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2 The Effects of Commercial, Fiscal, Monetary, and Exchange Rate Policies on the Real Exchange Rate

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2.1 Introduction

Adjustments of nominal exchange rates provide a mechanism through which the general level of prices in one country may be modified to correspond to the general level of prices in other countries. This mechanism thus serves to neutralize the real effects of differential monetary disturbances in different countries. In contrast, the principal effect of commercial policies is on the relative prices of goods entering into international trade and hence on the allocation of real resources among sectors of the economy. Despite this fundamental difference between the prime mission and basic purpose of nominal exchange rate adjustments and commercial policies, it has long been recognized that exchange rates can, in some circumstances, be manipulated to affect relative commodity prices and thereby replicate many of the effects of commercial policies.

In the past, observers have recognized three important channels through which policies designed to modify exchange rates can influence relative commodity prices in a manner similar to that achieved by commercial policies. First, systems of multiple exchange rates in which different nominal exchange rates are applied to different categories of imports and exports are known to be essentially equivalent to a system of import and export taxes and subsidies. (The standard reference on this subject is Bhagwati 1968; see also Corden 1971, chap. 4; and Corden 1967.) Second, in the presence of rigidities or stickiness in the nominal prices of domestic goods or of goods entering into international

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trade, or in the wages of factors employed in producing these goods, movements in the nominal exchange rate, even under a unified exchange rate regime, clearly have the capacity to affect relative commodity prices and influence the allocation of resources. This assumption is explicitly or implicitly employed in many of the earlier analyses of the effects of devaluation, including the classic contributions of Meade (1951), Harberger (1950), Machlup (1955), and Tsiang (1961). It is also the fundamental source of the real effects of nominal exchange rate changes in the more recent analyses that assume only temporary stickiness of nominal wages or prices, such as Dornbusch (1976; 1980), Buiter and Miller (1983), and Mussa (1977; 1982a; 1984). Third, even with a unified exchange rate and without nominal price or wage stickiness, government policies that affect either the distribution of expenditures among goods or the level of spending relative to income are known to have some capacity to influence the "real exchange rate," defined as the relative price of one country's output in terms of another country's output. This idea is clearly present in the work of Meade (1951), Pearce (1961), and Corden (1960), as well as in more recent contributions, such as Dornbusch (1975) and the literature on the "Dutch disease."

The purpose of this paper is to explore in a more explicitly dynamic framework the third of these channels. Section 2.2 describes and discusses the model of the real sector of the economy that is used as the basis for this exploration. This model is consistent both with the two-country, two-commodity model of real trade theory (modified to allow for differences between spending and income in the home country) and with the "dependent economy" model. The basic equations of this model are specified in a log-linear form that permits easier manipulation of the dynamic version of the model in the subsequent sections of the paper. In this model, as in the standard trade theory model, the equilibrium value of the (logarithm of the) relative price of domestic goods in terms of foreign goods is consistent with any given value of the trade balance of the home country, for given values of the exogenous parameters and policy variables that influence domestic and foreign demand for domestic and foreign goods. This relative price is identified with the concept of the real exchange rate. It is shown that the standard results of real trade theory apply with respect to the comparative statics effects of various government policies on this relative price. In particular, imposing a tariff on imported goods in the home country lowers the relative price of domestic goods in terms of foreign goods in that country. This result is taken as representative of the effects of commercial policy on the real exchange rate. A shift in spending by either domestic or foreign residents toward foreign goods at the expense of domestic goods (perhaps induced by government policy) has a similar qualitative effect on the real exchange rate. So, too, does a transfer of purchasing power from domestic residents to foreign residents, which results in a trade-balance surplus for the home country. This result reflects the assumption that domestic residents have a positive marginal propensity to spend on domestic goods, whereas foreign residents have a zero marginal propensity to spend on the home country's domestic goods.

In section 2.3 the model is extended to allow for the endogenous determination of differences between income and spending by domestic residents as a function of both their net asset holdings and the domestic real interest rate. Equilibrium in the balance of payments requires that this difference between income and spending by domestic residents equal the current-account balance, which is the trade balance determined by the real sector model of section 2.2 augmented by real interest income on net foreign asset holdings. This balance-of-payments equilibrium condition provides the basis for a comparative statics analysis of the effects of a variety of government policies on the real exchange rate. This comparative statics analysis, however, ignores the dynamic repercussions of expected changes in the real exchange rate and in the path of private net asset holdings.

In section 2.4 these dynamic considerations are taken into account and a solution is provided for the complete dynamic version of the model developed in the previous two sections. The solution reveals that the equilibrium value of the real exchange rate at any moment depends on expectations concerning the exogenous factors that will influence the trade balance in all future periods (including government commercial policies) and on expectations concerning the exogenous factors that will influence the desired relationship between income and spending in all future periods. For constant values of these exogenous influences, the dynamic behavior of the real exchange rate is driven by a process of adjusting the private stock of net foreign assets in a manner similar to that delineated in several recent models of the relationship between the exchange rate and the current account.

In section 2.5 this dynamic model is applied to an analysis of government fiscal policies. A temporary shift in government spending toward domestic goods at the expense of government spending on foreign goods initially appreciates the real exchange rate (raises the relative price of domestic goods), but to a smaller extent than would a permanent spending shift of the same magnitude. This temporary spending shift also induces a temporary current-account surplus and an increase in private net asset holdings, which in turn moderate the immediate effect of the spending shift on the real exchange rate by spreading some of its effect into periods after the spending shift itself has ended. A similar mechanism operates in the case of a permanent spending shift that is expected to occur at some future date. Because private agents anticipate the effect of this future spending shift on the real exchange rate, the actual real exchange rate and the level of private net asset holding react in advance of the actual start of the spending shift. A temporary general fiscal expansion, financed by an increase in government debt, is also shown to appreciate the real exchange rate in the short run, even though private agents may correctly forecast the future taxes that will be necessary to pay the interest on the expanded government debt. As with the temporary spending shift, this temporary fiscal expansion causes a temporary increase in private net asset holdings, which assists in spreading out over time the effects of this fiscal expansion on the real exchange rate. In the long run, the temporary fiscal expansion depresses the real exchange rate because the higher taxes necessary to finance the interest on the expanded government debt depress demand for domestic goods.

Section 2.6 considers the effects of capital controls. These controls can influence the real exchange rate by affecting the permissible difference between spending and income and hence the level of the current-account balance. It is argued, however, that capital controls have only a limited capacity to affect the long-run average level of the real exchange rate. Their principal effect is to influence the responsiveness of the real exchange rate to various forms of economic disturbances. In general, a capital control that fixes the permissible value of the current-account balance increases the sensitivity of the real exchange rate to disturbances (such as changes in commercial policies) that shift spending between domestic and foreign goods; but it reduces the sensitivity of the real exchange rate to disturbances that affect the general level of spending relative to income.

Section 2.7 presents an analysis of how monetary policy and nominal exchange rate policy can interact to influence the behavior of the real exchange rate. In the present model, which assumes full flexibility of all nominal prices, monetary policy cannot influence the real exchange rate when the nominal exchange rate is fully flexible. Similarly, nominal exchange rate policy cannot influence the real exchange rate when the domestic money supply is allowed full flexibility to adjust to official settlements surpluses and deficits. A policy that fixes a path for both the nominal money supply and the nominal exchange rate, however, can influence the real exchange rate and other real variables by affecting the behavior of the real money supply. To support such a combination of monetary policy and exchange rate policy, a government usually must intervene in the foreign exchange market on a sterilized basis. Such intervention necessarily implies differences between government spending and government revenue that are the fiscal effect of sterilized intervention. In the absence of full Ricardian equivalence between debt financing and tax financing of government expenditure, this fiscal effect of sterilized intervention provides a channel through which the combination of monetary and nominal exchange rate policies can affect the real sector of the economy and, in particular, the real exchange rate.

One example of such a combination of monetary and exchange rate policies is one that simultaneously fixes a level of the domestic money supply and pegs a value of the nominal exchange rate. In general, such a policy combination is dynamically unstable because the stock of government debt required to finance official intervention in support of the policy expands exponentially. This dynamic instability implies that a continued belief in the viability of such a policy combination by private asset holders is inconsistent with rational expectations—an assumption that is employed in the dynamic model developed in section 2.4. To deal with this difficulty, I assume that private agents foresee the possibility of a change in the nominal exchange rate and relate the probability of such a change and its expected magnitude to the cumulative extent of official intervention in support of the current nominal exchange rate. Under this assumption, it is shown that so long as the assessed probability of an immediate parity change remains negligible, the real exchange rate is influenced by the combination of fixed nominal money supply and the pegged nominal exchange rate in exactly the same way as if private agents never foresaw any prospect of a change in the exchange rate. When the cumulative extent of official intervention reaches the point at which people begin to suspect a significant probability of a parity change in the near future, the nature of the dynamic system is modified. The flow of intervention required to support the existing nominal exchange rate begins to accelerate, and the real exchange that was previously held constant by a constant money supply and nominal exchange rate begins to rise, in the case of a prospective devaluation, or fall, in the case of a prospective appreciation. Ultimately, there is a change in the nominal exchange rate and an adjustment of the real exchange rate to the level that is appropriate for the new nominal exchange rate and the size of the domestic money supply.

With slight modifications, this analysis also applies to a policy that fixes the rate of growth of the domestic money supply and the rate of crawl of the nominal exchange rate, with occasional major changes in the nominal exchange rate used to correct persistent payments imbalances. The behavior pattern of the real exchange rate, of the current-account balance, and of other related variables under this combination of policies is reminiscent of the experiences of some developing countries.

The paper concludes with a brief restatement of its main contribution to the literature and a discussion of the broader range of issues to which its analytical framework might be applied.

2.2 Goods Market Equilibrium, the Trade Balance, and the Real Exchange Rate

Consider a moderate-sized country that produces and consumes two goods: a domestic good that is different from goods produced in the rest of the world, and a traded good (sometimes referred to as the imported good or foreign good) that is identical to goods produced in the rest of the world. This country exports some of its domestic good to the rest of the world and imports some of the traded good from the rest of the world. In addition, the country trades securities, denominated in units of traded goods, with the rest of the world.

The country under consideration is assumed to be small with respect to world trade in traded goods and securities in the sense that it takes as given the real interest rate in the world securities market for securities denominated in traded goods, r^*. This interest rate is independent of the flow or stock amount of the borrowing and lending the country engages in to finance the difference between the value of its exports of the domestic good and the cost of its imports of the traded good. The country is not small, however, with respect to the market for its domestic good. Rather, it faces a foreign demand for this good that is less than infinitely elastic with respect to the relative price of this good in terms of the traded good. Specifically, the value of foreign excess demand for the domestic good (measured in units of the traded good) is given by:

$$d^* = -\beta^* q^* + x^*, \tag{1}$$

where q^* is the (logarithm of the) relative price of the domestic good in terms of the traded goods available to foreign purchasers; $\beta^* > 0$ measures the sensitivity of foreign demand for the domestic good to variations in q^*; and x^* summarizes the exogenous factors affecting foreign demand for the domestic good. Since $\beta^* > 0$, the relative price elasticity of foreign demand for the domestic good, $\eta^* = d[\log(d^*)]/dq^* = -(\beta^*/d^*) - 1$ is negative.

Production possibilities in the home country are described by a smooth, convex transformation curve, with the implication that the supply of the domestic good is an increasing function of its relative price, whereas the supply of the traded good is a decreasing function of that relative price. Domestic demand for the domestic good is a decreasing function of its relative price, and domestic demand for the traded good is an increasing function of that relative price. Domestic demand for each good is an increasing function of total domestic spending. This standard specification of supply and demand conditions in the home country is consistent with the following log-linear specification of domestic excess demand for traded goods, f, and of the value (in terms of the traded good) of domestic excess demand for the domestic good, d, such that:

$$f = \beta q - x + (1 - \sigma)\psi \tag{2}$$

$$d = -\beta q + x + \sigma\psi. \tag{3}$$

In these excess demand functions, q denotes the logarithm of the price of the domestic good relative to the price paid for the traded good by domestic producers and consumers; $\beta > 0$ measures the sensitivity of these excess demands to changes in q; σ and $1 - \sigma$ are the shares of the domestic good and the traded good, respectively, in domestic spending; ψ is the excess of domestic spending over the value of the domestic product; and x summarizes the exogenous factors affecting domestic excess demands for the domestic and traded goods (including tastes, production possibilities, and government policies). Note that the total value of domestic excess demand for both goods, $d + f$, must equal the excess of domestic spending over the value of the domestic product, ψ. Note also that changes in q or x, holding ψ constant, must have offsetting effects on d and f. Note finally that since β is assumed to be positive, the relative price elasticity of domestic demand for imports of the traded good, $\eta = -\beta/f$, is negative.

