THE DETERMINATION OF EQUILIBRIUM REAL EXCHANGE RATE*

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C H A P T E R 2

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ABSTRACT

This paper corresponds to Chapter 2 of the forthcoming book Real Exchange Rates, Devaluation and Adjustment: Exchange Rate Policy in Developing Countries. This work investigates several aspects related to exchange rates in developing nations. Theoretical models of equilibrium and disequilibrium exchange rates are developed; the behavior of real exchange rates is investigated for a large cross section of countries; and the effectiveness of devaluation is assessed for a group of 39 developing nations.

CHAPTER 2

The Determination of Equilibrium Real Exchange Rates

This chapter deals with the economics of equilibrium real exchange rates. It analyzes theoretically the way in which equilibrium real exchange rates react to a number of (real) disturbances, including terms of trade shocks, changes in the tax system and technological progress. Since real exchange rate misalignment is defined as <u>sustained departures of the actual real exchange rate from its equilibrium value</u>, the understanding of the economics of equilibrium real exchange rates is a fundamental first step in any attempt to understand real exchange rate misalignment and overvaluation.

Simplified views based on the Purchasing Power Parity theory have suggested that the equilibrium RER is a constant that does not vary through time. In rigor, however, there is no reason why the value of the RER required to attain internal and external equilibrium should be a constant number; it would indeed be an extraordinary coincidence if it was. Changing world conditions, productivity improvements, adjustments to trade barriers, and changes in taxation, among many other factors, will affect the path of RER compatible with the attainment of internal and external equilibrium. Only to the extent that we have a firm understanding of the way equilibrium RERs react to changes in their fundamental determinants, can we meaningfully discuss issues related to sustained deviations of actual RERs from their equilibrium value, or RER misalignment.

In this chapter, a benchmark intertemporal general equilibrium model of a small open economy is developed to analyze how the equilibrium path of the real exchange rate responds to a series of disturbances. The benchmark model assumes that the economy is formed by optimizing consumers and producers, and by a government. It is also assumed that there is perfect foresight. The importation of commodities is subject to a tariff, while foreign borrowing is subject to a nonprohibitive tax. There is investment; however, it is assumed that the labor force does not grow. The model is set up using intertemporal duality theory, and emphasizes the intertemporal linkages between different shocks and relative prices. This model provides an abstract minimal real framework to analyze the behavior of equilibrium RERs. Throughout most of the benchmark analysis it is assumed that prices are flexible, and that there is full employment and perfect competition. Later in the chapter some of these assumptions are relaxed and the way in which RER react under alternative conditions -- including rigid wages and unemployment -- are discussed. The strategy followed in this chapter is to concentrate on essentials, eschewing unnecessary complications. For this reason the model is completely real; the role of monetary disturbances and their effect on actual RERs behavior, misalignment and overvaluation is relegated to Chapter 3.

2.1. Equilibrium Real Exchange Rates

The equilibrium real exchange rate (ERER) is that relative price of tradables to nontradables that, for given sustainable (equilibrium) values of other relevant variables such as taxes, international prices and technology, results in the simultaneous attainment of internal and external equilibrium.[1] Internal equilibrium means that the nontradable goods market clears in the current period, and is expected to be in equilibrium in future periods. In this definition of equilibrium RER it is implicit the idea that this equilibrium takes place with unemployment at the "natural" level. External equilibrium, on the other hand, is attained when the intertemporal budget constraint that states that the discounted sum of a country's current account has to be equal to zero, is satisfied. In other words, external equilibrium means that the current account balances (current and future) are compatible with long run sustainable capital flows.[2]

A number of important implications follow from this definition of equilibrium real exchange rate. First, as noted above, the ERER is not an immutable number. When there are changes in any of the other variables that affect the country's internal and external equilibria, there will also be changes in the equilibrium real exchange rate. For example, the RER "required" to attain equilibrium will not be the same with a very low world price of the country's main export, than with a very high price of that good. In a sense, then, the ERER is itself a function of a number of variables including import tariffs, export taxes, real interest rates, capital controls and so on. These immediate determinants of the ERER are the <u>real exchange rate "fundamentals"</u>. Second, the ERER will not only be affected by current "fundamentals," but also by the expected future evolution of these variables. To the extent that there are possibilities for intertemporal substitution of consumption via foreign borrowing and lending, and of intertemporal substitution in production via investment, expected future events -- such as an expected future change in the international terms of trade, for example -- will have an effect on the current value of the ERER. In particular, the behavior of the equilibrium real exchange rate will depend on whether changes in fundamentals are perceived as being permanent or temporary. If there is perfect international borrowing, a temporary disturbance to, say, the terms of trade, will affect the complete future path of equilibrium RERs. However, if there is rationing in the international credit market, intertemporal substitution through consumption will be cut, and temporary disturbances will tend to affect the ERER in the short run only. In this case a distinction between short-run and long-run equilibrium real exchange rates becomes useful.

2.2. A Benchmark Model of Equilibrium Real Exchange Rates

In order to formally model the behavior of equilibrium real exchange rates it is necessary to develop a complete intertemporal framework able to capture how both policy induced disturbances and exogenous shocks affect the path of equilibrium relative prices in the economy. In this chapter such a framework is developed, and the way in which equilibrium RERs react to a series of changes in "fundamentals" is analyzed. We start with the benchmark case, characterized by a highly stylized intertemporal model with full employment, no price rigidities and no international credit rationing. This allows us to understand the most fundamental aspects of the economics of equilibrium real exchange rates. We then relax some of these assumptions, and investigate the ways in which the results are altered.

Although the framework used in this chapter is general enough as to accommodate many goods and factors, it is useful to think of this small economy as being comprised of a large number of profit maximizing firms, that produce three goods -- exportables (X), importables (M) and nontradables (N) -- using constant returns to scale technology, under perfect competition. It is assumed that there are more factors than tradable goods, so that factor price equalization does not hold. One way to think about this is by assuming that each sector uses capital, labor and natural resources.

There are two periods only -- the present (period 1) and the future (period 2) -- and there is perfect foresight. Residents of this small country can borrow or lend internationally. There are, however, taxes on foreign borrowing; the domestic (real) interest rate exceeds the world interest rate. The intertemporal constraint states that at the end of period 2 the country has paid its debts. The importation of M is subject to specific import tariffs both in periods 1 and 2. In this model the current account is equal to savings minus investment in each period. Consumers maximize intertemporal utility and consume all three goods.

There is a government that, in the general case, consumes both tradables and nontradables. Government expenditure is financed from four sources: nondistortionary taxes, proceeds from import tariffs, proceeds from the taxation of foreign borrowing by the private sector, and borrowing from abroad. As in the case of the private sector, the government is subject to an intertemporal constraint: the discounted value of government expenditure (including foreign debt service) has to equal the discounted value of income from taxation.

In addition to the private sector and government budget constraints, internal equilibrium requires that the nontradable market clears <u>in each period</u>. That is, the quantity supplied of nontradables has to equal the sum of the private and public sectors demands for these goods. The model is completely real; there is no money or other nominal assets.

<u>Revenue and Expenditure Functions</u>

A convenient and elegant way of setting up this intertemporal optimizing model is by using duality theory.[3] A tilde (~) over a variable indicates that that is a period 2 variable (i.e., $\tilde{R}$ is the revenue function in period 2); subscripts refer to partial derivatives with respect to that variable (i.e., R_q is the partial derivative of R with respect to q; $\tilde{R}_{\tilde{q}\tilde{p}}$ is the second derivative of $\tilde{R}$ with respect to $\tilde{q}$ and $\tilde{p}$). Throughout the model we set the world price of exportables as the numeraire.

The production side of the model is characterized, in each period, by revenue functions -- R and $\tilde{R}$ for periods 1 and 2 -- that give us the maximum revenue that optimizing firms obtain from producing X, M and N, subject to prevailing domestic prices, available technology -- summarized by the production possibilities function F( ) -- and available factors of production.[4] For period 1 the revenue function is given by:

$$R = \max\{Q_X + pQ_M + qQ_N \;/\; F(Q,V) \leq 0\} \tag{2.1}$$

where Q_X, Q_m, Q_N are quantities produced of exportables, importables and nontradables in that period. Q is a vector that summarizes these quantities produced; V is a vector of factors of production; $F(\;)$ is the production function that summarizes existing technology; p is the domestic price of importables relative to exportables; and q is the price of nontradables relative to exportables in period 1. Equation (2.1) can then be rewritten in the following way:

$$R = R(p,q,V) \tag{2.2}$$

This is the maximized value of output in period 1 in terms of exportables. Naturally, the revenue function for period 2 can be written in a similar way.

