncertainty about the future stance of fiscal policy, "safe havens," and monetary policy effects, are part of a more complete explanation.

The model may nevertheless help in evaluating whether observed exchange rate patterns are related to fundamental policy factors, rather than to portfolio shifts or the volatility of expectations. A crucial issue in macroeconomic policy is that of determining the pattern of current account balances and real exchange rates among industrial countries that would be sustainable in the medium term (Artus and Knight 1984). Standard portfolio balance models have not yielded many practical insights into this problem. The present model, because it considers saving and investment decisions in the context of longer-term asset stock equilibrium, may help to evaluate sustainable levels of current accounts and real exchange rates, and to indicate how they depend on one important set of determinants, the stance of fiscal policies in major countries.

Data Sources

Except where noted otherwise, all flow data are taken from the national accounts of the country concerned. Sources: Data Resources Inc. (DRI) for the United States; and Organization for Economic Cooperation and Development (OECD) National Accounts, 1960-77 and 1971-83, for the Federal Republic of Germany and Japan. Real flows and stocks are valued at 1980, local currency prices.

Variables for the United States, The Federal Republic of Germany and Japan (i = US, GE, JA)

B_i = real government net debt, calculated by cumulating general government fiscal deficits from benchmark figures, based on debt/GDP ratios in 1982 (Muller and Price 1984): 23.6 percent for the United States, 23.4 percent for Japan, and 19.8 percent for the Federal Republic of Germany. The net debt series was then divided by the GDP deflator.

DEF_i = real general government deficit corrected for inflation, calculated as $B_i - B_i(-1)$

F_i = real net foreign asset position, calculated by cumulating N_i, using benchmark figures for nominal net claims on foreigners valued in local currency at the end of 1982, and divided by the 1982 GDP deflator. For the United States, the benchmark is $149.5 billion (Department of Commerce, Survey of Current Business, June 1984, p. 75); for Germany DM 66.5 billion (Monthly Report of the Deutsche Bundesbank, October 1984, p. 35); and for Japan $24.7 billion (Bank of Japan, Economic Statistics Annual, 1983, p. 248).

GAP_i = output gap, as a percentage of capacity output: equals actual GDP divided by capacity output (YC_i) minus one. As YC_i is calculated, GAP_i is the same as the output gap in manufacturing (Artus 1977).

$GAPF_i$ = foreign output gap: actual GDP for 9 industrial countries (excluding the country concerned) divided by the corresponding potential output, minus one. The set of 10 countries is the United States, Japan, Germany, the United Kingdom, France, Italy, Canada, Belgium, the Netherlands, and Sweden.

I_i = real private net investment, residential plus nonresidential.

K_i = real private net capital stock. For the United States it was calculated as the sum of the nonresidential and residential real stocks, minus the government residential stock

(Source: DRI). For the Federal Republic of Germany and Japan, K_i was calculated by cumulating I_i using a benchmark figure. For the Federal Republic of Germany this figure was the 1970 total net capital stock minus the 1970 government capital stock (OECD, Flows and Stocks of Fixed Capital, 1955-80). For Japan, where a real net capital stock figure was not available, preliminary estimation of an investment equation chose the value of the 1960 capital/GDP ratio (3.18) that maximized the fit of the equation.

MV_i = volume of non-oil merchandise imports, in real, local-currency terms. Source: International Monetary Fund.

N_i = national accounts net exports of goods and services divided by the GDP deflator.

R_i = real long-term interest rate, calculated as the nominal long-term government bond rate (Source: IMF, International Financial Statistics) minus the percentage change in the GDP deflator. The result was divided by 100 to get an interest rate expressed as a decimal fraction.

$REEX_i$ = real effective exchange rate index, 1980 = 1 (increase indicates appreciation); calculated as the country's normalized unit labor costs (NULC) relative to a weighted average of its competitors' NULC, in a common currency (Source: IMF, International Financial Statistics).

RES_i = Residual current account item, equal to the oil trade balance, the balance on services excluding investment income, and unilateral transfers. Calculated as $N_i - XV_i + MV_i - R_i * F_i(-1)$.

S_i = real net private saving, calculated as $N_i + I_i + DEF_i$.

W_i = real private sector net wealth, calculated as $\phi_i * B_i + K_i + F_i$.

XV_i = volume of non-oil merchandise exports, in real, local-currency terms. Source: International Monetary Fund.

YC_i = capacity GDP: calculated by applying the gap between actual and potential manufacturing output (Artus 1977) to actual GDP.

Variables for Germany and Japan:

$ERDOT_i$ = expected rate of change of the bilateral real exchange rate against the U.S. dollar (depreciation, if positive): calculated as $R_{US} - R_i$.

Variables for the Rest of the World (ROW)

NROW = proxy for the ROW real current balance, calculated as -(NUS + NGE/1.815 + NJA/225.82): denominators contain 1980 bilateral rates against the dollar of the deutsche mark and the yen.

RROW = real interest rate, calculated as a GDP-weighted average of R_{US}, R_{GE}, and R_{JA}.

YCROW = capacity output, in 1980 U.S. dollars, calculated by aggregating the remaining 7 out of our sample of 10 industrial countries.

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