The relative price of the domestic good confronting domestic residents differs from the relative price confronting foreign residents when the government of the home country imposes an ad valorem tariff on imports of traded goods or, equivalently, an ad valorem tax on exports of domestic goods. Formally, the effects of such commercial policies are indicated by the following relationship:

$$q^* = q + \tau, \tag{4}$$

where τ is the logarithm of one (1) plus the ad valorem tax rate on either imports of the traded good or exports of the domestic good.

With this commercial policy in force, the condition for equilibrium in the market for the domestic good that must be satisfied at all times is expressed by:

$$0 = d + d^* = -(\beta + \beta^*)q + (x + x^* - \beta^*\tau) + \sigma\psi. \tag{5}$$

Further, at all times, the trade balance of the home country is the excess of the value of its exports of the domestic good, d^*, over the value of its imports of the traded good; that is:

$$T = -(\beta + \beta^*)q + (x + x^* - \beta^*\tau) - (1 - \sigma)\psi. \tag{6}$$

From equations (5) and (6), we arrive at the conclusion:

$$T = \nu(z - q) = -\psi, \tag{7}$$

where $\nu \equiv (\beta + \beta^*)/\sigma$, and $z = (x + x^* + \beta^*\tau)/(\beta + \beta^*)$. This result expresses the equivalence between the absorption and elasticities approaches to analyzing the trade balance. According to the elasticities approach, the trade balance depends on the terms of trade (represented by q) through the relationship $T = \nu(z - q)$. According to the absorption approach, the trade balance equals the excess of the value of the domestic product over the domestic expenditure, that is, $T = -\psi$.

It is worthwhile to emphasize that this result concerning the trade balance and the equations that underlie it are consistent with several possible specifications of the production structure of the economy. One specification is that of the standard two-country, two-commodity model described in the pure theory of international trade (summarized, for instance, by Mundell 1968, chaps. 1–3). In this specification, both the domestic good and the foreign good are produced (as well as consumed) in the home country, and the domestic good is distinguished only by the fact that it is exported by the home country. Another specification, one more commonly used in two-country, macroeconomic models (see Mussa 1979 and the references cited there), states that the home country produces only its domestic good and the rest of the world produces only the foreign good. A third specification is the "dependent economy" model developed by Salter (1959) and Swan (1960), which has been widely applied in both trade theory and open economy macroeconomics. In this specification, the domestic good is a nontraded good that is produced and consumed exclusively within the home country (d^* therefore is equal to zero), while the foreign good is an internationally traded good that is produced and consumed in the home country and may be either imported or exported depending on whether the home country has a trade deficit or a trade surplus. All of the analysis in this paper is consistent with all three of these specifications of production structure, though the interpretation of some results depends on the particular specification one has in mind.

The standard results of the real theory of international trade concerning the effects of import tariffs or export taxes and transfers paid to residents of the home country (usually derived in the standard two-country, two-commodity model) are obtained by applying implicit differentiation to equation (7) and evaluating the results where $T = 0$, such that:

$$dq/d\tau = -\beta^*/(\beta + \beta^*);\ dq^*/d\tau = \beta/(\beta + \beta^*) \tag{8}$$

$$dq/d(-\psi) = dq^*/d(-\psi) = \sigma/(\beta + \beta^*). \tag{9}$$

The positive value of the denominator in (8) and (9), $\beta + \beta^*$, reflects the fact that the Marshall-Lerner condition is satisfied; that is, the sum of the import demand elasticities plus one (1) is negative, such that:

$$(10) \quad \eta + \eta^* + 1 = (-\beta/f) + [(-\beta^*/d^*) - 1] + 1 \\ = -(\beta + \beta^*)/f < 0.$$

Equation (8) expresses the standard result that a tariff on traded goods imported into the home country reduces the relative domestic price of domestic goods (increases the relative domestic price of traded goods) and increases the relative foreign price of domestic goods. (See, for example, Mundell 1968, chap. 3.) Equation (9) says that a transfer received by residents of the home country (which allows an excess of domestic spending over domestic income, represented by a positive value of $-\psi$) pushes up the relative price of domestic goods. This positive effect of a transfer received (and spent) by domestic residents on the relative price of domestic goods reflects a determinate sign of the transfer problem criterion (see again Mundell 1968, chap. 2) that arises because the marginal propensity of domestic residents to spend on domestic goods is positive, whereas the marginal propensity of foreigners (who pay the transfer) to spend on domestic goods is zero.

For the purposes of this discussion, equation (8) is a key result that summarizes the basic mechanism through which commercial policy works its effects on the economy. Specifically, changes in commercial policy, represented by changes in τ, affect the relative price of domestic goods and thereby affect all of the production and consumption decisions that are influenced by this relative price. If the relative price of domestic goods is defined as the "real exchange rate," it follows that other policies can replicate the effects of commercial policy to the extent that they have similar effects on the real exchange rate.

There are two general mechanisms through which economic policies may have such effects on the real exchange rate. First, economic policies can affect the exogenous shift variable, x, that appears in the domestic excess demand functions and perhaps also the exogenous shift variable, x^*, that appears in the foreign excess demand function for the domestic good. Formally, the effects of changes in x and x^* on q are obtained by implicit differentiation of the trade balance equilibrium condition, $T = \nu \cdot (z - q) = 0$, such that:

$$(11) \quad dq/dx = dq^*/dx = 1/(\beta + \beta^*); \; dq/dx^* = dq^*/dx^* = 1/(\beta + \beta^*).$$

For example, a shift of government spending in the home country away from domestic goods and toward domestically produced traded goods induces a decrease in x and implies a decrease in q that is similar to that induced by an increase in the tariff rate. Alternatively, a tax-financed increase in government spending directed toward traded goods induces a decrease in x because the reduction in private sector spending resulting from the tax increase is spread over both domestic and traded goods. Second, as indicated by equation (9), economic policies can affect the real exchange rate by altering the difference between domestic spending and domestic income. Specifically, any policy that reduces domestic spending relative to domestic income (holding x, s^*, and τ constant) will reduce q and replicate the effects of an increase in the tariff rate on imports of traded goods. Further investigation of this mechanism through which economic policies can affect the real exchange rate and thereby replicate many of the effects of commercial policy is the principal subject of the remainder of paper.

2.3 Balance-of-Payments Equilibrium and Comparative Statics

To analyze policies that affect the real exchange rate by influencing the difference between spending and income, we must specify the determinants of differences between spending and income and describe the condition of balance-of-payments equilibrium. This equilibrium condition may then be employed to provide an initial comparative statics analysis of the effects of a variety of policies on the real exchange rate.

Suppose that the desired excess of private spending over private income for the country under consideration is given by:

$$h = \mu A - \alpha r + u, \tag{12}$$

where h measures the excess of spending over income in terms of traded goods; A is the net stock of privately held assets denominated in traded goods; r is the real rate of return that domestic residents expect to earn on their net asset holdings; u summarizes the exogenous factors affecting h (including some government policies); and $\mu > 0$ and $\alpha > 0$ are parameters indicating the responsiveness of h to variations in A and r. Since privately issued securities net out against privately held securities, net private securities holdings must consist of securities issued by foreigners (or debts owed to foreigners if $A < 0$) or holdings of bonds issued by the domestic government. Since real interest income earned on private net asset holdings is included in private sector income, the positive value of the parameter μ implies that a rise in A increases desired private spending by more than it increases private income. Further, since excesses of private spending over private income must be financed at the expense of private net asset holdings, it follows that:

$$D(A) = -h \tag{13}$$

where $D[A(t)] = A(t + 1) - A(t)$ is the forward difference in the level of A.

The excess of spending over income for the home country includes the excess of government spending over government revenue, g, as well as the excess of private spending over private income, h. Government spending includes the real interest that the government must pay on its outstanding stock of government debt, G. The excess of government spending over government revenue is financed by issuing (or retiring) government debt, that is:

$$D(G) = g. \tag{14}$$

The net asset position of the home country as a whole, N, is equal to the excess of privately held net assets over the outstanding stock of government debt, such that:

$$N = A - G. \tag{15}$$

The change in this net asset position corresponds to the total excess of income over spending, or:

$$D(N) = -(h + g). \tag{16}$$

The desired change in net assets implied by equation (16) may be thought of as the desired capital outflow of the home country. For the economic system to be in equilibrium, this desired capital outflow must correspond to the current-account balance, which is the sum of the trade balance and the service-account balance. The trade balance is given by equation (7) as $T = \nu(z - q)$. The service-account balance is the real interest income that the home country earns on its net asset position, which is equal to the real interest rate prevailing in the world securities market, r^*, multiplied by $N = A - G$. If equation (12) is substituted into equation (16), the critical requirement for momentary equilibrium in the economic system may be expressed as the balance-of-payments equilibrium condition, or:

$$\nu(z - q) + r^*(A - G) = \alpha r - \mu A - u - g. \tag{17}$$

In this condition, the expected real rate of return on private asset holdings is not identified with r^* because some government policies induce divergences between r and r^* and because expected changes in the relative price of domestic goods also imply such divergences.

Preliminary conclusions concerning the capacity of various policies to replicate the effects of commercial policy by influencing the real exchange rate may be obtained by applying implicit differentiation to the balance-of-payments equilibrium condition (17). These conclusions are only preliminary because they ignore the dynamic effects of induced changes in asset stocks and of changes in anticipations of future policies, which are examined in later sections. But they do apply (under appropriate assumptions and specifications) to the long-run effects of permanent changes in government policies when account is taken of these dynamic complications.

First, consider an increase in the outstanding stock of government debt. If z, A, r, u, and g are held constant, the change in q necessary to maintain balance-of-payments equilibrium in the face of an increase in G is given by:

$$dq/DG = -r^*/v = -\sigma r^*/(\beta + \beta^*). \tag{18}$$

The explanation of this result is that a larger stock of government debt requires a higher flow of net interest payments to the foreigners who must be the holders of this debt if the net assets of the private sector are constant. With a constant desired capital outflow (or inflow), this increase in net interest payments requires an improvement in the trade balance, which in turn requires a lower relative price of domestic goods. This conclusion, it should be emphasized, does not depend on the assumption that the increased taxes necessary to finance the interest on the expanded government debt are ignored by the private sector. Since g is defined as the excess of government spending (including interest payments on government debt) over government revenue, and since g is held constant, the implicit assumption is that taxes are increased sufficiently to pay the increased interest on the expanded government debt. Private sector income falls by the amount of this increase in taxes. Since h is the excess of private sector spending over private sector income, and since h is held constant in the derivation of equation (18), this result embodies the assumption that private sector spending falls by the amount of the increased taxes necessary to finance interest payments on the expanded government debt. Indeed, the decline in the relative price of the domestic good in response to an increase in the outstanding stock of government debt is precisely the appropriate relative price response to a transfer of spending from domestic residents, who have a positive marginal propensity to spend on domestic goods, to foreigners (the recipients of the interest paid on the net government debt), who have a zero marginal propensity to spend on domestic goods.