Revenue functions have a number of convenient properties that make their use in formal modeling highly attractive. First, their derivatives with respect to prices yield the corresponding supply functions (Dixit and Norman 1980, pp. 31-33). Thus, if we denote the partial derivatives with respect to a particular argument by a subindex, we have that:

$$\begin{aligned} &\frac{\partial R}{\partial p} = R_p = Q_M(p,\ldots) \quad \text{supply function of } M \text{ in period } 1 \\ &\frac{\partial \tilde{R}}{\partial \tilde{q}} = \tilde{R}_{\tilde{q}} = \tilde{Q}_N(\tilde{q},\ldots) \quad \text{supply function of } N \text{ in period } 2. \end{aligned} \tag{2.3}$$

Another convenient property of revenue functions is that they are convex, implying that $R_{pp} = \frac{\partial Q_M}{\partial p} \geq 0$ and that $R_{qq} = \frac{\partial Q_N}{\partial q} \geq 0$. That is, supply curves slope upwards. We assume that the three goods compete for the given amount of resources, and that there are no intermediate inputs; thus, the cross price derivatives of the revenue functions are negative.[5]

Consumers are assumed to maximize the present value of utility, subject to their intertemporal constraint. Assuming that the utility function is time separable, with each subutility function homothetic, the representative consumer problem can be stated as follows:

$$\max W(U(C_N, C_M, C_X),\ \tilde{U}(\tilde{C}_N, \tilde{C}_M, \tilde{C}_X)) \tag{2.4}$$

subject to

$$C_X + pC_M + qC_M + \delta(\tilde{C}_X + \tilde{p}\tilde{C}_M + \tilde{q}\tilde{C}_N) \leq \text{Wealth}$$

where W is the utility function; U and $\tilde{U}$ are periods 1 and 2 subutility functions; C_N, C_M, C_X $(\tilde{C}_N, \tilde{C}_M, \tilde{C}_X)$ are consumption of N, M and X in period 1(2). As before, p and $\tilde{p}$ are the (domestic) price of importables relative to exportables in periods 1 and 2, and q and $\tilde{q}$ are the price of nontradables relative to exportables in periods 1 and 2. δ is the domestic discount factor equal to $(1+r)^{-1}$, and r is the domestic real interest rate in terms of the exportable good.

Wealth is the discounted sum of consumer's income in both periods. Income, in turn, is given in each period by three components: (1) income from labor services rendered to firms; (2) income from the renting of capital stock that consumers own to domestic firms; (3) and income obtained from government transfers. Given the nature of preferences, the consumer optimization problem can be thought of as taking place in two stages. First, the consumer decides how to allocate her wealth across periods.

Second, she decides how to distribute each period (optimal) expenditure across the three goods.

The demand side of the model can be conveniently summarized by a twice differentiable concave expenditure function, that gives the minimum discounted value of expenditure required to attain a level of utility $\tilde{W}$, for given domestic prices in periods 1 and 2:

$$E = \min\{C_X + pC_M + qC_N + \delta(\tilde{C}_X + \tilde{p}\tilde{C}_M + \tilde{q}\tilde{C}_X)\} \tag{2.5}$$

subject to $W(U,\tilde{U}) \geq \tilde{W}$. Where C_X, C_M, C_N and $\tilde{C}_X, \tilde{C}_M, \tilde{C}_N$ refer to consumption of exportables, importables and nontradables in periods 1 and 2. This expenditure function can be written as a function of prices and utility only (Dixit and Norman 1980):

$$E = E(p,q,\delta\tilde{p},\delta\tilde{q};W) \tag{2.6}$$

Furthermore, since we have assumed that the utility function is weakly separable with each period subutility homothetic, equation (2.6) can be written as:

$$E = E(\pi(p,q),\ \delta\tilde{\pi}(\tilde{p},\tilde{q});W) \tag{2.7}$$

where $\pi(\ )$ and $\tilde{\pi}(\ )$ are exact price indexes for periods 1 and 2, and are interpreted as unit expenditure functions (see Svensson and Razin, 1983). A convenient property of the expenditure function is that its partial derivatives with respect to prices are equal to the respective compensated (Hicksian) demand function. For example, the derivative of E with respect to p is equal to the compensated demand function for importables in period 1. In general, the following relations hold (where, as before, subindexes refer to partial derivatives with respect to that argument):

$$E_p = \frac{\partial E}{\partial \pi}\frac{\partial \pi}{\partial p} = E_\pi \pi_p = D_M(p,\ldots)$$

$$E_q = \frac{\partial E}{\partial \pi}\frac{\partial \pi}{\partial q} = E_\pi \pi_q = D_N(q,\ldots) \tag{2.8}$$

$$E_{\tilde{p}} = \frac{\partial E}{\partial \tilde{\pi}}\frac{\partial \tilde{\pi}}{\partial \tilde{p}} = E_{\tilde{\pi}} \tilde{\pi}_{\tilde{p}} = \tilde{D}_M(\tilde{p},\ldots)$$

$$E_{\tilde{q}} = \frac{\partial E}{\partial \tilde{\pi}}\frac{\partial \tilde{\pi}}{\partial \tilde{q}} = E_{\tilde{\pi}} \tilde{\pi}_{\tilde{q}} = \tilde{D}_M(\tilde{q},\ldots)$$

where $D_M(\tilde{D}_M)$ and D_N $(\tilde{D}_N)$ are the Hicksian demand functions for M and N in period 1(2), and π_p amd π_q are the derivatives of the exact price indexes with respect to the relative prices of importables and nontradables in period 1. Since the π's are unit expenditure functions, these derivatives can be interpreted as expenditure shares of M and N in period 1. By concavity of E it follows that the second own derivatives are negative -- E_{pp}, E_{qq}. $E_{\tilde{p}\tilde{p}}$, $E_{\tilde{q}\tilde{q}} < 0$ -- reflecting the fact that the demand curves slope downward. Given our assumption of time-separable utility function, expenditure in periods 1 and 2 are substitutes, implying that all intertemporal cross elasticities are positive. However, since in every period there are three goods, any two of them can be complements. It is possible, then, that in each period one of the <u>intra</u>temporal cross elasticities will be negative.

<u>The Model</u>

The general model is given by equations (2.9) through (2.18), where the (world) price of exportables has been taken as the numeraire:

$$R(1,p,q,V,K) + \delta\tilde{R}(1,\tilde{p},\tilde{q};\tilde{V},K+I)$$
$$- I(\delta) - T - \delta\tilde{T} = E(\pi(1,p,q),\delta\tilde{\pi}(1,\tilde{p},\tilde{q}),W), \tag{2.9}$$

$$G_X + p^*G_M + qG_N + \delta^*(\tilde{G}_X + \tilde{p}^*\tilde{G}_M + \tilde{q}\tilde{G}_N) = \tau(E_p - R_p) + \delta^*\tilde{\tau}(E_{\tilde{p}} - \tilde{R}_{\tilde{p}})$$
$$+ b(NCA) + T + \delta^*\tilde{T} \tag{2.10}$$

$$R_q = E_q + G_N, \tag{2.11}$$

$$\tilde{R}_{\tilde{q}} = E_{\tilde{q}} + \tilde{G}_N \tag{2.12}$$

$$p = p* + \tau, \tag{2.13}$$

$$\tilde{p} = \tilde{p}* + \tilde{\tau}, \tag{2.14}$$

$$\delta\tilde{R}_K = 1, \tag{2.15}$$

$$P_T^* = \gamma P_M^* + (1-\gamma)P_X^*;\ \tilde{P}_T^* = \gamma\tilde{P}_M^* + (1-\gamma)\tilde{P}_X^*;\ (P_X^* = \tilde{P}_X^* = 1) \tag{2.16}$$

$$RER = (P_T^*/P_N);\ R\tilde{E}R = (\tilde{P}_T^*/\tilde{P}_N) \tag{2.17}$$

Table 2.1 contains the notation used.

Equation (2.9) is the intertemporal budget constraint for the private sector and states that present value of income valued at domestic prices has to equal present value of private expenditure. Given the assumption of a tax on foreign borrowing, the discount factor used in (2.9) is the domestic factor δ smaller than the world discount factor $\delta*$.

Equation (2.10) is the government intertemporal budget constraint. It states that the discounted value of government expenditure has to equal the present value of government income from taxation. Notice that since the government does not have to balance its budget period-by-period, equation (2.11) implicitly assumes that the government can borrow from abroad.[6] If period 1 income falls short of expenditure, the difference is made up with foreign loans. Since this is a two periods model, the amount of borrowing in period 1 is equal to the stock of public debt at the end of the period. Alternatively, one can assume that in period 1 the government "inherits" a certain stock of foreign debt (see Frenkel and Razin, 1987). There is, however, no domestic debt. NCA, which is equal to $(\tilde{R}-\tilde{\pi}E_{\tilde{\pi}})$ in (2.10) is the private sector current account surplus in period 2; b(NCA) is the discounted value of taxes on foreign borrowing paid by the private sector.

Table 2.1

Notation Used in Model of Equilibrium Real Exchange Rates

$R(\ )$; $\tilde{R}(\ )$	Revenue functions in periods 1 and 2. Their partial derivatives with respect to each price are equal to the supply functions.
p; $\tilde{p}$	Domestic relative price of importables in period i.
q; $\tilde{q}$	Relative price of nontradables in period i.
V; $\tilde{V}$	Vector of factors of production, excluding capital.
K	Capital stock in period 1.
$I(\ )$	Investment in period 1.
δ^*	World discount factor, equal to $(1+r^*)^{-1}$, where r^* is world real interest rate in terms of exportables.
δ	Domestic discount factor, equal to $(1+r)^{-1}$. Since there is a tax on foreign borrowing, $\delta < \delta^*$.
$b = (\delta^*-\delta)$	Discounted value of tax payments per unit borrowed from abroad.
p^*; $\tilde{p}^*$	World relative price of imports in period i.
τ; $\tilde{\tau}$	Import tariffs in period i.
T; $(\tilde{T})$	Lump sum tax in period i.
G_X, G_M, G_N; $\tilde{G}_X, \tilde{G}_M, \tilde{G}_N$	Quantities of goods X, M and N consumed by government in periods 1 and 2.
$E(\ )$	Intertemporal expenditure function.
$\pi(1,p,q)$; $\tilde{\pi}(\ )$	Exact price indexes for periods 1 and 2; which under assumptions of homothecity and separability, corresponds to unit expenditure functions.
W	Total welfare.