Essential to equation (18) is an implicit assumption that the private sector does not view government debt as a liability, in the sense that the stock of such debt exerts a negative effect on the desired excess of private spending over private income that is equivalent to the positive effect, μA, exerted by privately held net assets. This assumption is consistent with the notion of Metzler (1951) and Mundell (1960) that marketable assets exert a positive effect on desired spending beyond the effect of their yield on income, but that future tax liabilities associated with government debt are not regarded as marketable liabilities that offset this effect of marketable assets. (An alternative approach to eliminating Ricardian equivalence between debt financing and tax financing of government expenditures is to assume an overlapping-generations model with no bequest motive. For a recent and elegant version of this model, see Blanchard 1984; see Frenkel and Razin 1984 for an application of this model in the context of an open economy.) Were this not the case, a term $-\mu G$ would have to be included among the factors affecting the desired excess of private spending over private income, so that equation (12) would become:

$$h = \mu(A - G) - \alpha r + u. \tag{12'}$$

This modification would add the term μG to the right-hand side of the balance-of-payments equilibrium condition (17) and would modify the result (18) to:

$$dq/dG = -(r^* + \mu)/\nu. \tag{18'}$$

This result, however, would not represent the long-run equilibrium effect of an increase in the stock of government debt because in equation (12′) an increase in G implies a reduction in h and hence an increase in the rate of accumulation of privately held net assets. The long-run cumulative effect of this change in private asset accumulation is that privately held net assets would rise by exactly the amount of the increase in the stock of government debt. In the long run, therefore, there would be no reduction in domestic spending and an increase in foreign spending because the increased interest and associated taxes on the expanded government debt would be exactly offset by the increased interest received on privately held net assets. Consequently, under these conditions an increase in the stock of government debt would have no long-run effect on the relative price of domestic goods. (In Barro's [1974] terminology, there would be no long-run net wealth effect from changes in the stock of government debt because they would be fully offset by changes in private security holdings.)

Consider now a second dynamic complication: a temporary reduction in the general level of taxation. The short-run effect of this policy is a temporary increase in government expenditure relative to government revenue, that is, a temporary increase in g. Maintaining balance-of-payments equilibrium in the face of this increase in g, with given values of z, A, G, r, and u, requires an increase in the relative price of domestic goods, such that:

$$dq/dg = 1/\nu = \sigma/(\beta + \beta^*). \tag{19}$$

This result embodies the assumption that the private sector does not forecast the future tax liability implicit in the flow of government debt that finances the current tax reduction. As a result, the excess of private spending over private income does not decline in response to the increase in government expenditure relative to government revenue; instead, private spending rises to the extent of the tax reduction. Part of this increase in private spending is for purchases of domestic goods and thus forces an increase in the relative price of those goods to maintain equilibrium in the domestic goods market. Over time, the temporary reduction in taxes enlarges the stock of government debt, and (under the assumptions of this analysis) this increase in the stock of government debt tends to offset the direct effect of the tax reduction in reducing q. Ultimately, when taxes are increased sufficiently to eliminate the government deficit, the long-run effect of the temporary tax reduction is to raise the long-run stock of government debt and the long-run level of taxes required to finance the interest on this debt. The long-term effect of the temporary tax reduction (again, under the assumptions of this analysis) is therefore to reduce the long-term equilibrium value of the real exchange rate for precisely the reasons discussed above in connection with the effects of an increase in the outstanding stock of government debt.

Third, consider a policy that permanently raises the expected real rate of return for private asset holders, such as a permanent reduction in the tax rate on interest income. At given values of A, G, g, u, and z, an increase in r reduces the desired excess of private spending over private income and requires a reduction in q to maintain balance-of-payments equilibrium, that is:

$$dq/dr = -\alpha/\nu. \tag{20}$$

Over time, however, the reduction in h implied by an increase in r generates a higher net stock of privately held assets, and the effect of an increase in A on the relative price of domestic goods is given by:

$$dq/dA = (\mu + r^*)/\nu. \tag{21}$$

The cumulative change in A necessary to offset the increase in r and return h to the zero value consistent with no further changes in A is given by $\Delta A = (\alpha/\mu)\Delta r$, where Δr is the policy-induced change in r. It is easily shown that the combined long-run effect of the increase in r and the induced increase in A on the relative price of domestic goods is given by:

$$\Delta q = (-\alpha/\nu)\Delta r + [(\mu + r^*)/\nu]\Delta A = (r^*/\nu)\Delta A = (\alpha r^*/\nu)\Delta r. \tag{22}$$

The reason for this increase in the long-run equilibrium value of q in response to a policy-induced increase in r is that the long-run level of income of domestic residents rises due to the increase in A and domestic residents spend a fraction of this increased income on domestic goods, thereby forcing an increase in their relative price. This example points to the importance of distinguishing between short-run and long-run effects when considering the consequences of government policies that affect the real exchange rate.

2.4 A Dynamic Model of the Real Exchange Rate

A complete, dynamic analysis of government policies that affect the real exchange rate must take account of endogenously determined changes in the net stock of privately held assets that occur as the counterpart of current-account imbalances. The analysis must also account for the influence of expected changes in the relative price of domestic goods on economic behavior. To provide a benchmark for such an analysis, it is useful first to examine the dynamic interactions among the real exchange rate, the net stock of privately held assets, and the current-account balance in the absence of any government interventions. For this purpose, it is assumed that the stock of government debt is constant at zero and that government expenditure and government revenue are also zero.

Since no tax is imposed on private security holdings, the interest rate earned on such holdings is the real interest rate, r^*, that prevails in the world securities market. The real rate of return that influences private spending and saving decisions, r, however, is equal to r^* only when no capital gains or losses on private security holdings are anticipated. More generally, the expected real rate of return for private security holders is given by:

$$r = r^* - \sigma D^e(q), \tag{23}$$

where $D^e(q)$ denotes the expected rate of change in the relative price of domestic goods. The rationale for this relationship is that the real yield relevant for the spending and saving decisions of domestic residents is measured relative to a consumption basket that contains both domestic and traded goods. This real yield on a security with a fixed price and fixed interest rate in terms of traded goods is less than r^* to the extent of the expected growth rate of the relative price of domestic goods, multiplied by the share of domestic goods in the consumption basket. This assumption concerning the domestic real interest rate is a common feature of models that allow for changes in the real exchange rate, in particular, those in Dornbusch (1983), Mussa (1982a; 1984), and Obstfeld (1981a; 1983).

This specification of the domestic real interest rate, together with the assumptions that $G = 0$ and $g = 0$, implies that the balance-of-payments equilibrium condition (17) can be written as:

$$\nu(z - q) + r^*A = w - \alpha\sigma D^e(q) - \mu A, \tag{24}$$

where $w \equiv \alpha r^* - u$ summarizes all of the exogenous factors (including the world real interest rate) that influence the desired excess of private income over private spending. Equation (26) is a dynamic equation because it specifies the expected rate of change of the relative price of domestic goods and because it specifies the net stock of privately held assets. That stock changes whenever private income differs from private spending. More specifically:

(25) $$D(A) = -h = w - \alpha\sigma D^e(q) - \mu A.$$

Under the assumption of the rationality of expectations, equations (24) and (25) constitute a dynamic system that constrains the expected evolution of the relative price of domestic goods and the net stock of privately held assets, conditional on the information available at a given date. In matrix form, this dynamic system may be written as:

(26) $$\begin{bmatrix} \alpha\sigma D^e - \nu & r^* + \mu \\ \alpha\sigma D^e & \mu + D^e \end{bmatrix} \begin{bmatrix} q \\ A \end{bmatrix} = \begin{bmatrix} w - \nu z \\ w \end{bmatrix}.$$

The economically appropriate solution of this dynamic system yields the following expression for the current expected equilibrium value of the real exchange rate, $q^e(t) = E[q(t); t]$:

(27) $$q^e(t) = \bar{q}(t) + \gamma[A^e(t) - \bar{A}(t)],$$

where $\bar{q}(t)$ is the current expected long-run equilibrium value of the real exchange rate; $A^e(t) = E[A(t); t]$ is the current expected level of net private asset holdings; $\bar{A}$ is the current expected long-run equilibrium level of net private asset holdings; and $\gamma > 0$ is a parameter that determines the responsiveness of $q^e(t)$ to deviations between $A^e(t)$ and $\bar{A}(t)$. The values of $\bar{q}(t)$, $\bar{A}(t)$, and γ are determined by:

(28) $$\bar{q}(t) = \bar{\bar{q}}(t) + (r^*/\nu)\bar{A}(t)$$

(29) $$\bar{\bar{q}}(t) = (1 - \theta)\left(\sum_{j=0}^{\infty}\theta^j\right)\{E[z(t + j); t]\}$$

(30) $$\bar{A}(t) = (1 - \theta)\left(\sum_{j=0}^{\infty}\theta^j\right)\{E[w(t + j)/\mu; t]\}$$

(31) $$\gamma = (\lambda/\nu) - (1/\alpha\sigma),$$

where the discount factor θ involved in the definitions of $\bar{A}(t)$ and $\bar{\bar{q}}(t)$ is given by:

(32) $$\theta = 1/(1 + \lambda),$$

and where λ is the positive characteristic root associated with the dynamic system (26), such that:

$$(33) \quad \lambda = (1/2)\{[r^* + (\nu/\alpha\sigma)] + \sqrt{[r^* + (\nu/\alpha\sigma)]^2 + 4(\nu\mu/\alpha\sigma)}\}.$$

The results (28) through (33) may be interpreted as follows. (For further discussion, see Mussa 1984.) Equation (16) states that the current expected long-run equilibrium real exchange rate, $\bar{q}(t)$, is the real exchange rate expected to make the present discounted value (using the discount factor θ) of trade imbalances equal to zero, namely, $\bar{\bar{q}}(t)$ as defined by (29), adjusted for the effect of expected net interest income on the current expected long-run equilibrium level of privately held net assets. According to equation (30), this expected long-run equilibrium level of privately held net assets is the expected present discounted value (using the discount factor θ) of the exogenous factors affecting the desired excess of private spending over private income, divided by the sensitivity of this excess of private income over private spending to the actual level of privately held net assets. Equation (31) defines the reduced-form parameter, γ, that appears in (27) in terms of the more basic parameters that appear in the balance-of-payments equilibrium condition (24). From (33), it is easily established that $\gamma > r^*/\nu$, which is necessarily positive. Equation (32) indicates that the positive characteristic root λ plays the role of the "discount rate" in the expressions that define $\bar{\bar{q}}(t)$ and $\bar{A}(t)$. Equation (33) relates the value of this discount rate to the parameters that appear in the balance-of-payments equilibrium condition (24).

Because no restriction has been placed on the expected behavior of the exogenous factors affecting the trade balance (the z terms) or on the exogenous factors affecting the desired excess of private income over private spending (the w terms), these results provide a description of the determinants of the current expected equilibrium real exchange rate under a wide variety of possible assumptions about how economic conditions are expected to change over time. This generalizability has its costs: it increases the complexity of the model required for the analysis. But it also has important benefits: it allows an analysis of expected changes in government policies and other exogenous variables; it incorporates a variety of notions of permanent and transitory changes in government policies and other exogenous variables; and it distinguishes between the expected effects of expected changes in these exogenous variables and the unexpected effects attributable to new information about present and future government policies and other exogenous disturbances.

When the exogenous factors affecting the trade balance and the desired excess of private spending are known to have constant values (say, $z[s] = \bar{z}$ for all s terms and $w[s] = \bar{w}$ for all s terms), the dynamic process governing the expected evolution of the real exchange rate and the net stock of privately held assets can be described quite simply. Since there is no good reason to distinguish between the expected and the actual values of q and A when the z and w terms are equal to known constants, this description applies just as well to the actual evolution of q and A. The description is illustrated in those terms in figure 2.1. The dynamic process described in this figure embodies the essential features of a number of recent analyses of the dynamic interactions among the current-account balance, the level of net foreign assets, and the real exchange rate, in particular, those in Kouri (1976), Calvo and Rodriquez (1977), Dornbusch and Fischer (1980), and Obstfeld (1981a).

Suppose that the initial net level of privately held assets, A_0, is greater than the long-run equilibrium level, $\bar{A} = \bar{w}/\mu$. Then, as illustrated in the left-hand side of the figure, the initial equilibrium real exchange rate, $q_0 = \bar{q} + \gamma(A_0 - \bar{A})$, must be above the long-run equilibrium real exchange rate, $\bar{q} = \bar{z} + (r^*/\nu)\bar{A}$. As illustrated in the right-hand side of the figure, this initial real exchange rate implies an initial current-account deficit, $b_0 = \nu(\bar{z} - q_0) + r^*A_0 = (\nu\gamma - r^*)(\bar{A} - A_0) < 0$. This current-account deficit implies a decline in the net stock of privately held assets between period 0 and period 1, such that $D(A_0) = b_0 = (\nu\gamma - r^*)(A - A_0) < 0$. This decline in net assets implies that the real exchange rate in period 1, $q_1 = \bar{q} + \gamma(A_1 - \bar{A})$, as determined on the right side of the figure, must be below its previous value but still above its long-run equilibrium value. The fact that this decline in the real exchange rate, $D(q_0) - \gamma D(A_0) - \gamma b_0$, was anticipated in period 0 implies that the domestic real interest rate in that period, $r_0 = r^* - \sigma D(q_0)$, must have been above its long-run equilibrium value, r^*. In period 1, this process repeats, starting with a net stock of privately held assets, A_1, that is between A_0 and $\bar{A}$. Over time, the net stock of privately held assets, the real exchange rate, and the domestic real interest rate all gradually decline toward their respective long-run equilibrium values, and the current-account deficit is gradually eliminated.

The dynamic process illustrated in figure 2.1 is the process by which the economic system converges toward the fixed long-run equilibrium position determined by known constant values of the exogenous forcing variables z and w. The essential driving force in this adjustment process is the gradual adjustment of the net stock of privately held assets toward its long-run equilibrium level. There are limited circumstances in which this single element of a more complex dynamic system provides an essentially complete description of the dynamic response of the economic system to some change in economic conditions. In particular, consider a permanent (constant) increase in the tariff rate applied to imports of traded goods, $\Delta\tau > 0$. Such a tariff increase reduces the value of the exogenous forcing variable affecting the trade balance,

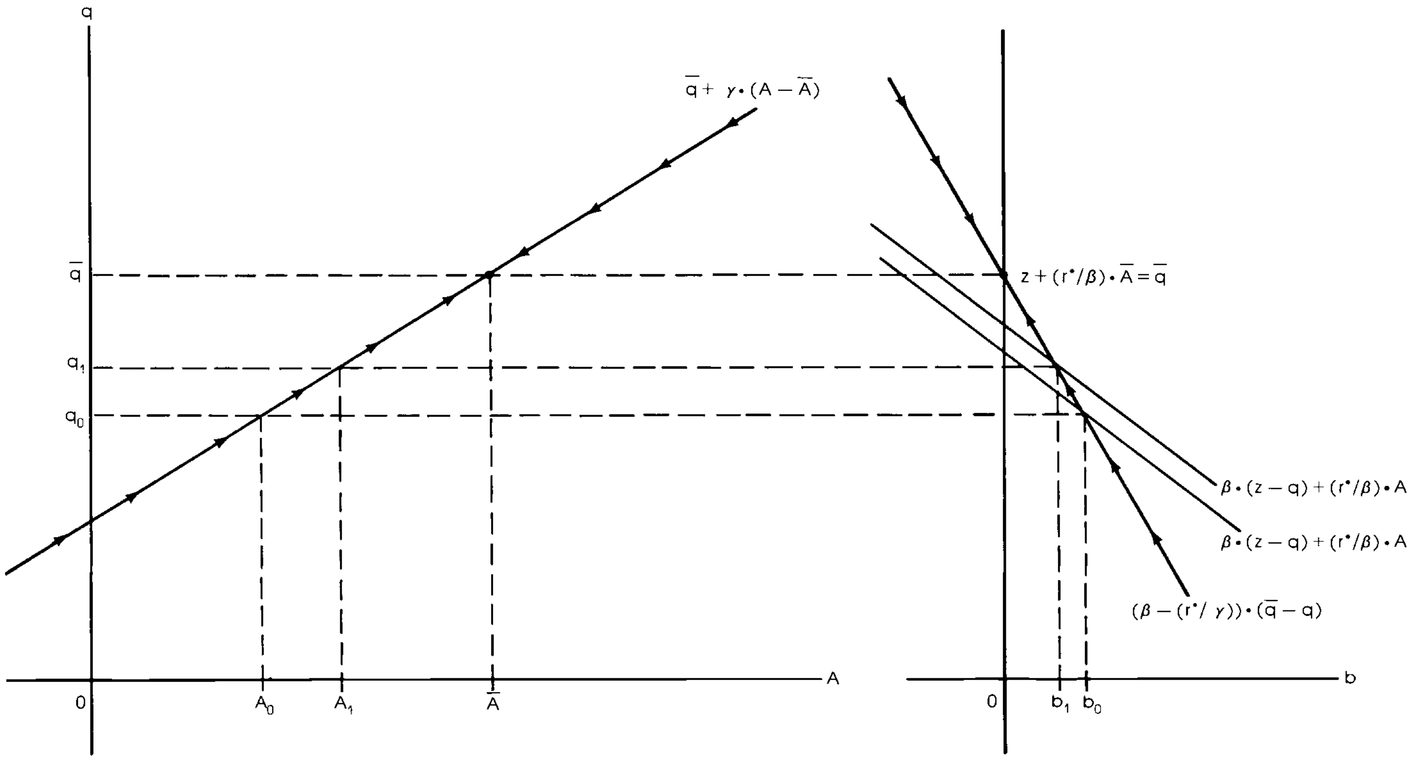

Fig. 2.1 The dynamic interaction among the exchange rate, asset stocks, and the current account.

$z = x + x^* - \beta^*\tau$, by a known constant amount, $\beta^*\Delta\tau$. This implies that the real exchange rate consistent with long-run equilibrium in the trade balance, $\bar{\bar{q}}$, falls by the amount $-\beta^*\Delta\tau$. If the tariff increase is assumed not to affect the exogenous factor that influences the desired excess of private spending over private income, it follows that there is no change in $\bar{A} = \bar{w}/\mu$ and hence that the real exchange rate consistent with long-run equilibrium in the current account, $\bar{q}$, falls by the same amount as $\bar{\bar{q}}$. In terms of figure 2.1, this means that the schedule showing $q(t)$ as a function of $A(t)$ on the right side and the schedule showing $b(t)$ as a function of $q(t)$ on the left both shift downward to the extent of the reduction in $\bar{\bar{q}}$ and $\bar{q}$. Whatever the net stock of privately held assets at the time of the permanent tariff increase, therefore, the immediate effect of the tariff increase is to reduce $q(t)$ by the same amount as the reductions in $\bar{\bar{q}}$ and $\bar{q}$. Depending on whether $A(t)$ is greater or less than $\bar{A}$, q will subsequently fall or rise toward its new long-run equilibrium value as A converges to $\bar{A}$. At each moment, q will be below the value it would have had in the absence of the tariff increase by precisely the amount that measures the long-run equilibrium effect of the tariff increase.

The dynamic system of equation (26) and its solution given by equations (28) through (33) may also be used to analyze changes in the tariff rate that are expected to be temporary or permanent at some future date. Such commercial policy changes imply either a temporary change in the level of the forcing variable, z, that will occur at some specific future date. These changes may also imply changes in the exogenous forcing variable, w, that accounts for the desired spending and saving behavior of the private sector. The reason w may be affected is that temporary changes in commercial policy or changes that are expected to occur at a future date affect the expected time path of the real exchange rate and hence private incentives for spending and saving. This point has recently been emphasized by Razin and Svennsson (1983) (see also Svennsson and Razin 1983) and is represented formally in the present model by allowing for changes in the path of w as well as in the path of z. Given the prescribed changes in the paths of these exogenous forcing variables, the general solution of the model provides a description of how the real exchange rate responds to expected temporary or future changes in commercial policy.

2.5 Fiscal Policy and the Real Exchange Rate

The dynamic model presented in the previous section may be applied to analyze the effect on the real exchange rate of shifts of government spending between domestic and foreign goods. Recall that in section 2.2 an increase in government spending on domestic goods at the expense of government spending on foreign goods is represented by an increase in the exogenous factor x that enters positively into the value of excess demand for domestic goods and negatively into the value of excess demand for foreign goods. In the dynamic model of section 2.4, such an increase in x translates into a corresponding increase in the exogenous forcing variable, z. It follows that an unexpected permanent shift in government spending away from foreign goods and toward domestic goods, $\Delta x > 0$, will increase the equilibrium real exchange rate given by equation (27) by a constant amount, $\Delta q = (\sigma/\nu)\Delta x$, at every moment, relative to the value it would have had in the absence of this government spending shift. This result is, of course, the same as the one obtained in the initial comparative statics analysis of a government spending shift described in section 2.2.

The virtue of the dynamic model of section 2.4 is that it permits analysis of any more complicated shift in the actual or expected distribution of government spending between domestic and foreign goods. In particular, consider an unexpected shift of government spending toward domestic goods, Δx, at time t that is expected to last only T periods. The effect of this unexpected temporary spending shift on the real exchange rate in period t is $\Delta q(t) = (\sigma/\nu)(\Delta x)(1 - \theta^T)$, which is smaller than the effect of a permanent spending shift of the same magnitude. As the time when the spending shift will be terminated approaches, the effect of the shift on the real exchange rate consistent with long-run trade-balance equilibrium diminishes, with $\Delta\bar{\bar{q}}(s) = (\sigma/\nu)(\Delta x)(1 - \theta^{T+t-s})$ for $t < s < (T + t)$. The effect on $\bar{\bar{q}}$, however, is not the only effect of the temporary spending shift on the real exchange rate. Because private asset holders know that the spending shift is temporary, they anticipate that q will change in period $t + T$ when the temporary spending shifts ends. This anticipated change in q affects the expected real interest rate for domestic residents who consume both domestic and foreign goods and thereby affects their spending and saving behavior. Between period t and period $t + T$, domestic residents expect future declines in q and therefore save more than they otherwise would. This implies that the private net stock of foreign assets, $A(s)$, rises above the level it would otherwise have for $t < s < (t + T)$. It follows that $\Delta q(s) > \Delta\bar{\bar{q}}(s)$ for $t < s < (t + T)$. Moreover, since $A(t + T)$ is greater than the value it would have in the absence of the temporary spending shift, it follows that $q(s)$ remains somewhat above the level it would have in the absence of the temporary spending shift for $s \geqslant (T + t)$ and only gradually converges back toward its previous path, as the increase in A built up between t and $t + T$ is gradually run down.

Another application of the dynamic model is in the analysis of a shift in government spending expected to occur at date $s = t + T$ that lies

T periods in the future. Suppose that private agents first learn of this spending shift in period t and that they expect it will be permanent once it starts in period $t + T$. Even though this expected future spending shift has no immediate direct effect on excess demands for domestic and foreign goods, it does have an immediate effect on the real exchange rate equal to $\Delta q(t) = (\sigma/\nu)(\Delta x)(\theta^T)$, where Δx is the size of the permanent spending shift that is expected to occur at $t + T$. The source of this change in $q(t)$ is the change in the real exchange rate anticipated to be consistent with long-run equilibrium in the trade balance, $\Delta\bar{\bar{q}}(t)$. Over the period between t and $t + T$, the real exchange rate is also affected by induced changes in private net asset holdings, which are reduced relative to their previously expected path because private agents anticipate increases in q as the moment of the spending shift approaches. The decrease in $A(t + T)$ relative to the level it would have had in the absence of anticipations of the spending shift implies that $q(t + T)$ as determined by equation (27) is below the level it would have if the spending shift suddenly became known at $T + t$. Thus, the effect of spending shift being anticipated in period t, rather than becoming known in period $t + T$, is that the adjustment of the real exchange rate to this spending shift is spread out over time, rather than occurring all at once in period $t + T$. Some of the adjustment of q takes place immediately when the spending shift is first anticipated in period t. Further adjustment of q happens between t and $t + T$, and some adjustment takes place after $t + T$, as private net asset holdings are raised back to the path they would have followed in the absence of anticipations of the spending shift.