Table 2.1 continued

NCA	Noninterest current account of the private sector in period 2.
P^*_M, P^*_X; $\tilde{P}^*_M, \tilde{P}^*_X$	Nominal world prices of M and X in periods 1 and 2. Notice that we assume that $P^*_X = \tilde{P}^*_X = 1$.
P_N; $\tilde{P}_N$	Nominal price of nontradables in periods 1 and 2.
P^*_T; $\tilde{P}^*_T$	World prices of tradables, computed as an index of the prices of X and M.
RER; $\tilde{\text{RER}}$	Definition of the real exchange rate in period i.

Notice that the use of the world discount factor $\delta*$ in (2.10) reflects the assumption that in this model the government is not subject to the tax on foreign borrowing.

Equation (2.11) and (2.12) are the equilibrium conditions for the nontradables market in periods 1 and 2; in each of these periods the quantity supplied of N (R_q and $\tilde{R}_{\tilde{q}}$) has to equal the sum of the quantity demanded by the private sector (E_q amd $E_{\tilde{q}}$) and by the government. Given the assumptions about preferences (separability and homothecity) the demand for N by the private sector in period 1 can be written as:

$$E_q = \pi_q E_\pi, \tag{2.18}$$

where π_q is the share of nontradables in period 1's expenditure, and E_π is <u>real</u> consumption (on all goods) in period 1. A corresponding expression holds for period 2.

Equations (2.13) and (2.14) specify the relation between domestic prices of importables, world prices of imports, and tariffs. It is assumed that the initial level of the import tariffs are those that the authorities deem compatible with, or conducive to, the desired long run allocation of resources. In that sense, then, in this chapter we will assume that tariffs are changed in order to generate a <u>new</u> desired allocation of resources, rather than to help establish balance of payments equilibrium. In Chapter 3, however, we will discuss the role of tariff hikes under conditions of balance of payments crises and real exchange rate overvaluation.

Equation (2.15) describes investment decisions, and states that profit maximizing firms will add to the capital stock until Tobin's "q" equals 1. This expression assumes that the stock of capital is made up of the numeraire good. This is only a simplifying assumption that helps clarify the exposition. Assuming that the capital is made up of other goods complicates the algebra without affecting in a significant way the results.

In this model we can distinguish between the "exportables real exchange rate" $(1/q)$ and the "importables real exchange rate" (p/q). Since the relative price of X and M can change we cannot really talk about a tradable goods composite. It is still possible, however to compute how an index of tradables prices evolve through time. Equation (2.16) is the definition of the price index for tradables, where γ and $(1-\gamma)$ are the weights of importables and exportables.[7] Equation (2.17) defines the real exchange rate index as the domestic relative price of tradables to nontradables. Equations (2.9) through (2.17) fully describe the inter and intratemporal (external and internal) equilibria in this economy.

Equilibrium Real Exchange Rates

In this model there is not one equilibrium value of the real exchange rate, but rather a vector of equilibrium relative prices and RERs. In fact, we can talk about the equilibrium path for the RER. Within this intertemporal framework the equilibrium RER in a particular period is defined as that relative price of tradables that, for given sustainable (equilibrium) values of other variables, such as world prices, technology and tariffs, equilibrates simultaneously the external and internal (i.e., nontradables) sectors. The vector of equilibrium RERs, $RER = (RER, R\tilde{E}R)$ is composed of those RERs that satisfy equations (2.9) through (2.17) for given values of the other fundamental variables. Notice that since we have assumed no rigidities, externalities, or market failures, our equilibrium real exchange rates imply the existence of "full" employment (see, however, sections 3 and 6).

From the inspection of equations (2.9)-(2.17) it is apparent that exogenous shocks in, say, the international terms of trade, will affect the vector of equilibrium relative prices and RERs through two interrelated channels. The first one is related to the intratemporal effects on resource allocation and consumption and production decisions. For example, as a result of a temporary worsening of the terms of trade, there will be a tendency to produce more and consume less of M in that period. This, plus the income effect resulting from the worsening of the terms of trade will generate an incipient disequilibrium in the nontradables market which will have to be resolved by a change in relative prices and in the equilibrium RER. In fact, if we assume that there is an absence of foreign borrowing these intratemporal effects will be the only relevant ones. However, with capital mobility and investment, as in the current model, there is an additional intertemporal channel through which changes in exogenous variables will affect the vector of equilibrium RERs. For example, in the case of a worsening of the terms of trade, the consumption discount factor $\tilde{\pi}\delta/\pi$ will be affected, altering the intertemporal allocation of consumption. Also, in that case the investment equilibrium condition (2.15) will be altered, affecting future output.

Naturally, without specifying the functional forms of the expenditure, revenue, and other functions in (2.9)-(2.17) it is not possible to write the vector of equilibrium relative prices of nontradables, nor the equilibrium real exchange rates, in an explicit form. It is possible, however, to write them implicitly as functions of all the sustainable levels of all exogenous variables (contemporaneous and anticipated) in the system:

$$RER = h(p^*, \tilde{p}^*, \tau, \tilde{\tau}, \delta, \delta^*, V, T, \tilde{T}, G_X, \tilde{G}_X, \ldots) \qquad (2.19)$$

$$\tilde{RER} = \tilde{h}(p^*, \tilde{p}^*, \tau, \tilde{\tau}, \delta, \delta^*, \tilde{V}, T, \tilde{T}, G_X, \tilde{G}_X, \ldots) \qquad (2.20)$$

Since the equilibrium relative price of nontradables is directly related -- through equation (2.17) -- to the equilibrium RER index, once the equilibrium relative prices of nontradables have been found, it is straightforward to use equation (2.17) to compute the vector of equilibrium RERs (2.19) and (2.20).

A crucial question is related to the way in which the equilibrium vectors of relative prices and RERs will change in response to different types of disturbances. That is, we are interested in the (most plausible) signs of the partial derivatives of RER and $\tilde{RER}$ with respect to their determinants. In the sections that follow the reaction of equilibrium RERs to exogenous changes in tariffs, terms of trade, exchange controls, government expenditure, and technology, are analyzed in some detail. Since the model in (2.9) through (2.17) is fairly complicated, we have adopted a strategy where for each particular distortion we use a slightly simplified version of the general model, that allows us to ignore aspects not essential to the question we are addressing.

2.3. Tariffs and Equilibrium Real Exchange Rates

In the economic development policy literature it has long been recognized that there is a relation between sustainable (i.e., long run) tariffs level and the equilibrium value of the real exchange rate. Much of this discussion has taken place within the context of trade liberalization reforms, and has dealt with the effect of (long term) tariff reductions on the equilibrium real exchange rate. Most of the analyses, however, have been quite vague and have been carried out in a partial equilibrium context. The traditionally accepted view among policymakers has been that a reduction in tariffs in a small country will always "require" a real (equilibrium) depreciation to maintain external balance. The argument usually given is based on a partial equilibrium interpretation of the elasticities approach, and runs along the following lines: a lower tariff will reduce the domestic price of importables, and consequently increase the demand for imports. This, in turn, will generate an external imbalance (i.e., a trade account deficit), which assuming that the Marshall-Lerner condition holds, will require a (real) devaluation to restore equilibrium. This view is clearly captured by the following quote from Balassa (1982, p. 16): "[E]liminating protective measures would necessitate a devaluation in order to offset the resulting deficit in the balance of payments".[8]

A common feature of most early models is that they were basically static, ignoring intertemporal effects. Also, these partial equilibrium models didn't incorporate explicitly the role of nontradable goods.

In order to formally analyze the interaction between tariffs, terms of trade and the RER, in this section we present a simplified version of the general model of equilibrium real exchange rates.[9] The main simplifications are: (1) we assume no government consumption; (2) we assume that there is no investment; and (3) we assume that there are no taxes on foreign borrowing. The domestic and foreign discount factors are thus equal, $\delta = \delta^*$. Later, however, we lift the non-investment assumption. This simplified model is summarized in equations (2.21) through (2.25), where the same notation as in Table 2.1 has been used:

$$R(1,p,q;V) + \delta^*\tilde{R}(1,\tilde{p},\tilde{q},\tilde{V}) + \tau(E_p - R_p) + \delta^*\tilde{\tau}(E_{\tilde{p}} - \tilde{R}_{\tilde{p}}) = E[\pi(1,p,q),\delta^*\tilde{\pi}(1,\tilde{p},\tilde{q}),W]. \tag{2.21}$$

$$R_q = E_q;\ \tilde{R}_{\tilde{q}} = E_{\tilde{q}} \tag{2.22}$$

$$p = p^* + \tau;\ \tilde{p} = \tilde{p}^* + \tilde{\tau}. \tag{2.23}$$

$$CA = R(\ ) + \tau(E_p - R_p) - \pi E_\pi \tag{2.24}$$

$$RER = (P_T^*/P_N);\ \tilde{R}ER = (\tilde{P}_T^*/\tilde{P}_N). \tag{2.25}$$

Equations (2.21)-(2.25) can be manipulated to find out how the vector of equilibrium RERs and the current account respond to disturbances such as changes in tariffs, shocks to the international terms of trade, international transfers, and changes in world interest rates.

Equation (2.21) is the intertemporal budget constraint, and states that present value of income -- generated through revenues from optimized production $R + \delta^*\tilde{R}$, plus tariffs collection -- has to equal present value of expenditure. Given the assumption of perfect access to the world capital market, the discount factor used in (2.21) is the world discount factor δ^*. Equations (2.22) are the equilibrium conditions for the nontradables market in periods 1 and 2. Equations (2.23) specify the relation between domestic prices of importables, world prices of imports and tariffs. Equation (2.24) describes the current account in period 1 as the difference between income and total expenditure in that period. Finally, equation (2.25) is the definition of the real exchange rate in period i. Following the discussion above, the vector of equilibrium RERs is defined as the pair RER and $\tilde{R}ER$ for which equations (2.21) through (2.24) hold simultaneously. That is, it is the vector of real exchange rates for which external and internal equilibrium is jointly attained, for given values of other key variables, such as external terms of trade, tariffs, world interest rates and tariffs. It is important to emphasize that in (2.21)-(2.25), as in the more general model, tariffs are used to alter long-run resource allocation, and not as a way to combat a balance of payments crisis. All exercises on tariff changes that follow, should be viewed, then, as responding to efforts aimed at changing this long run allocation of resources.

Figure 2.1 summarizes the initial equilibrium in the nontradables market in periods 1 and 2. Schedule HH depicts the combination of q and $\tilde{q}$ consistent with equilibrium in the nontradable goods market in period 1. Its slope is equal to:

$$\left.\frac{dq}{d\tilde{q}}\right|^{HH} = \frac{E_{q\tilde{q}}}{(R_{qq}-E_{qq})} > 0 \qquad (2.26)$$

where $E_{q\tilde{q}}$ is an intertemporal cross demand term that captures the reaction of the demand for N in period 1 (E_q) to an increase in nontradables prices in period 2. Since there are only two periods and the utility function is time separable, expenditure in periods 1 and 2 are substitutes, and thus this term is positive.[10] R_{qq} is the slope of the supply curve of N in period 1 and E_{qq} is the slope of the compensated demand curve. Then, $(R_{qq}-E_{qq})$ is positive. The intuition behind the positive slope of HH is the following: An increase in the price of N in period 2 will make consumption in that period relatively more expensive. As a result there will be a substitution away from period 2 and towards period 1 expenditure. This will put pressure on the market for N in period 1, and an incipient excess demand for N in that period will develop. The reestablishment of nontradable equilibrium in period 1 will require an increase the relative price of N.

Schedule $\tilde{H}\tilde{H}$ depicts the locus of q and $\tilde{q}$ compatible with nontradable market equilibrium in period 2. Its slope is positive and equal to:

$$\left.\frac{dq}{d\tilde{q}}\right|^{\tilde{H}\tilde{H}} = \frac{(\tilde{R}_{\tilde{q}\tilde{q}} - E_{\tilde{q}\tilde{q}})}{E_{q\tilde{q}}} > 0 \qquad (2.27)$$

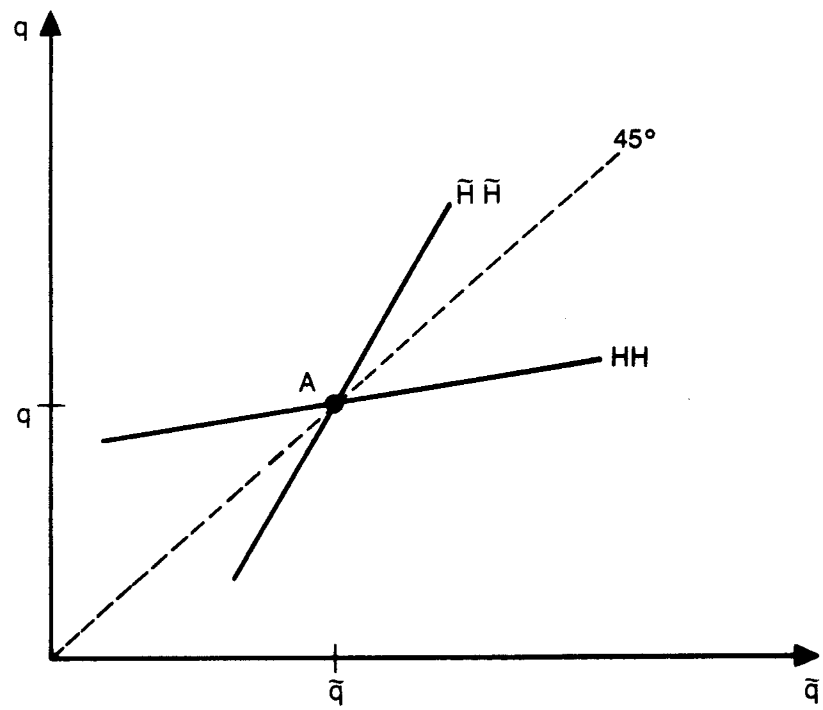


Figure 2.1

The intuition behind this positive slope is analogous to that of the HH schedule: an increase in q will make current consumption relatively more expensive, shifting expenditure into the future. As a result there will be a pressure on $\tilde{q}$, which will have to increase to reestablish equilibrium. Stability implies that the $\tilde{H}\tilde{H}$ schedule will be steeper than the HH curve (see Appendix).

The intersection of HH and $\tilde{H}\tilde{H}$ at A characterizes the (initial) relative prices of the nontradable goods market in periods 1 and 2 $(q,\tilde{q})$ compatible with the simultaneous attainment of intertemporal external equilibrium and internal equilibrium in both periods. In order to make the exposition clearer we have assumed that these equilibrium prices q and $\tilde{q}$ are equal; the 45° line passes through the initial equilibrium point A. Once the equilibrium values of q and $\tilde{q}$ are known, it is trivial to find RER and $\tilde{\text{RER}}$. Notice that the existence of intertemporal substitution in consumption is what makes these schedules slope upward. If there was no intertemporal substitution HH would be completely horizontal, while $\tilde{H}\tilde{H}$ would be vertical. Also, if this country had no access to borrowing in the international financial market, these schedules would be horizontal and vertical and there would be no intertemporal relation across nontradable markets.

Anticipated Future Import Tariffs and Equilibrium RERs

We now analyze how the anticipation of the future imposition of an import tariff will affect equilibrium RERs, and period 1's current account. In order to simplify the exposition we first assume that the initial condition is characterized by no import tariffs in either period $(\tau^1=\tau^2=0)$; this allows us to ignore first order income effects. Later we discuss the more general case of positive initial tariffs.

Consider the case where, in period 1, economic agents (correctly) expect that the government will impose an import tariff $\tilde{\tau}$ in period 2. This will shift both the HH and $\tilde{H}\tilde{H}$ schedules, generating a new vector of equilibrium relative prices, and real exchange rates. Let's first consider the case of the HH schedule. An anticipated import tariff in 2 means that the expected price of imports in that period will increase, making future consumption relatively more expensive. Consequently, via the intertemporal substitution effect, consumers will substitute expenditure away from period 2 and into period 1. This will result in an increase in the demand for all goods in period 1, including nontradables, and in a higher q. Consequently the HH curve will shift upward. The magnitude of this vertical shift is equal to:

$$dq\Big|_{d\tilde{q}=0}^{HH} = \{E_{q\tilde{p}}/(R_{qq}-E_{qq})\}\ d\tilde{\tau}. \tag{2.28}$$

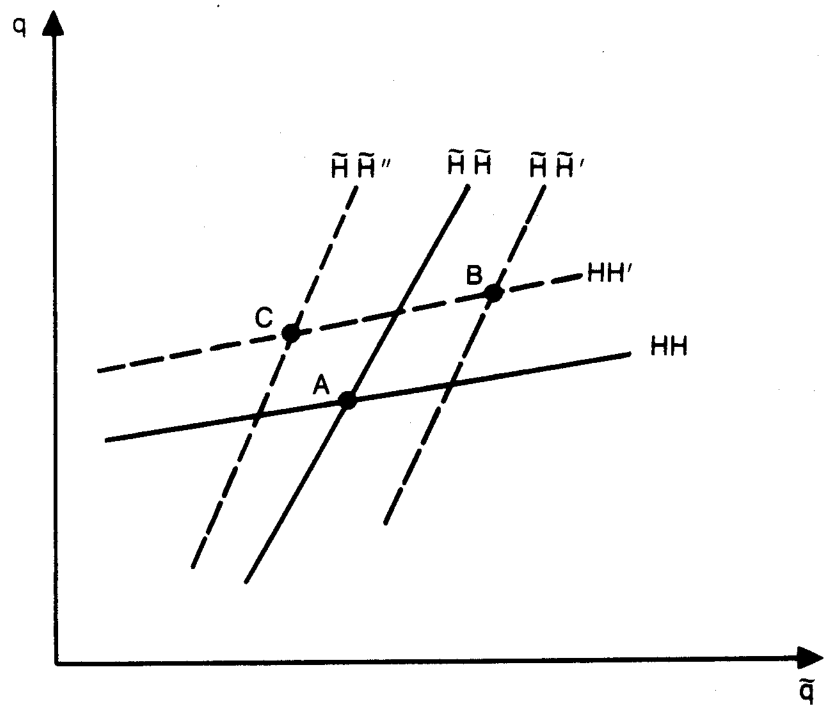
As this expression shows, the movement in the HH schedule is a reflection of the intertemporal degree of substitutability in consumption: it will be greater or smaller depending on whether $E_{q\tilde{p}}$ is large or small. In the extreme case of no intertemporal substitution $(E_{q\tilde{p}} = 0)$, the HH schedule will be horizontal, and will <u>not</u> shift as a result of expected future tariffs.