With slight modification, the dynamic model of section 2.4 may also be used to analyze the effects on the real exchange rate of general fiscal policy, defined as variations in the debt-financed difference between government expenditure and government revenue, g. To deal with general fiscal policy, the balance-of-payments equilibrium condition must be modified from equation (24) to:

$$(34)\qquad \nu(z - q) + r^*(A - G) = w - \alpha\sigma D^e(q) - \mu A - g,$$

where G is the stock of government debt, and g is the excess of government spending (including interest payments on outstanding debt) over government revenue. With this modification, the dynamic system determining the expected future evolution of q and A is given by:

$$(35)\qquad \begin{bmatrix} \alpha\sigma D^e - \nu & r^* + \mu \\ D^e & \mu + D^e \end{bmatrix} \begin{bmatrix} q \\ A \end{bmatrix} \begin{bmatrix} w - \nu z - g + r^*G \\ w \end{bmatrix}.$$

The only difference between this dynamic system and the dynamic system in (26) is that the exogenous forcing variable in the top equation is now $w - vz - g + r^*G$, whereas before it was simply $w - vz$. The additional term $(r^*G - g)$ in this forcing variable accounts for the effects of general fiscal policy. The solution of the dynamic system (35) is the same as the solution of the dynamic system (26), as given by (27) through (33), except that the expression for the real exchange rate consistent with long-run equilibrium in the trade balance, $\bar{\bar{q}}(t)$, given by (29) must be modified by replacing the forcing variable $z(t + j)$ with $y(t + j) = z(t + j) + (1/v)[g(t + j) - r^*G(t + j)]$.

With this modification in mind, consider now an unexpected temporary fiscal expansion in which lump-sum taxes are cut by a constant amount for T periods, starting in the current period t, without any tax increases to finance the increased interest payments on the expanding government debt until period $t + T$, when taxes are raised sufficiently to eliminate the deficit. This policy translates into a constant unexpected increase in $y(s)$ for $t \leq s < (t + T)$ and a constant unexpected decrease in $y(s)$ for $s \geq (t + T)$ equal to the interest on the increase in the government debt between t and $t + T$. The effect of this fiscal policy on the real exchange rate at time t is given by:

$$(36) \qquad \Delta q(t) = \Delta \bar{\bar{q}}(t) = (1 - \theta)[1 - \theta^T(1 + r^*)^T](\Delta\kappa/v) > 0,$$

where $\Delta\kappa > 0$ is the amount of the reduction in lump-sum taxes (relative to their previously expected path) between t and $t + T$. This effect on the real exchange rate is positive because the discount rate λ used in calculating $\bar{\bar{q}}(t)$, as given by (33), is larger than r^* and therefore implies that $\theta^T(1 + r^*)^T = [(1 + r^*)/(1 + \lambda)]^T$ is less than one. As time goes by, the size of the increase in $\bar{\bar{q}}(s)$ for $t < s < (t + T)$ diminishes and ultimately turns negative because the number of future periods in which taxes will be lower is diminishing and the date at which taxes will be raised to cover the deficit is approaching. After time $t + T$, $\bar{\bar{q}}(s)$ is reduced permanently by the amount $(\Delta\kappa/v)[(1 + r^*)^T - 1]$, which represents the long-run equilibrium effect on $\bar{\bar{q}}$ of the increased taxes that are imposed to finance the increased interest on the expanded stock of government debt.

Except in period t, the response of $q(s)$ to the fiscal policy does not mirror exactly the response of $\bar{\bar{q}}(s)$ because the expectations of changes in q induced by the policy influence private saving behavior and hence the path of the private net stock of foreign assets. Specifically, since q is expected to decline after its initial upward jump in period t, $A(s)$ rises above its level in the absence of the fiscal policy for $t < s < (t + T)$ and gradually falls back to its previous path for $s \geq (t + T)$. In accord with equation (27), this increase in $A(s)$ relative to its previous path results in an increase in $q(s)$ relative to $\bar{\bar{q}}(s)$. The overall result, as illustrated in figure 2.2, is that during the interval between t and $t + T$, $\Delta q(s)$ remains positive even after $\Delta\bar{\bar{q}}(s)$ has become negative. By period $t + T$, $\Delta q(s)$ is negative but smaller in absolute value than $\Delta\bar{\bar{q}}(s)$. Only as the increased net stock of private asset holdings built up between t and $t + T$ is run down does $\Delta q(s)$ fall to the long-run equilibrium level of $\Delta\bar{\bar{q}}(s)$.

This analysis of the effects of general fiscal policy can be extended to other examples embodying alternative specifications of the paths of g and G and hence of the exogenous forcing variable $y = z + (1/v)(g - r^*G)$. Rather than pursuing such examples, however, it is more useful

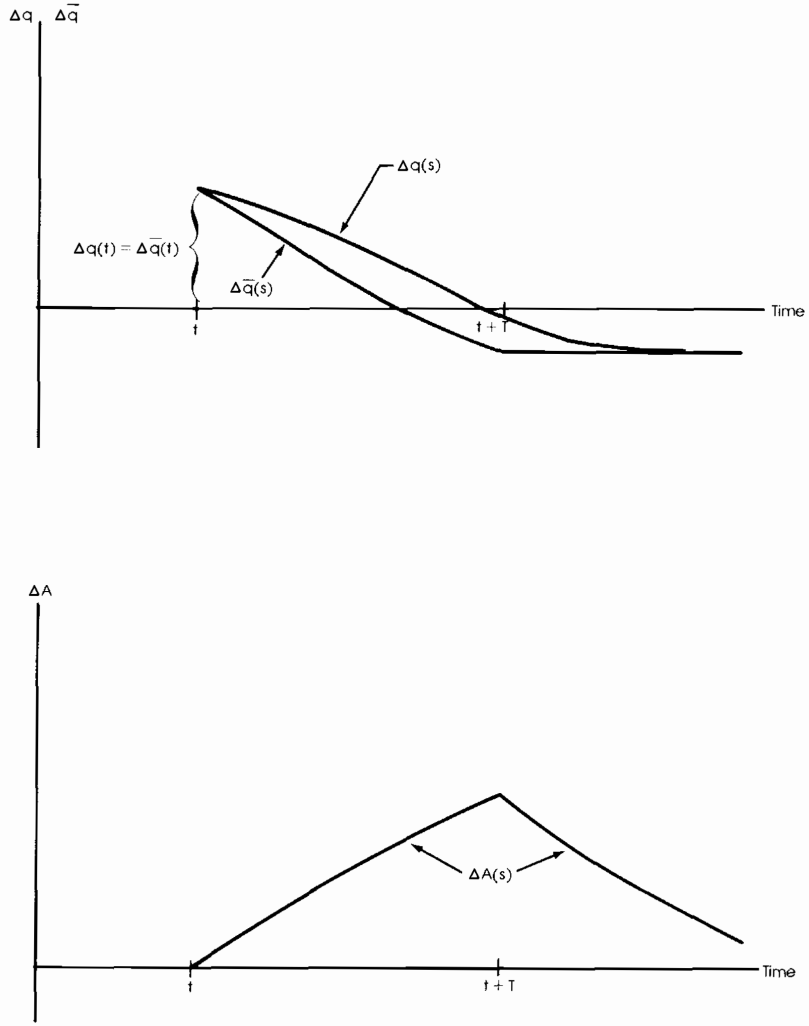

Fig. 2.2 The effects of a temporary fiscal expansion on the real exchange rate and on private net holdings of foreign assets.

to investigate the elements of the specification of the present model that allow general fiscal policy to influence the behavior of the real exchange rate.

The short-run effect of expansionary fiscal policy in raising the real exchange rate does not depend on the failure of private asset holders to forecast future tax liabilities correctly or on the failure of the government to impose taxes sufficient to pay the interest on the government debt. It does depend, however, on the absence of full Ricardian equivalence between debt-financed and tax-financed government spending. In the example just considered (as should be the case in any well-specified example of fiscal policy), the government's intertemporal budget constraint is satisfied because the government ultimately (starting in period $t + T$) raises taxes sufficiently to pay the interest on the expanded stock of government debt. Private agents foresee this tax increase starting in period t when the policy is introduced, and the reaction of the real exchange rate to the new policy, as given by equation (36), reflects the anticipation of these future taxes. The effect of the anticipated increase in future taxes reduces but does not eliminate the expansionary effect of the government deficit because the discount rate, λ, that is applied to determine the effect of future taxes on the current real exchange rate is greater than the interest rate, r^*, on government debt. If private saving responded immediately to the government deficit in the manner required to maintain Ricardian equivalence between debt financing and tax financing of government spending, there would be no such expansionary effect of fiscal policy. In this case, the exogenous variable, w, which accounts for the exogenous factors affecting the desired excess of private income over private spending, would rise immediately to offset any increase in g and leave no room for government deficits to affect the aggregate level of desired spending. The present analysis, which excludes such an offsetting effect of private saving, implicitly assumes that general fiscal policy operates in the same way as do shifts in the desired intertemporal distribution of private spending. This assumption would be entirely appropriate even under the conditions of Ricardian equivalence, if the government always acted in the interests of its country's private asset holders, with its budget deficits and surpluses reflecting private preferences regarding the intertemporal distribution of spending relative to income.

2.6 Capital Controls and the Real Exchange Rate

In the preceding analysis of the behavior of the real exchange rate, it has been assumed that private agents can borrow and lend in the world market whatever amount they want (denominated in terms of foreign goods) at the prevailing real interest rate, r^*. Through capital controls policies a government may limit the extent of private credit flows and thereby influence the behavior of the real exchange rate. Specifically, looking back at the expression for the trade balance given in equation (7), $T = \nu(z - q) = -\psi$, it follows that any policy that affects $-\psi$ (the excess of domestic income over the value of domestic output) by controlling international capital flows must, for a given value of z, affect the level of q.

Formally, there are a variety of ways in which capital controls can be introduced into the model used to determine the behavior of the real exchange rate. By far the simplest is to specify that the international flow of net private capital (the change in the net private stock of foreign securities) is controlled directly by the government during each period. The policy-determined net outflow of capital (that is, the increase in private net holdings of foreign assets) in period t is denoted by $a(t)$. Returning to the base-case assumptions that government revenue is equal to government expenditure ($g = 0$) and that there is no outstanding government debt ($G = 0$), the condition for balance-of-payments equilibrium in the presence of capital controls is expressed by the requirement:

$$\nu(z(t) - q(t)) + r^*A(t) = a(t). \tag{37}$$

Solving this condition for $q(t)$, it follows that the (logarithm of the) real exchange rate is given by:

$$q(t) = z(t) + (1/\nu)[r^*A(t) - a(t)]. \tag{38}$$

It is apparent that a higher permissible capital outflow or a lower permissible capital inflow in the current period (that is, a lower value of $a[t]$) implies a lower current real exchange rate (a lower value of $q[t]$). But since greater current capital outflows or smaller current capital inflows mean larger future private net holdings of foreign assets (higher future values of $A[s]$ for $s > t$), a higher current value of $a(t)$ implies lower future values of $q(s)$ for $s > t$.

In considering the effects of capital controls on the real exchange rate, it is useful to distinguish between persistent effects on the level of the real exchange rate and effects on the variability of the real exchange rate in response to different types of economic disturbances. The capacity of capital controls to maintain a long-run average value of the real exchange rate different from the long-run average that would prevail in the absence of such controls is limited to the ability of such controls to maintain a long-run average value of A that differs from its long-run equilibrium value in the absence of controls. Specifically, comparing the long-run average value of q determined by equation (38) (denoted by $\tilde{q}_c$ for the average with controls) with the long-run average value of q determined by (27) (denoted by $\tilde{q}_n$ for the average with no controls), under the assumption that the processes generating the z terms and the w terms are stationary, we find that:

$$\tilde{q}_c - \tilde{q}_n = (r^*/v)(\tilde{A}_c - \tilde{A}_n), \tag{39}$$

where $\tilde{A}_c$ and $\tilde{A}_n$ are the long-run average values of A with and without controls, respectively. This result reflects the fact that interest income earned on private net foreign asset holdings is spent partly on domestic goods, thereby implying that a higher long-run average level of private net foreign asset holdings requires a higher long-run average level of q to maintain equilibrium in the market for domestic goods. For relevant sizes of the parameters r^* and v, it is apparent that for capital controls to have a substantial long-run effect on the average value of the real exchange rate, they must have a large effect on the long-run average level of private net holdings of foreign assets.

In contrast to their limited capacity to affect the long-run average level of the real exchange rate, capital controls can substantially affect the responsiveness of the real exchange rate to temporary disturbances. Again, a comparison of equations (38) and (27) shows that under capital controls, with a fixed value of $a(t)$, the current value of $q(t)$ responds one-for-one with variations in $z(t)$, whereas in the absence of controls, $q(t)$ depends on the discounted present value of the current z and all expected future values of z. It follows that a temporary, one-period disturbance to $z(t)$ will have a much stronger effect on $q(t)$ under capital controls (with $a[t]$ fixed) than in the absence of controls. This is because in the absence of controls the capital flow will adjust to accommodate part of the current disturbance to $z(t)$ and thereby spread the effect of the disturbance over time. More generally, this principle applies to any form of temporary disturbance to the value of z: capital controls (with a fixed path of $a[t]$) tend to accentuate the effects of such disturbances on the real exchange rate.