The imposition of an (anticipated) import tariff in period 2 will also affect the $\tilde{H}\tilde{H}$ schedule. In this case, however, in addition to the intertemporal effect already discussed, there will also be an intratemporal effect related to the change in relative prices in period 2. Since the expected tariff will make future consumption more expensive, the <u>inter</u>temporal effect will generate forces towards a reduction in $\tilde{q}$, and a leftward movement of $\tilde{H}\tilde{H}$. The <u>intra</u>temporal effect, on the other hand, can either reinforce or tend to offset those forces. The higher domestic price of imports in period 2 will reduce the quantity demanded of M in that period. Depending on whether importables and nontradables are substitutes or complements in consumption, in that period, the quantity demanded of N will increase or decline. If as is the most plausible case at this level of aggregation, N and M are substitutes in consumption, the imposition of the period 2 tariff will increase the demand for N. In this case the $\tilde{H}\tilde{H}$ curve will shift to the right. Under the more implausible assumption of complementarity ($E_{\tilde{q}\tilde{p}} < 0$) it may shift to the left. Formally, the horizontal shift of $\tilde{H}\tilde{H}$ is equal to:

$$d\tilde{q}\Bigg|_{dq=0}^{\tilde{H}\tilde{H}} = \frac{\left(E_{\tilde{q}\tilde{p}} - \tilde{R}_{\tilde{p}\tilde{q}}\right)}{\left(R_{\tilde{q}\tilde{q}} - E_{\tilde{q}\tilde{q}}\right)} d\tilde{\tau} \tag{2.29}$$

It is clear from (2.29) that a sufficient condition for the $\tilde{H}\tilde{H}$ to shift to the right is that $E_{\tilde{p}\tilde{q}} > 0$. In fact, unless otherwise indicated, in the rest of this chapter we will assume that M and N are substitutes in consumption, and that the intratemporal cross derivatives are positive.

Figure 2.2 illustrates the new equilibrium (point B) under our assumption that N and M are (net) substitutes: the new (after tariff anticipation) equilibrium schedules are HH′ and $\tilde{H}\tilde{H}'$. In this case the anticipation of an import tariff results in a higher relative price of nontradables in periods 1 and 2. That is, the equilibrium RER appreciates in both periods, as a result of the expected tariff. Notice, however, that there is nothing in the model that tells us which of the two curves shifts by more (see below for the exact expression for $(dq/d\tilde{\tau})$ and $(d\tilde{q}/d\tilde{\tau})$). This gives rise to the possibility of some interesting equilibrium paths for the RERs. For example, it is possible to observe an "equilibrium



q
$\tilde{H}\tilde{H}''$
$\tilde{H}\tilde{H}$
$\tilde{H}\tilde{H}'$
B
HH'
C
HH
A
$\tilde{q}$

Figure 2.2

overshooting", where (relative to the no-tariff case) q increases by more than $\tilde{q}$. This would be the case if the HH shifts to the left by more than what $\tilde{H}\tilde{H}$ shifts to the right. In this case the new equilibrium point is above the 45° line as illustrated in Figure 2.3.[11]

Figure 2.4 provides a diagrammatical illustration of four possible paths for the real exchange rate in periods 1 and 2 as a result of the anticipation of an import tariff. In these diagrams $\bar{q}$ is the equilibrium RER in both periods under the assumption of no tariffs, and is used as a benchmark for comparison. q and $\tilde{q}$ are the equilibrium relative prices in periods 1 and 2 in the anticipated tariff case. Panel (a) in Figure 2.4 illustrates what we have called "equilibrium overshooting" of the relative price, where in the tariff case q and $\tilde{q}$ are higher than in the non-tariff case, but the adjustment implies an equilibrium reduction of q in period 2. By analogy, case (b) can be called "equilibrium undershooting". Here both q and $\tilde{q}$ are also higher than in the non-tariff case. Now, however, the adjustment path requires an equilibrium increase of $\tilde{q}$ in period 2, over and above the higher q in period 1. Panel (c) is the most "traditional" case, where as a consequence of the anticipated tariff the RER appreciates by the same amount in both periods. Panel (d) depicts the case where the equilibrium RERs move in opposite directions in each period. In period 1 there is a real appreciation, relative to the non-tariff case, while in period 2, the period when the tariff is actually imposed, there is a real depreciation.

From equations (2.21) through (2.25) it is possible to formally find the equilibrium changes in q and $\tilde{q}$ as a result of the anticipated import tariff:

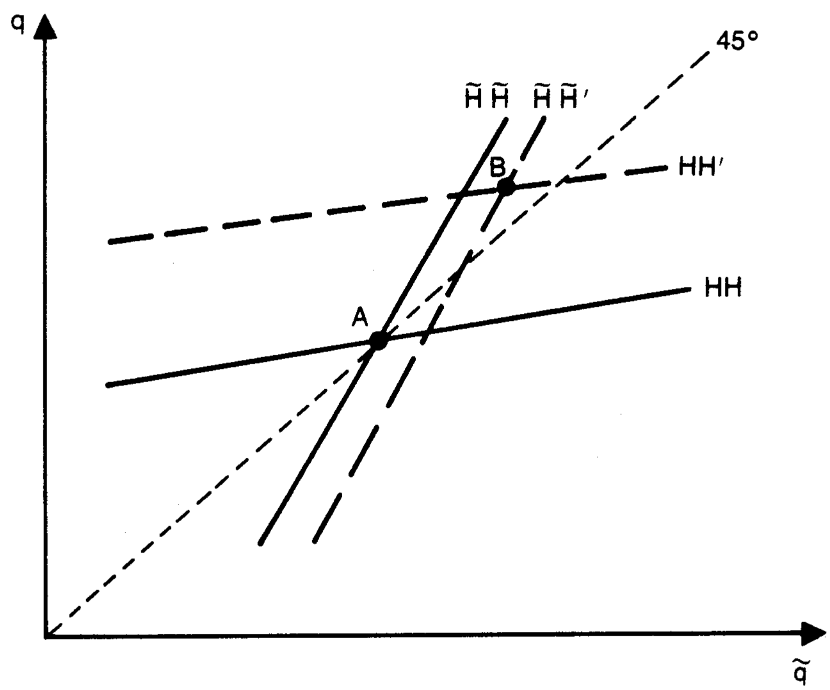


Figure 2.3

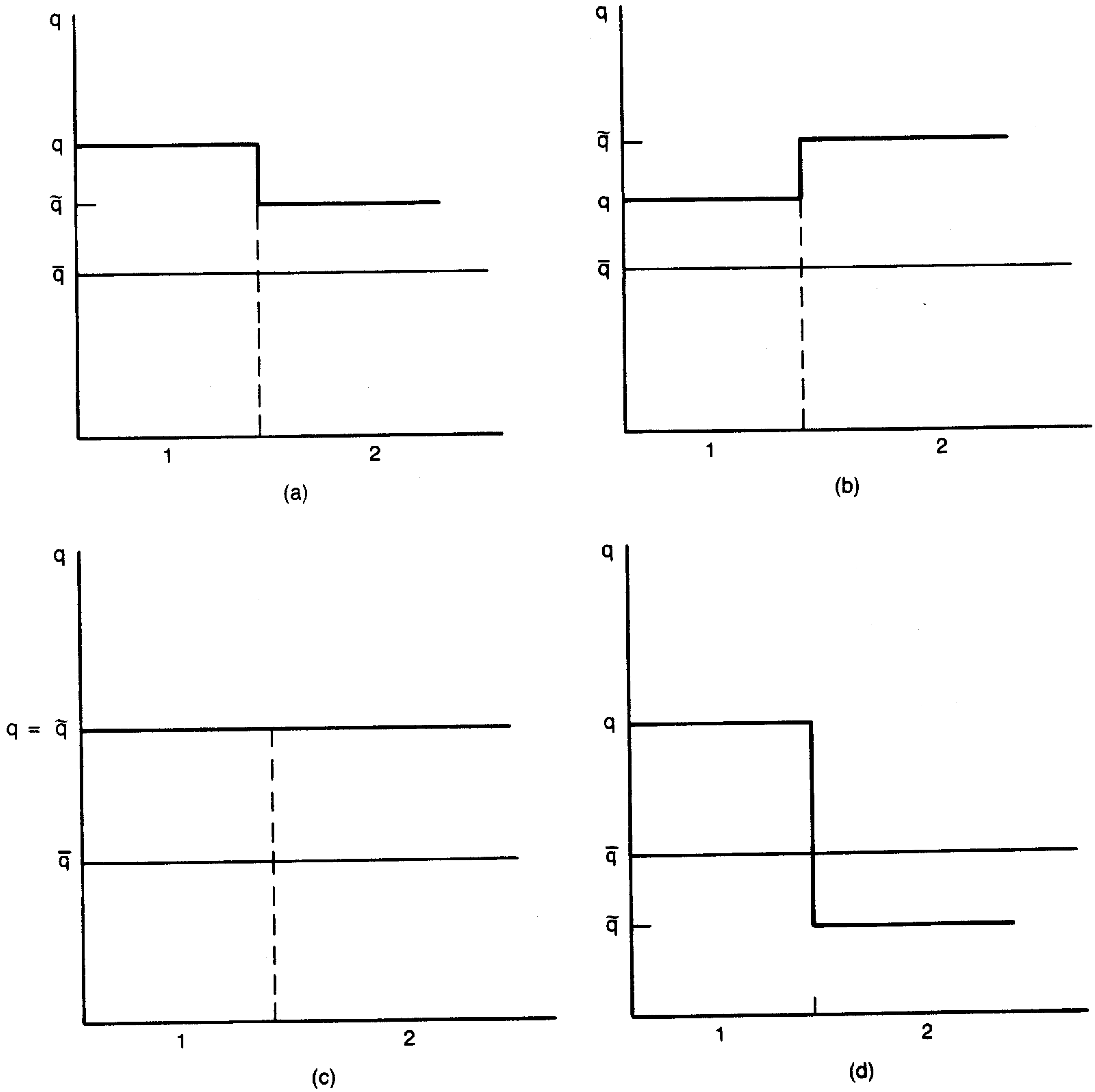


Figure 2.4

$$\frac{dq}{d\tilde{\tau}} = -\left(\frac{1}{\Delta}\right)\left\{E_{q\tilde{p}}\left(\tilde{R}_{\tilde{q}\tilde{q}} - E_{\tilde{q}\tilde{q}}\right) + E_{q\tilde{q}}\left(E_{\tilde{q}\tilde{p}} - \tilde{R}_{\tilde{q}\tilde{p}}\right)\right\} \tag{2.30}$$

$$\frac{d\tilde{q}}{d\tilde{\tau}} = -\left(\frac{1}{\Delta}\right)\left\{\left(R_{qq} - E_{qq}\right)\left(E_{\tilde{q}\tilde{p}} - \tilde{R}_{\tilde{q}\tilde{p}}\right) + E_{q\tilde{p}}\,E_{\tilde{q}p}\right\} \tag{2.31}$$

where (see Appendix)

$$\Delta = -\left[\left(R_{qq} - E_{qq}\right)\left(\tilde{R}_{\tilde{q}\tilde{q}} - E_{\tilde{q}\tilde{q}}\right) - E_{\tilde{q}q}\,E_{q\tilde{q}}\right] < 0.$$

Equations (2.30) and (2.31) formally confirm the preceding diagrammatic analysis, showing that in this three good-two period model, an anticipated import tariff can, in principle, generate interesting dynamic paths of the equilibrium real exchange rate under a pure real equilibrium analysis. They also show that substitutability everywhere in demand, is a sufficient condition to guarantee that the exports real exchange rate will appreciate in both periods as a consequence of the anticipated tariff.

The discussion presented above has focused on the real exchange rate for exportables $(1/q)$. The effects of the tariff on the domestic relative price of importables to nontradables can easily be found by analyzing the behavior of (p/q).

Although a tariff -- and a terms of trade shock, for that matter -- will alter the relative price of importables to exportables, it is still possible to analyze how the <u>index</u> of the equilibrium real exchange rate, or relative price of tradables to nontradables will be affected by the tariff. In equation (2.25) we defined the real exchange rate as: $RER = (P^*_T/P_N)$, where P^*_T is the international price of tradables, defined as: $P^*_T = \gamma P^*_X + (1-\gamma)P^*_M$, where the γ's are weights. Since we have assumed that the world price of exports is the numeraire, we can rewrite the change in the equilibrium RER in period 1 as: (there is a perfectly equivalent expression for period 2):

$$\frac{d(RER\ )}{d\tilde{\tau}} = \frac{\gamma d(1/q\ )}{d\tilde{\tau}} + (1-\gamma)\frac{d(p^*/q)}{d\tilde{\tau}} \qquad (2.32)$$

From our previous calculations of $(dq/d\tau)$ we can easily compute the change in the index of equilibrium real exchange rates. It is straightforward to show that under substitutability everywhere the anticipated tariff will result in an equilibrium real exchange rate appreciation in the current period -- as well as in the future -- when the tariff is imposed.

The Current Account

From equation (2.24) it is possible to find out how the current account in period 1 will respond to the anticipated tariff:[12]

$$\frac{dCA}{d\tilde{\tau}} = -\delta^* \pi E_{\pi\tilde{\pi}} \tilde{\pi}_{\tilde{p}} - \pi E_{\pi\pi}\pi_q \left(\frac{dq}{d\tilde{\tau}}\right) - \delta^* \tilde{\pi}_{\tilde{q}} \pi E_{\pi\tilde{\pi}} \left(\frac{d\tilde{q}}{d\tilde{\tau}}\right) \qquad (2.33)$$

The presence of an $E_{\pi\tilde{\pi}}$ or $E_{\pi\pi}$ term in every one of the right hand side terms of equation (2.33) clearly highlights the fact that the anticipated imposition of a future tariff will affect the current account via intertemporal channels. The first term in the RHS of equation (2.33) is negative and captures the direct effect of the anticipation of a tariff in period 2 on the current account in period 1. The intuition for this negative effect is straightforward. The anticipated higher period two tariff makes period 2 consumption relatively more expensive, and as a result of this the public substitutes consumption away from period 2 into period 1, generating a worsening of the current account balance in period 1. The magnitude of this effect will depend both on the intertemporal substitution effect $E_{\pi\tilde{\pi}}$ and on the initial share of imports on period 2 expenditure $\tilde{\pi}_{\tilde{p}}$.

The second and third terms on the RHS of equation (2.33) are <u>indirect</u> effects, that operate via changes in periods 1 and 2 equilibrium real exchange rates. The interpretation of these two indirect terms is quite straightforward within the intertemporal framework of the current model. If the anticipated tariff results in an equilibrium real appreciation in period 1, $(dq/d\tilde{\tau}) > 0$, there will be an offsetting force towards a current account improvement. The reasoning is simple. If the anticipated tariff results in a higher equilibrium price of nontradables in period 1 (i.e., in a real appreciation in 1), there will be substitution away from period 1 expenditure, generating an improvement in the current account in that period. The third term on the RHS relates the change in period 2's RER to period 1's current account. If as a consequence of the anticipated tariff $\tilde{q}$ increases (see equation (2.31) above for the conditions under which this will take place), there will be a tendency to substitute expenditure away from period 2 into period 1, generating forces that will tend to worsen period 1's current account.

The total effect of the anticipation of an import tariff on period 1's current account will depend on the strength of the intertemporal price effects, initial expenditure on importables and nontradables, and on the effects of the tariff on the RER vector. This result contrasts with the traditional static view where the conditions for tariffs improving the current account are related to imports and exports elasticities within each period. An important result of this analysis is that, under very plausible conditions, it is possible that the sole anticipation of the enactment of future protectionist policies will worsen today's current account. Moreover, it is possible to simultaneously observe a worsening of the current account and a real depreciation; a combination that would puzzle a number of observers, including the media.

Temporary and Permanent Tariffs

The model developed above can be easily used to analyze the effects of temporary and permanent tariffs on the path of equilibrium RERs and on the current account. In particular, the diagrammatic analysis can handle both of these cases. As is discussed in Edwards (1989), in the case of temporary tariffs (i.e., a period 1 tariff only), it is easy to show that, once again, "equilibrium overshooting" can result where the initial equilibrium relative price of N(q) increases -- in relation to the nontariff benchmark case -- by more than the equilibrium price of N in period 2.

It is interesting to compare the reaction of the RER in period 1 to the imposition of a temporary and a permanent tariffs; we find unequivocally that a permanent tariff will appreciate the equilibrium real exchange rate in period 1 by more than a temporary tariff imposed in that period only. See Edwards (1989).

Positive Initial Tariffs

In the above discussion we have assumed that tariffs are initially equal to zero. This is a very convenient assumption since in this case there are no first order income effects. In reality, however, things are different, since most countries have already (large) tariffs and other types of import restrictions in effect.

With positive initial tariffs further changes in protection will generate first order income effects. Figuring out the nature, magnitude and direction of these effects is not trivial. For example if initially there are import tariffs in periods 1 and 2 a tariff liberalization in one of the periods only can have either a negative or a positive welfare effect, due to well known second best reasons. Only in the rather extreme case where there is a permanent liberalization, with tariffs in both periods being reduced by the same amount $d\tau = d\tau^1 = d\tau^2$, and where there are no other distortions, can we be sure that the tariff reduction will have a positive welfare effect.

Formal derivations for the case of positive tariffs can be found in Edwards (1987). The resulting equations turn out to be quite cumbersome. However, these long equations tend to hide a somewhat straightforward intuition. If, for example, the hike in period 1's tariff reduces welfare via traditional efficiency costs, there will be a negative income effect in both periods. If nontradables are normal goods, there will be a decline in the demand for these goods and a tendency for their price to go down in each period. It is easy to establish that if all goods are substitutes in demand and the substitution effect dominates the income effect, a hike in period 1's tariffs will generate an equilibrium real exchange rate appreciation in both periods.[13] Notice that although this result corresponds with the traditional policy literature, we have reached it through a very different approach.