The other side of the coin is that capital controls reduce the sensitivity of the real exchange rate to disturbances in the values of w, that is, to disturbances that affect the desired excess of income over spending. Equation (27) reveals that disturbances to w affect $q(t)$ in the absence of capital controls because $q(t)$ depends on $\bar{A}(t)$, and $\bar{A}(t)$ depends on a discounted sum of the present and expected future values of w. Looking at (38), however, we find that neither the current w nor any expected future value of w affects the current value of $q(t)$. Thus, capital controls, with a fixed value of $a(t)$, insulate $q(t)$ from disturbances to the value of w.

There is no necessity, of course, for capital controls to maintain a fixed value of $a(t)$ in the face of all forms of economic disturbances. In particular, if a government wanted to stabilize the behavior of the real exchange rate (over and above the stability resulting from the absence of capital controls), it would seek to increase or reduce the value of $a(t)$ to offset positive or negative disturbances to $z(t)$, while holding $a(t)$ constant in the face of disturbances to the value of w.

A special circumstance in which a government might wish to manipulate the international flow of capital is if it is pursuing other policies designed to affect the real exchange rate. In particular, consider the unexpected temporary shift of government spending toward domestic goods and away from foreign goods discussed at the beginning of section 2.5. Because private asset holders anticipate declining values of q subsequent to the impact of this spending shift, the rate at which they accumulate net foreign assets will increase in the absence of capital controls. Later on, especially after period $t + T$ when the spending shift ends, the increase in private net holdings of foreign assets maintains q at a level somewhat higher than it would otherwise be. But in period t and in the periods immediately following, the increase in private saving diminishes the effect of the spending shift in raising the relative price of domestic goods. If the government wished to maximize the effect of the spending shift in raising $q(t)$, it would limit the extent of the capital outflow (the purchase of foreign assets by domestic residents) in order to bottle up the effect of the spending shift toward domestic goods. A similar capital controls policy would also be pursued by a government that wished to maximize the effect on the real exchange rate of the unexpected temporary fiscal expansion discussed at the end of section 2.5.

Much of this analysis of capital controls carries over to the analysis of exchange rate systems in which governments maintain two separate nominal exchange rates: one for current-account transactions, and one for capital-account transactions. (See Dornbusch 1984 and the references cited there for an analysis of these systems.) Dual exchange rate systems are usually designed so that the current-account rate is fixed or determined by a crawling peg, while the capital-account rate is allowed to be determined by market forces. The effect, indeed the purpose, of such a system is to control the extent of private international capital flows, with the differential between the capital-account and the current-account exchange rates measuring the effective rationing price of whatever net amount of foreign exchange is allowed to become available for financing private capital flows.

2.7 The Combined Effects of Monetary and Exchange Rate Policy

An especially important mechanism through which economic policies affect the real exchange rate and thereby replicate some of the effects of commercial policies is through the interaction of monetary policies and policies designed to influence the nominal exchange rate. To analyze the implications of this combination of policies, it is necessary to broaden the model introduced in the earlier sections by introducing appropriate monetary elements. The condition for equilibrium in the domestic money market is expressed by the requirement:

$$m = k + p^* + e + lq - \xi D^e(e), \tag{40}$$

where m denotes the logarithm of the nominal money supply; k summarizes the exogenous factors affecting the logarithm of the demand for domestic money; e denotes the logarithm of the nominal exchange rate (defined as the price of a unit of world money in terms of domestic money); p^* denotes the logarithm of the world money price of traded goods; $l > 0$ is the elasticity of money demand with respect to the relative price of domestic goods; and $\xi > 0$ is the semielasticity of money demand with respect to the expected rate of change in the nominal exchange rate. The unitary coefficients on p^* and e in (40) are justified by the assumption that the demand for domestic money is unit elastic with respect to the general level of domestic prices. The positive coefficient of q in (40) reflects the effect of increases in q in raising the demand for domestic money, both by raising the general level of domestic prices (given p^* and e) and by increasing the real value of domestic output measured in terms of traded goods. The negative coefficient of $D^e(e)$ in (40) reflects the negative effect on domestic money demand of an increase in the domestic nominal interest rate that results from an increase in the expected depreciation rate of the foreign exchange value of domestic money.

When the nominal exchange rate is freely flexible, and when goods prices adjust instantaneously to maintain equilibrium in the goods markets, monetary policy exerts no influence on the real exchange rate, q, or on any other variable in the real sector of the economy. (See Mussa 1984 for further discussion.) This conclusion is based on the assumption that the behavioral equations and equilibrium conditions for the real sector of the economy that were described and analyzed in the preceding sections of this paper require no modification to accommodate the condition of domestic money market equilibrium given in equation (40). Specifically, this means that we abstract from any real balance effect through which the real value of domestic money balances might affect the desired excess of domestic real spending over domestic real income. We also assume that under a freely flexible exchange rate, the real sector of the economy is not affected by the fiscal effects of money creation and destruction. The revenue that the government derives from money creation is redistributed to the private sector through lump-sum transfers. The private sector then uses these transfers to pay the inflation tax on its real money balances that results from domestic money creation under a flexible exchange rate. Private sector spending on domestic and foreign goods is therefore assumed to be unaffected by the fiscal effects of money creation under a flexible exchange rate.

Given the conclusion that the real sector of the economy is not affected by monetary policy under a flexible exchange rate, the money market equilibrium condition of equation (40) may be used to determine the behavior of the nominal exchange rate, treating the behavior of the money supply and of the determinants of money demand as exogenous. Specifically, treating (40) as a forward-looking difference equation in the expected level of e (and ruling out "bubbles" in the solution), it follows that:

$$(41)\qquad E[e(s); t] = (1 - \phi)\left(\sum_{j=0}^{\infty} \phi^j\right)\{E[m(s + j) - \kappa(s + j); t]\},$$

where $\phi = \xi/(1 + \xi)$, and $\kappa(u) = k(u) + p^*(u) + lq(u)$. This result, which is familiar from monetary models of exchange rate determination (see Mussa 1976; 1982a; 1982b; or 1984), states that the (logarithm of the) expected nominal exchange rate is a discounted sum of expected present and future differences between the (logarithm of the) nominal money supply and the (logarithm of the) component of money demand that does not depend on the exchange rate. Included in this component of money demand is the influence of the behavior of the (logarithm of the) relative price of domestic goods, which is determined independently of the behavior of the domestic money supply.

The real exchange rate and other real sector variables are not influenced by the behavior of the money supply or by the nominal exchange rate under a flexible exchange rate regime because under this regime the nominal exchange rate always adjusts to offset variations in the money supply and preserve monetary neutrality. This neutrality breaks down, even in the absence of real balance effects or nominal price stickiness, when the exchange rate is not freely flexible. To see why this is so and how monetary policy and nominal exchange rate policy may interact to influence the real exchange rate, it is useful to consider the specific case in which the (logarithm of the) money supply is held constant at $\bar{m}$ and the (logarithm of the) nominal exchange rate is pegged at $\bar{e}$. A similar analysis applies to the case in which the rate of money supply growth is held constant and the rate of change in the nominal exchange rate is fixed by some predetermined rate of crawl.

With e pegged at $\bar{e}$ and m fixed at $\bar{m}$, and if private asset holders expect no change in the nominal exchange rate (so that $D^e[e] = 0$), the only variable that is free to adjust to satisfy the money market equilibrium in equation (40) is the (logarithm of the) real exchange rate. Specifically, the value of q that is consistent with (40) is given by:

$$(42)\qquad q = (1/l)[\bar{m} - \bar{e} - p^* - k].$$

This relationship indicates that for any given value of k and p^*, the greater the level of $\bar{m}$, the greater the level of q required to maintain money market equilibrium; and the greater the level of $\bar{e}$, the lower the level of q required to maintain money market equilibrium. It follows that with a pegged exchange rate, the real exchange rate is not independent of the policy-determined level of the money supply; and with a policy-determined level of the money supply, the real exchange rate is not independent of the policy-determined value of the nominal exchange rate.

To maintain e at $\bar{e}$ and simultaneously keep m at $\bar{m}$, the government of the home country will generally need to intervene in the foreign exchange market and sterilize the effects of its interventions on the domestic money supply. Analytically, it is simplest to deal with such sterilized intervention by assuming that the government keeps the domestic credit component of the money supply constant and finances necessary interventions in the foreign exchange market by borrowing and lending on the world capital market. The required extent of government borrowing is determined by the balance-of-payments equilibrium condition:

$$(43) \qquad \nu(z - q) + r^*(A - G) = w - \alpha\sigma D^e(q) - \mu A - g,$$

where G represents the outstanding stock of government debt, and g represents the flow of government borrowing to finance intervention. Interest in G is assumed to be financed by lump-sum taxes.

The flow of government intervention is represented by the same variable, g, as was previously used to denote the excess of government spending over government revenue. This specification is appropriate because when the government borrows in the world capital market to finance its foreign exchange intervention, it is necessarily financing an excess of spending over revenue. This is the fiscal effect of sterilized intervention in the foreign exchange market. Specifically, if government spending on goods and services is constant (as will be assumed throughout this discussion), there must be a reduction in lump-sum taxes to correspond to government borrowing to finance intervention in the support of the foreign exchange value of domestic money; and there must be an increase in lump-sum taxes to correspond to the government lending (or repayment of past borrowings) that occurs when the government intervenes to prevent appreciation of the foreign exchange value of domestic money.

The fiscal effect of foreign exchange market intervention has important implications for the spending behavior of the private sector. If the government must intervene to support the foreign exchange value of domestic money, the domestic money market is in "quasi-equilibrium" in the sense that the current demand for the stock of domestic money is equal to the current supply, but domestic money holders wish to run down their money balance over time. This running down of money balances over time implies an incipient excess of private sector spending over private sector income that private agents plan to finance at the expense of money holdings, without any effect on the rate of change in the net foreign asset holdings of the private sector. Under a flexible exchange rate, this incipient excess of private spending over private income financed out of money balances would not emerge because the exchange rate would adjust to the level at which the stock of money is willingly held, and the planned rate of money accumulation corresponds to the expected rate of monetary expansion (both of which are zero when m is held constant at $\bar{m}$). When the exchange rate is pegged at a value that necessitates intervention in support of the foreign exchange value of domestic money, the incipient excess of private sector spending over income corresponding to the planned rate of reduction in money balances is offset by the reduction in lump-sum taxes associated with the fiscal effect of government intervention in the foreign exchange market. This result must be so because with sterilized intervention, the actual level of domestic money balances does not decline, implying that the private sector does not succeed in spending in excess of its actual income (taking account of reduced lump-sum taxes) at the expense of its money balances. The actual excess of private sector spending over private sector income therefore corresponds to the desired rate of decumulation of private net holdings of foreign assets, $-D(A) = -w + \alpha\sigma D^e(q) + \mu A$, which is determined by exactly the same factors as those analyzed in the earlier sections of this paper.

It should be emphasized that this analysis of the interaction between private sector spending behavior and the fiscal effect of sterilized intervention in the foreign exchange market does not rely on a traditional real balance effect, in which the level of real money balances influences the desired level of private spending. With a given nominal money supply, incipient differences between spending and income that the private sector plans to finance out of money balances arise only when the government pegs the nominal exchange rate at a value different from that which would prevail under a flexible exchange rate regime.

On the other hand, it should also be emphasized that the analysis of this interaction does rely on the assumption that the private sector fails to foresee the effect of current government borrowing and lending (carried out in support of foreign exchange market intervention) on the future tax liabilities of the private sector. If there were a full Ricardian offset of private sector saving for government borrowing, there would be no mechanism through which the flow to government borrowing or the stock of government debt would influence the real sector of the economy. Thus, there would be no way (at least in the context of the present model) for a policy of sterilized intervention to maintain the real exchange rate at the level determined by equation (42) if the pegged value of the nominal exchange rate differs from the nominal exchange rate that would prevail under exchange rate flexibility. (In a portfolio balance model in which asset holders have distinct demands for securities denominated in different national monies, however, there is some latitude for sterilized intervention to affect the exchange rate; see for example, Kenen 1981 and Henderson 1984.)