Investment

Up to now we have assumed that there is no investment. As a result, all of the intertemporal action has come from the demand side. If investment is incorporated, via equation (2.15), we will also have intertemporal effects on the supply side. Once investment is added the capital stock in period 2 becomes an endogenous variable. More specifically, it is possible to relate additions to the capital stock (dK) to a permanent change in tariffs and to real exchange rate changes:

$$\left(\frac{dK}{d\tau}\right) = -\left(\frac{\tilde{R}_{Kp}}{\tilde{R}_{KK}}\right) - \left(\frac{\tilde{R}_{Kq}}{\tilde{R}_{KK}}\right)\left(\frac{dq}{d\tau}\right) \tag{2.34}$$

where $\tilde{R}_{KK} < 0$ is the slope of the marginal product of capital schedule; $\tilde{R}_{K\tilde{p}}$ and $\tilde{R}_{K\tilde{q}}$ are Rybczinski terms whose signs will depend on the relative ordering of factor intensities across sectors. Notice that the second term on the RHS includes $(d\tilde{q}/d\tau)$, indicating that the permanent tariff will also affect investment via the future change in the equilibrium real exchange rate.

2.4 Terms of Trade and the Equilibrium Real Exchange Rate

In this section we investigate the way in which terms of trade changes affect the equilibrium path of real exchange rates. Since in Section 2.3 we have already invested in understanding the way in which the model works, our discussion here will be rather brief.

The developing nations have traditionally been subject to important terms of trade shocks; many of the poorer countries, in fact, face highly volatile terms of trade. Naturally, these exogenous changes of the external terms of trade -- or "world" relative price of exportables to importables -- will affect the equilibrium path of real exchange rates. The traditional wisdom is that if the terms of trade deteriorate an equilibrium real depreciation will result. For example, Carlos Diaz-Alejandro (1982 p. 33) stated that:

> [S]tandard models...predict that the following variables... influence its real exchange rates...: an improvement [in terms of trade] will lead to appreciation.

Most traditional analyses of the effect of terms of trade changes on the equilibrium real exchange rate have emphasized almost exclusively the role of the income effect generated by the change in the external terms of trade. The argument usually goes the following way: a deterioration of the terms of trade reduces real income and results in a decline in the demand for nontradable goods. In order to restore equilibrium the relative price of nontradables has to decline (i.e., there has to be an equilibrium real depreciation). A problem with this view, however, is that the income effect is only part of the story -- and under some circumstances, not even the most important one. In order to understand the way in which terms of trade shocks affect the equilibrium real exchange rate both income and substitution effects, as well as intertemporal ramifications, should be analyzed.

In this section we briefly investigate how exogenous changes in international terms of trade ($p*$ and $\tilde{p}*$) affect the equilibrium path of the real exchange rate, concentrating exclusively on a permanent terms of trade worsening (equiproportional increase in $p*$ and $\tilde{p}*$).[14] Throughout the section we assume that initial tariffs are very low, so that we can evaluate our derivatives around $\tau = \tilde{\tau} \approx 0$. We maintain the assumptions of section 2.3 -- no government consumption, no investment, and no taxes on foreign borrowing -- so that we still use the simplified model (2.21)-(2.25). Now, however, even if tariffs are zero, we cannot ignore the income effect associated with a change in the terms of trade.

Equations (2.35) and (2.36) capture the effect of a permanent terms of trade shock on the vector of equilibrium RERs.

$$\frac{dq}{dp*} = \frac{dq}{d\tau} + \left(\frac{1}{\Delta}\right) \left(E_{q\tilde{q}}\, \tilde{\pi}_{\tilde{q}} E_{\tilde{\pi}} E_{\tilde{\pi}W} + \pi_q E_{\pi W} \left(R_{\tilde{q}\tilde{q}} - E_{\tilde{q}\tilde{q}}\right)\right) \tag{2.35}$$

$$\left((E_p - R_p) + \delta*(E_{\tilde{p}} - \tilde{R}_{\tilde{p}})\right)$$

$$\frac{d\tilde{q}}{dp*} = \frac{d\tilde{q}}{d\tau} + \left(\frac{1}{\Delta}\right) \left((R_{qq} - E_{qq})\, \tilde{\pi}_{\tilde{q}} E_{\tilde{\pi}W} + E_{\tilde{q}q} \pi_q E_{\pi W}\right) \tag{2.36}$$

$$\left[(E_p - R_p) + \delta*(E_{\tilde{p}} - \tilde{R}_{\tilde{p}})\right]$$

where $dq/d\tau$ and $d\tilde{q}/d\tau$ are the pure substitution effects. Under our assumption of (net) substitutability, these are positive. Notice that now the negative income effects are proportional to the present value of total imports. Again, as in the case of tariffs, it is not possible to know *a priori* which relative price of nontradables will be affected by more as a result of a permanent terms of trade shock.[15]

The analysis presented in this section is readily applicable to the "Dutch-Disease" case, where there is a world price-generated export boom in an enclave export sector (i.e., oil). The simplest way to address this case is by assuming that the country in question doesn't consume the booming commodity. In this way all intratemporal substitution effects on the consumption side are severed. Naturally, we would still have important intertemporal effects as well as substitution in supply.[16]

The cases of anticipated and temporary terms of trade shocks can be analyzed in the same way. As in the analysis just presented, the real exchange rate reaction to these disturbances will be the sum of a substitution effect and an income effect proportional to imports.

2.5 Exchange Controls, Capital Flows and Equilibrium Real Exchange Rates

Most countries -- developed or developing -- have traditionally imposed several types of controls that result in some impediment to free borrowing and lending. In the general model of RER determination presented in section 2.2 of this chapter, these capital controls were modelled as a tax on foreign borrowing that resulted in a domestic interest rate that exceeds the world (real) rate of interest.[17] The extent of capital controls are many times altered by the economic authorities, generating adjustments of the amounts borrowed and lent, and in the equilibrium path of relative prices. For example, a liberalization of the capital account reduces the tax on foreign borrowing, bringing domestic interest rates more in line with world interest rates. Liberalization programs of this type have been implemented in the recent past by a number of developing countries. Perhaps the best known of these programs were pursued by the countries of the Southern Cone of Latin America in the late 1970s.[18] Changes in world interest rates will also have an important effect on decisions related to foreign borrowing, and on the equilibrium path of the real exchange rate. Also, from time to time, countries increase the extent of capital controls. Naturally, the analysis that follows will shed light on the reaction of the equilibrium RER in this case.

Some authors have investigated, at more or less informal levels, the relation between capital mobility and equilibrium real exchange rates. McKinnon (1976) provided an early analysis using a two-goods (tradables and nontradables) model with factor specificity, where he considers the effect of an <u>exogenous</u> capital inflow on the relative price of tradables to nontradables. This inflow of capital allows expenditures to exceed income, generating an incipient excess demand for nontradables. To restore equilibrium, the relative price of nontradables has to rise -- that is a real appreciation has to take place.

The analysis of McKinnon (1976), as well as those by Corden (1981) and Harberger (1982, 1983) are carried out under the assumption that the change in the level of capital flows is largely exogenous. This, of course, need not be the case; in fact, in many cases capital movements tend to be endogenous, responding to a number of variables including interest rate differentials. In this section we use a simplified version of the general model in Section 2.2 to formally investigate the way in which a change in the degree of capital account restrictions affect the path of equilibrium real exchange rates.[19] We also look at the effects of this deregulation policy on borrowing and lending decisions, analyzing whether one would observe comovements of equilibrium real exchange rate and capital flows. In order to make the exposition more clear we make some simplifying assumptions to the general model of Section 2.2: (1) we first assume that there are no import tariffs; (see below, however, for a discussion on what happens if $\tau \neq 0$.) (2) we further assume that international prices of X and M do not change, so that these two goods can then be aggregated into a composite tradable good (T). We now denote the relative price of nontradables to tradables in period as f and $\tilde{f}$ (i.e., $f = P_N/P_T$). That is, f, $\tilde{f}$ are the inverse of the real exchange rate in each period. Assuming, further, that there is no investment, and that the government hands back to the public the tax proceeds, the model in section 2.2 is now rewritten in the following way:

$$R(1,f;V) + \delta\tilde{R}(1,\tilde{f};V) + b(NCA) = E[\pi(1,f),\delta\tilde{\pi}(1,\tilde{f}),W] \tag{2.37}$$

$$b = (\delta^* - \delta) > 0 \tag{2.38}$$

$$R_f = E_f \tag{2.39}$$

$$\tilde{R}_{\tilde{f}} = E_{\tilde{f}} \tag{2.40}$$

$$RER = 1/f; \quad R\tilde{E}R = 1/\tilde{f}; \tag{2.41}$$

where a notation consistent with the preceding sections has been used. R( ) is a revenue function; E( ) is the intertemporal expenditure function; W is utility, $\pi^i(\ )$ is an exact price index; R_f is supply of N in period 1; and E_f is demand of N in period 1. There are equivalent expressions for period 2 variables. Notice that contrary to the free capital mobility case, we have now used the domestic discount factor δ, instead of the world factor δ^*. The term b(NCA) is the discounted value of the proceeds from the taxation of foreign borrowing, where b is the tax.[20] Since we have assumed in this section, that government consumption is zero, these tax proceeds are handed back to the public in a nondistortionary way.