If the conditions for the fiscal effect of sterilized intervention to influence the real exchange rate are assumed to be satisfied, the behavior of the real exchange rate becomes sensitive to monetary policy and exchange rate policy. Specifically, a fixed nominal money supply, $\bar{m}$, and a fixed nominal exchange rate, $\bar{e}$, maintained by a policy of sterilized intervention, determine the level of the real exchange rate through the relationship in equation (42). Given this value of the real exchange rate, the balance-of-payments equilibrium condition (43) determines the extent of official intervention (financed by government borrowing in the world capital market) that is required to maintain this value of the real exchange rate, such that:

$$(44)\quad g = r^*G - (r^* + \mu)A - \alpha\sigma D^e(q) + w - vz + (v/l)[\bar{m} - \bar{e} - p^* - k + \xi D^e(e)].$$

Since $D(G) = g$, and under the assumption that no change is expected in the nominal exchange rate or in the real exchange rate, the dynamic law governing the evolution of the stock of government debt is given by:

$$(45)\quad D(G) = r^*G - (r^* + \mu)A + w - vz + (v/l)(\bar{m} - \bar{e} - p^* - k).$$

The dynamic law governing the evolution of the stock of privately held foreign assets (again under the assumption of no expected change in q) is given by:

$$(46)\quad D(A) = w - \mu A.$$

Together, (45) and (46) constitute the dynamic system that determines the joint evolution of G and A with a fixed money supply and a pegged nominal exchange rate, under the assumption that no change is expected in either the nominal or the real exchange rate.

This dynamic system has two characteristic roots: a stable one, $\lambda_1 = -\mu < 0$; and an unstable one, $\lambda_2 = r^*$. The stable characteristic root is associated with the dynamic process that governs the evolution of the private stock of net foreign assets. With a fixed value of the forcing variable, w, which measures exogenous influences on private sector desired saving, the stock of privately held foreign assets necessarily converges to a long-run equilibrium level of w/μ. The unstable characteristic root is associated with the dynamic process governing the evolution of the stock of government debt. With fixed values of the forcing variables, w, z, p^*, and k and of the policy-determined variables, $\bar{m}$ and $\bar{e}$, there is for each initial stock of private net foreign assets a unique initial stock of government debt for which the subsequent stock of government debt converges to a finite steady-state level. Specifically, if A is initially at its long-run equilibrium level, w/μ, the stock of government debt must be:

$$\bar{G} = (w/\mu) + (\nu/r^*)(z - q), \tag{47}$$

where q is given by equation (42). At this level of G, and only at this level of G, the flow of government intervention required to maintain the pegged nominal exchange rate and the fixed nominal money supply will be zero, implying that the outstanding stock of government debt will not be changing. If $G > \bar{G}$ (with $A = w/\mu$), the required flow of intervention will be positive, implying an explosively expanding stock of government debt. If $G < \bar{G}$ (with $A = w/\mu$), the required flow of intervention will be negative, implying an explosively contracting stock of government debt (or explosively expanding stock of government lending).

This dynamic instability in the behavior of the stock of government debt applies for any assumed behavior of the exogenous forcing variables. It reflects the fundamental economic instability of a policy that seeks to maintain a constant nominal exchange rate and a constant nominal money stock by means of sterilized intervention. For any path of the exogenous forcing variables z, w, p^*, and k, and for any policy-determined value of $\bar{m}$, there is only one fixed value of $\bar{e}$ that can be sustained by sterilized intervention (with a finite bound on government borrowing and lending). In general, therefore, a policy of fixing the nominal money supply and pegging the nominal exchange rate is not viable and cannot permanently sustain an arbitrary value of the real exchange rate.

Rationality of expectations presumably implies that private asset holders recognize the long-run nonviability of a policy that fixes the nominal money supply and pegs the nominal exchange rate. If a government must persistently intervene to support the foreign exchange value of domestic money, private agents will suspect that at some point the money supply will need to be contracted or domestic money will need to be devalued (an increase in $\bar{e}$). Conversely, if a government must persistently intervene to prevent appreciation of the foreign exchange value of domestic money, private agents will suspect either a money supply increase or an exchange rate appreciation (a reduction in $\bar{e}$). For purposes of the present discussion of the real exchange rate, it is useful to focus on the case of persistent intervention in support of the foreign exchange value of domestic money, whereby adjustment is expected to come through a nominal exchange rate devaluation (an increase in $\bar{e}$). This case has been a common pattern of economic policy in a number of developing countries.

It is possible to model expectations of a devaluation in several ways, each of which will yield somewhat different implications. The approach adopted here will be to assume that expectations of a devaluation are based, at least in part, on the cumulative extent of past intervention in support of the current nominal exchange rate. Specifically, assuming that G was zero when the current exchange rate was established, suppose that G must reach some critical level, $\hat{G}$, before private asset holders begin to expect any significant probability of a parity change in the near future. This implies that $D^e(e) = 0$, so long as $G < \hat{G}$. It follows that so long as $G < \hat{G}$, q will be determined by equation (42). Thus, so long as cumulative intervention in support of the current nominal exchange rate remains below the critical level, $\hat{G}$, the real exchange rate will be at the level dictated by money market equilibrium for the policy-determined values of $\bar{m}$ and $\bar{e}$. Under this assumption about expectations of devaluation, the combination of monetary policy and nominal exchange rate policy therefore has the capacity to influence the real exchange rate, at least over some finite time period.

When G rises above $\hat{G}$, the expected rate of devaluation is assumed to be given by:

$$D^e(e) = \rho(G - \hat{G}). \tag{48}$$

The factor ρ reflects both the expected probability of devaluation (during the next brief time interval) and the expected extent of devaluation if a parity change occurs (during this brief interval). Given this assumption about $D^e(e)$, the level of q consistent with money market equilibrium is still given by equation (42) when $G < \hat{G}$, whereas when $G > \hat{G}$, the level of q is given by:

$$q = (1/l)[\bar{m} - \bar{e} - p^* - k + \xi\rho(G - \hat{G})]. \tag{49}$$

When $G < \hat{G}$, the expected rate of change in q, $D^e(q)$, is zero. When $G > \hat{G}$, the expected rate of change in q is given by:

$$D^e(q) = -\epsilon(G - \hat{G}) + (\xi\rho/l)[D(G)], \tag{50}$$

where $\epsilon = (1 + \xi)(\rho/l) > 0$, and $D(G) = g$ is the flow of intervention when no devaluation takes place. This result reflects the assumption that if a devaluation occurs during the next brief time interval, the expectation of a further devaluation during the following brief time interval falls to zero.

With these assumptions, it follows that during the period between devaluations, when $G < \hat{G}$, q is constant at the level q determined by (42), and the evolution of A and G are determined by the dynamic system of (45) and (46). The comments previously made about this dynamic system apply here as well, except for the fact that in this case, the intervention tends to support the foreign exchange value of domestic money, and G is generally growing over time. When G reaches $\hat{G}$ and before the devaluation actually occurs, q is determined by (49) and the evolution of A and G are determined by the dynamic system:

$$(51)\qquad D(A) = w - \mu A + \alpha\sigma\epsilon(G - \hat{G}) - (\alpha\sigma\xi\rho/l)[D(G)]$$

$$(52)\qquad D(G) = r^*G - (r^* + \mu)A + w - vz + \alpha\sigma\epsilon(G - \hat{G}) - (\alpha\sigma\xi\rho/l)[D(G)] + (v/l)[\bar{m} - \bar{e} - p^* - k + \xi\rho(G - \hat{G})].$$

This dynamic system has one negative characteristic root, $\lambda_1 > -\mu$, and one positive characteristic root, $\lambda_2 > r^*$. As in the previous case, the negative root is associated with the process of convergence of the private stock of net foreign assets toward its steady-state level; and the positive root is associated with the explosive behavior of the stock of government debt. The fact that the positive characteristic root is now greater than its previous value of r^* indicates that private agents' anticipation of a devaluation contributes to the explosive tendency of the dynamic system. The economic explanation of this result is the following. As private agents come to expect a significant probability of a devaluation of the nominal exchange rate, the domestic nominal interest rate must rise and the demand for domestic money must decline. To offset this factor tending to reduce the demand for domestic money and thus maintain money market equilibrium, q must rise. This rise in q implies an increase in the flow of intervention required to maintain the nominal exchange rate and the nominal money supply and sustain balance-of-payments equilibrium. In turn, this larger flow of intervention accelerates the growth of the outstanding stock of government debt and thereby further accelerates the explosive tendency of the dynamic system. Moreover, as $D^e(e)$ rises as the result of increases in the assessed probability of devaluation and in the expected magnitude of devaluation, private agents no longer expect a zero rate of change in the real exchange rate. Initially, when G is near $\hat{G}$, $D^e(q)$ is negative because the expected effect of the growth of G (conditional on no devaluation), $(\xi\rho/l)[D(G)]$, outweighs the expected effect of devaluation (conditional on its occurrence), $-\epsilon(G - \hat{G})$. This initial negative value of $D^e(q)$ tends to reduce the extent of intervention required to maintain balance-of-payments equilibrium and partially offsets the acceleration of the growth of G induced by the higher level of q. Later, when G grows large relative to $\hat{G}$, $D^e(q)$ will become positive and thus become yet another factor contributing to the explosive tendency of the dynamic system.

The behavior of the real exchange rate and the nominal and real interest rates in this dynamic process are as follows. So long as G remains below $\hat{G}$, q is constant at the level determined by equation (42), which is above the value that q would have if the nominal exchange rate was not sustained by intervention in support of the pegged foreign exchange value of domestic money. Indeed, as shown in section 2.2, the excess of spending over income that is financed by the fiscal effect of intervention in the foreign exchange market may be thought of as the proximate cause of the higher level of q. Since $D^e(e) = 0$ and $D^e(q) = 0$ while G remains below $\hat{G}$, the domestic nominal interest rate remains at the level of the world nominal interest rate, i^*, and the domestic real interest rate remains at the level of the world real interest rate, r^*. As G rises above $\hat{G}$, the level of q determined by equation (49) is forced higher and higher by rising assessments of the probability and likely extent of devaluation, as summarized by the increasing value of $D^e(e) = \rho(G - \hat{G})$. As $D^e(e)$ rises, the domestic nominal interest rate rises further and further above the world nominal interest rate.

The domestic real interest rate follows a somewhat different pattern. When G initially rises just above $\hat{G}$, the expected real domestic interest rate, $r = r^* - \sigma D^e(q)$, falls below r^* because the positive effect of expected growth in G (conditional on no devaluation) on $D^e(q)$, $(\xi\rho/l)[D(G)]$, outweighs the negative effect associated with the expectation of devaluation, $-\epsilon(G - \hat{G})$. Later on, the factor $-\epsilon(G - \hat{G})$ tending to induce a negative value of $D^e(q)$ outweighs the positive factor $(\xi\rho/l)[D(G)]$ tending to induce a positive value of $D^e(q)$, and $D^e(q)$ becomes negative. At this point the domestic real interest rate, $r^* - [\sigma D^e(q)]$, rises above the world real interest rate, r^*, and it continues to rise until the moment of devaluation.

The general features of this description of real exchange rate behavior and domestic nominal and real interest rate behavior apply under a broader range of assumptions about the conduct of monetary policy and exchange rate policy. Specifically, consider a policy under which the nominal exchange rate is depreciated at a predetermined rate of crawl, supplemented by occasional major devaluations, and the money supply is made to grow at a rate greater than the growth in the demand for money at the predetermined rate of crawl of the exchange rate. Suppose that when major devaluations occur under this general policy regime, they are of sufficient magnitude that for some time afterward private agents do not expect another major devaluation. Also suppose that the extent of the major devaluation is such that for some time afterward there is a balance-of-payments surplus (on an official settlements basis) that allows the government to repay loans used to finance the intervention in support of the exchange rate prior to the last major devaluation. Under these assumptions, the path of the real exchange rate and of other relevant variables will be something like the following.

In the initial period following a major devaluation, during which private agents do not predict another immediate major devaluation, the level of q is determined by the money market equilibrium condition to be:

$$(53) \qquad q = (1/l)(m - e - p^* - k),$$

where m and e are the policy-determined (but not constant) values of the (logarithm of the) money supply and the (logarithm of the) price of foreign exchange; and, for simplicity, p^* and k are assumed constant. By assumption, the rate of growth of the money supply, $D(m)$, is greater than the rate of crawl of the nominal exchange rate, $D(e)$. Thus, the level of q determined by (53) will be rising over time at the rate:

$$(54) \qquad D(q) = (1/l)[D(m) - D(e)].$$

The extent of the major devaluation is assumed to be such that the level of q for some period after the devaluation is consistent with an official settlements surplus, the magnitude of which is given by:

$$(55) \qquad D(G) = r^*G - (r^* + \mu)A - (\alpha\sigma/l)[D(m) - D(e)] + (v/l)(m - e - p^* - k).$$

The dynamic behavior of the private stock of net foreign assets during this period is given by:

$$(56) \qquad D(A) = w - \mu A - (\alpha\sigma/l)[D(m) - D(e)].$$

Assuming that private asset holders correctly anticipate the increase in q determined by (54), the domestic real interest rate, $r^* - \sigma D^e(q)$, remains below the world real interest rate during this period.

With the passage of time, the level of q determined by (53) rises sufficiently that the official settlements balance shifts from surplus to deficit. The repayment of government debt during the period of surplus, however, is assumed to restore confidence that there will not be an immediate major devaluation. Accordingly, the level of q, its rate of change, the extent of intervention required to maintain balance-of-payments equilibrium, and the rate of change in private net holdings of foreign assets continue to be determined by (53) through (56). When the cumulative effect of official settlements deficits pushes government borrowings above the critical level $\hat{G}$ at which private agents begin to suspect a significant probability of a major devaluation, these equations need to be modified along the lines previously discussed. The rate of increase in q is accelerated by rising expectations of the probability and likely magnitude of a major devaluation. The ex ante domestic real interest rate, $r = r^* - \sigma D^e(q)$ initially declines relative to the value it would have in the absence of anticipations of a major devaluation, but later r rises as G rises significantly above $\hat{G}$. The official settlements deficit and the rate of government borrowing to finance this deficit rise more rapidly as a consequence of anticipations of a major devaluation, thereby contributing to the explosive tendency of the dynamic system.

When the major devaluation occurs, the nominal price of foreign exchange (an increase in e) jumps up, and the real exchange rate (a reduction in q) jumps down. Subsequently, the just-described patterns of behavior of the real exchange rate, the domestic real interest rate, and the official settlements balance all repeat themselves until the next major devaluation.

Alternative assumptions about the conduct of monetary policy and exchange rate policy will yield different conclusions concerning the behavior of the real exchange rate and other related variables. Given the general purpose of this paper, the important general conclusion of this analysis is that the combination of a policy that controls the nominal money supply and a policy that controls the nominal exchange rate, supported by a policy of official intervention in the foreign exchange market, has some capacity to influence the behavior of the real exchange rate and other real economic variables. This capacity arises from two sources. First, the policy combination inevitably influences the behavior of the real value of the money supply, and this behavior should be expected to influence the behavior of other real variables, including the real exchange rate. Second, so long as the private sector does not adjust its spending relative to its income to offset fully the debt-financed difference between government spending and government revenue, the fiscal effect of sterilized intervention in the foreign exchange market will affect the aggregate difference between spending and income for the economy as a whole. It is through this channel that the intervention will affect the relative prices that sustain equilibrium in the goods markets. For this effect to be present, it is not essential that private asset holders totally disregard the future tax liabilities implicit in the current flow of government borrowing. But it is essential that they not reduce their own spending relative to their income to offset fully the government borrowing used to finance the intervention in the foreign exchange market. Of course, in order for this effect to be substantial, the flow of borrowing to finance the intervention must be large, and the offset of private sector spending in response to government borrowing must not be too great.

2.8 Conclusion

This paper has developed a general analytical framework that may be used to analyze how a variety of government policies and other exogenous disturbances can affect the real exchange rate and thereby influence the allocation of resources in ways similar to the effects of commercial policy. Two broad classes of government policies and exogenous disturbances can have such effects: policies and disturbances that affect the distribution of domestic spending between domestic goods and foreign (or traded) goods; and policies and disturbances that affect the level of domestic spending relative to domestic income. In some cases, the effects of such policies and disturbances on the real exchange rate and on the allocation of resources may be quite transparent, as is the case, for instance, when a government shifts its own spending from purchasing military equipment in the world arms market to pursuing domestic development projects that employ primarily domestic labor. In other cases, the mechanisms through which the real exchange rate is affected may be more obscure. They may be obscure, for example, in the case of capital controls that depress the relative price of domestic goods in terms of foreign goods by limiting the excess of domestic spending over domestic income that can be financed by an inflow of foreign capital. Another example is the case of a combined policy of pegging the path of the nominal exchange rate and fixing the path of the domestic nominal money supply, whereby the excess of government spending over government revenue appears under the guise of reserve losses or official foreign borrowing to support sterilized intervention in the foreign exchange market.

The model developed in this paper has essentially the same static structure as the two basic models that have traditionally been applied in the theory of international trade and in analyses of the effects of commercial policies. These are the standard two-country, two-commodity model summarized by Mundell (1968) and the dependent economy model of Salter (1959) and Swan (1960). The key innovation of the present analysis is that these models are made dynamic by taking account both of changes in net foreign asset positions caused by current-account imbalances and of the effects of changes in net asset positions and anticipated changes in relative prices on the relationship between spending and income. This innovation allows an analysis of policies and disturbances the effects of which cannot be fully appreciated within the context of a wholly static model. It permits analysis of, for example, temporary changes in commercial policies or changes in commercial policies that are anticipated to occur at a future date. It also allows us to examine temporary or anticipated future changes in either the level or the distribution of government spending, of capital controls, and of nonsustainable policies that fix, for some period of time, both the path of the nominal exchange rate and the path of the nominal money supply.

Finally, it is worthwhile emphasizing that the analytical framework developed in this paper can be applied to a wider set of issues than those examined here. For example, it is often suggested that some

Latin American countries suffered severe economic disturbances in the late 1970s and early 1980s, first, as a consequence of a sudden influx of foreign capital and, then, from an even more sudden curtailment of their capacity to borrow in the world capital market. This type of disturbance can easily be analyzed in the framework developed in this paper by specifying an appropriate path for the actual and expected evolution of the exogenous forcing variable, w, that influences the difference between income and spending. The influx of foreign capital would be represented by a downward shift in the actual and expected future values of w, which implies an increase in the real exchange rate (the relative price of domestic goods in terms of foreign goods) and a current-account deficit financed by the inflow of foreign capital. The sudden, unanticipated curtailment of access to foreign credit corresponds to an upward shift in the actual and expected future value of w to above the level it had before the influx of foreign credit. This shift induces a decline in the real exchange rate to below its level prior to the influx of foreign credit and an improvement in the trade balance of sufficient magnitude to allow the country to pay the interest on its expanded stock of foreign debt. The analysis carried out in this paper would suggest that a policy limiting international capital flows would reduce the sensitivity of the real exchange rate to this type of disturbance. The present framework is capable of analyzing any other form of disturbance that can be described as an alteration in the actual and expected time paths of either the exogenous variable that affects the desired distribution of spending or the exogenous variable that affects the relationship between spending and income.

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Comment Jeffrey A. Frankel

Mussa's paper is a masterful tour de force. Armed with a clean log-linear model and his usual clear expository style, Mussa sets out to conquer a veritable universe of macroeconomic questions. He examines the effects of shifts in the composition of government spending, tax cuts, capital controls, and some combinations of monetary policy and exchange rate policy, including a crawl with occasional major devaluations. Throughout he keeps track not only of the accumulating stock of foreign assets, as Pentti Kouri did in his classic exchange rate model, but also of the interest rate, interest payments in the international service account, the accumulating stock of government debt, and government interest payments. Furthermore, he also assumes perfect foresight and distinguishes between temporary and permanent policy changes.

My only reservations about the paper concern truth in advertising. First, the term *real exchange rate* is somewhat misleading because it is used for the price of domestic goods in terms of traded goods (q), whereas the more common usage is the inverse of this. Second, the terms *traded good* and *domestic good* are themselves misleading because *both* goods are in fact internationally traded, as I understand it. They should instead be called the "importable" and the "exportable" goods.

Third, it could be considered misleading to call the country under analysis "medium sized" instead of "large." The country produces some of each good, whereas the rest of the world produces only one, the importable good. There is therefore one sense in which the domestic country is bigger than the rest of the countries in the world. Finally, it is also misleading to present this paper at a conference on "Structural

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Adjustment and the Real Exchange Rate in Developing Countries" because the model has little to do with LDCs. Aside from the fact that the country in question is not a minor participant in the goods markets, it is a country with sufficiently developed financial markets that the government practices sterilized foreign exchange intervention and that the effect of a fiscal expansion is to cause a real appreciation of the currency. This characterization sounds more like the United States than Brazil.

I cannot resist recalling what they say about the Holy Roman Empire: It wasn't holy, it wasn't Roman, and it wasn't an empire.

My complaint that the paper is not particularly relevant to developing countries applies equally to several of the other papers presented here. We hear hardly anything about the international debt situation, for example. These are countries with serious problems—problems that have serious economic and political implications for the citizens of these countries and that are of serious intellectual interest for economists worldwide. To address these problems, we who in the past have worked primarily on the macroeconomics of the industrialized countries must do more than simply change the name of one of our jump variables.

Comment Kathie L. Krumm

In his very comprehensive paper, Mussa has examined a range of macroeconomic policies that affect the real exchange rate in a manner similar to the effects of commercial policy. In defining the discussion of any policy that affects the real exchange rate as equivalent to a discussion of the exchange rate as a tool of commercial policy, the paper is perhaps too broad ranging and not sufficiently focused.

Before returning to commercial policy and the topics I believe need more examination, I want to compliment the author on the integrated framework in which he has examined various policies. His handling of some of the dynamics is elegant, once I got used to the upside-down definition of the real exchange rate. I found a number of the results interesting. The modeling of capital controls, for example, illustrated the ways in which the macro economy and the real exchange rate respond quite differently to shocks in the presence of such controls; and the model is rich enough to allow for various formulations of capital controls. Furthermore, the shift of government expenditures between

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sectors is an interesting policy instrument to consider in theory, though it may not be a feasible instrument in practice, given the difficulties in identifying the degree of tradability of a sector, in integrating such an instrument into a budgeting framework, and in divorcing other sectoral concerns from the analysis.

This leads to me reason why this paper may not be relevant to most commercial policy concerns. Usually, commercial policy is not designed to affect the general relative price level, or we would see more uniform tariff rates and more effective protection rates. Instead, the policies are aimed at prices in particular sectors, either output prices or the prices of factors intensively used in a sector. If that is the case, it might be interesting to analyze which other macroeconomic policies have similar sectoral effects, such as sector-specific government expenditures, be they temporary or permanent, and capital controls favoring certain sectors. Another limitation of the paper for evaluating the role of the exchange rate as a tool of commercial policy is the absence of some framework for welfare analysis. For example, since both policies affect the real exchange rate in the same direction, when should the government shift expenditures to tradables rather than impose tariffs?

This paper seems to be motivated mainly by the adverse effects an appreciated real exchange rate is claimed to have on international trade competitiveness and employment, as appears to be the current situation in the United States, for instance. Mussa states at the outset his assumption of full employment, making it difficult to address a general concern with an appreciated real exchange rate as long as this has limited employment effects.

Finally, it is not clear how this analysis incorporates any features of the economy that are viewed as more critical for poor countries than for richer countries. Mussa's initial comment that governments often attempt to manipulate the real exchange rate for commercial policy purposes seems more relevant to developed than to developing countries. Nonetheless, the clean framework presented in this paper demonstrates the importance of understanding the interdependent effects of macroeconomic policies in both developing and developed countries and could be used to handle a number of issues raised in the study of macroeconomic adjustment packages.