Let us consider the case of a country with capital controls that decides to liberalize its capital account, reducing the extent to which foreign borrowing is taxed. Since $b = (\delta^{*}-\delta)$, a change in the tax on borrowing is equal to minus a change in the discount factor: $db = -d\delta$. The rest of the analysis will deal with changes in δ. Totally differentiating (2.39) - (2.40) we find out how the (inverse of the) equilibrium RER reacts to a liberalization of the capital account:

$$\frac{df}{d\delta} = -\left(\frac{E_W\ \pi}{\Delta''}\right)\left[\pi_f E_{\pi\tilde{\pi}}\ \tilde{R}_{\tilde{f}\tilde{f}} - \pi_f E_{\pi\tilde{\pi}}\ \tilde{\pi}_{\tilde{f}\tilde{f}}\right]$$

$$-b\tilde{\pi}\left(\frac{\tilde{R}_{\tilde{f}\tilde{f}} - E_{\tilde{\pi}}\tilde{\pi}_{\tilde{f}\tilde{f}}}{\Delta''}\right)(E_{\tilde{\pi}W}\tilde{\pi}\ \pi_f E_{\pi\tilde{\pi}} - E_{\pi W}\tilde{\pi}\ \pi_f E_{\tilde{f}\tilde{f}}) > 0 \qquad (2.42)$$

where Δ'' is the determinant of the system and is negative (Edwards 1989?).

Equation (2.42) is positive indicating that a liberalization of the capital account (i.e., a reduction in the tax on foreign borrowing will result in an increase in the relative price of nontradables, or in an <u>equilibrium real appreciation</u> in period 1. The intuition behind this real appreciation is simple. The adjustment takes place through two channels. The first, captured by the first term on the RHS of equation (2.42), is an intertemporal substitution effect, which operates via movements in the consumption rate of interest. The reduction of the tax on foreign borrowing (i.e., the increase in δ) makes future consumption relatively more expensive. As a result, people substitute intertemporally, consuming more of everything in period 1. This, of course, exercises pressure on the price of nontradables in period 1, generating an equilibrium real appreciation. Notice that if there is no intertemporal substitution (i.e., $E_{\pi\tilde{\pi}} = 0$) the first term on the RHS of (2.42) vanishes.

The second channel through which the liberalization of the capital account affects the real exchange rate is the income effect captured by the second term on the RHS of equation (2.42). An increase in δ towards its world level $\delta*$ reduces the only distortion in this economy, generating a positive welfare effect. Consequently the public will increase consumption, exercising a positive pressure on f. The magnitude of this income effect basically depends on two factors: (1) the propensities to consume in periods 1 and 2, which are related to $E_{\pi W}$ and $E_{\tilde{\pi} W}$; and (2) the initial level of the distortion b. If initially the tax is very low $b \approx 0$, the second term on the RHS of (2.42) will tend to disappear.

Naturally, the relaxation of capital controls will affect the amount of foreign borrowing. In period 1 the amount of foreign borrowing by the nationals of this country will be given by the difference between expenditure and income in that period (this, of course, assumes nontradables equilibrium):

$$B = \pi E_{\pi} - R(\ ) \tag{2.43}$$

B can be either positive or negative, indicating a net borrower or net lender position in the first period. Notice that since in this real model there are no international reserve holdings, this expression for foreign borrowing in period 1 is the negative of the current account. It is easy to show from (2.43) that as a result of the relaxation of capital controls there will be an increase in B, reflecting an increase in net borrowing in period 1. This net capital inflow in period 1 is the result of the two effects -- substitution and income -- discussed above.

In sum, as a result of the reduction in tax on borrowing, in period 1 we will simultaneously observe: (1) an inflow of "capital", or higher net borrowing from abroad; (2) a real appreciation (i.e., a higher f); and (3) a worsening of the current account in that period.

The relaxation of barriers to foreign borrowing will affect period 2's real exchange rate via the same two channels. As is shown in Edwards (1989-) whether the equilibrium real exchange rate appreciates or depreciates in period 2 will depend on whether the intertemporal substitution or income effect dominates.

Transfers, Exogenous Capital Flows and World Interest Rates

It is not unusual to find among the developing countries, "exogenous" capital movements that do not necessarily have an origin on interest rate differentials. A common case is given by foreign aid, where the poorer country can increase expenditure above income due to a transfer made from abroad. Also, capital flight stemming from political uncertainty can, in principle, be modelled as a negative transfer. This type of "exogenous capital inflows" (or outflows) will usually have an effect on the equilibrium path of the RER.[21]

The model used in this section can be easily amended to handle this "transfer problem". Assuming that there is a transfer in period 1 only, and denoting the transfer from abroad by H, the intertemporal budget constraint has to be written as:

$$R(1,f,V) + \delta\tilde{R}(1,\tilde{f},V) + b(NCA) + H = E[\pi(1,f),\delta\tilde{\pi}(1,\tilde{f}),W] \qquad (2.44)$$

It is easy to show now that as long as the propensities to consume nontradables in periods 1 and 2 are different from zero, the transfers will result in equilibrium real appreciation in both periods:

$$\frac{df}{dH} > 0; \quad \frac{d\tilde{f}}{dH} > 0 \qquad (2.45)$$

Of course, if the income elasticities of demand for home goods are zero, i.e., $\pi_f E_\pi = \tilde{\pi}_{\tilde{f}} E_{\tilde{\pi}} = 0$), the transfer will have <u>no effect on the equilibrium vector of RERs</u>. On the other hand, if for some reason, such as a prohibitive tax on foreign borrowing, there is no intertemporal substitution in consumption, the transfer will appreciate the real exchange rate in the first period only.[22]

The model developed in this chapter can be easily used to analyze how exogenous changes in world interest rates -- that is changes in δ^* -- will affect the path of equilibrium RERs. In the current two-period model changes in r^* will only have substitution effects. A higher r^* will make future consumption more expensive, generating the type of intertemporal substitution we discussed above.

2.6 <u>The Composition of Government Expenditure, Fiscal Debt and Equilibrium Real Exchange Rates</u>

In this model the government faces an intertemporal budget constraint. In the long run (period 2) it pays all its debt. The sources of government revenue are limited to different forms of taxation and to foreign borrowing. Naturally, since this is a completely real model the inflation tax is <u>not</u> an option faced by the government authorities. In that sense, then, although fiscal policy plays a real role it does not operate through the traditional macroeconomic channels that are usually emphasized in policy discussions on the developing countries.

Government decisions regarding the allocation of expenditure across goods and the type of taxes used will, under certain cases, have effects on the equilibrium real exchange rate. It is in this sense that we can say that fiscal policy -- or perhaps, more correctly, some real aspects of it -- are a component of the fundamental determinants of the equilibrium real exchange rate. However, as discussed in detail in Chapter 3, unsustainable fiscal expansions that are financed by the inflation tax will have no effect over the equilibrium real exchange rate; quite on the contrary, they will generate a divergence between the actual and equilibrium RER, or real exchange rate overvaluation. In this section we concentrate on how (real aspects of) fiscal policy will affect the behavior of equilibrium real exchange rates. We consider both changes in the composition of government expenditures as well as changes in the proportion of period 1 expenditures financed by issuing debt. The analysis of fiscal policies is particularly relevant for the case of the developing countries, where the government sector is usually prominent. Regarding taxation, we first assume that all taxes are of the non distortionary type. We then briefly discuss two more realistic cases where distortionary taxes -- consumption taxes and import tariffs -- are used to raise revenue. Throughout the analysis government can borrow internationally but, as the private sector, it faces an inter-temporal budget constraint.

A limitation of our two periods model is that, generally speaking, it is not possible to distinguish between fiscal borrowing and public debt. Period 1's fiscal borrowing becomes, after compounding it by the appropriate interest rate, the fiscal debt inherited in period 2. One possible way of introducing a distinction between borrowing and debt is by assuming that in period the government "inherits" some debt from previous periods (Frenkel and Razin, 1987).

In order to simplify the discussion and to fully concentrate on the relation between (real) fiscal policies and the equilibrium path of RERs we develop a simplified version of the general model of Section 2.2. It is first assumed that there are no import tariffs and that the terms of trade don't change. Consequently importables and exportables can again be aggregated into a single composite tradable good. Initially, it is assumed that the government raises revenue using non distortionary taxes T and $\tilde{T}$ in periods 1 and 2; the case of distortionary taxes is discussed later. As in Section 2.5, f and $\tilde{f}$ are the relative prices of nontradables -- or inverse of the RERs -- in periods 1 and 2. As before, and to simplify the analysis, investment is ignored. Our simplified model is given by equations (2.46) through (2.50):

$$R(1,f,V) + \delta^*\tilde{R}(1,\tilde{f},\tilde{V}) - T - \delta^*\tilde{T} = E(\pi(1,f),\delta^*\tilde{\pi}(1,\tilde{f}),W), \qquad (2.46)$$

$$G_T + fG_N + \delta^*(\tilde{G}_T + \tilde{f}\tilde{G}_N) = T + \delta^*\tilde{T}, \qquad (2.47)$$

$$R_f = E_f + G_N, \qquad (2.48)$$

$$\tilde{R}_{\tilde{f}} = E_{\tilde{f}} + \tilde{G}_N, \qquad (2.49)$$

$$RER = (1/f); \quad \tilde{RER} = (1/\tilde{f}). \qquad (2.50)$$

Equation (2.46) is the budget constraint for the private sector. T and $\tilde{T}$ are (nondistortionary) taxes in each period. Equation (2.47) is the government's budget constraint. It has been assumed that the government consumes both tradables and nontradables, and that it can borrow from abroad at the same (exogenously given) interest rate as the private sector. This equation also establishes that the discounted value of the government's consumption has to be equal to the present value of taxes. If in period 1 there is an income shortcoming, it is financed by borrowing from abroad. In order to clarify the analysis it is possible to break down Equation (2.47) into two equations:

$$(G_T + fG_N) - T = D \tag{2.47'}$$

$$D + \delta^*(\tilde{G}_T + \tilde{f}\tilde{G}_N) = \delta^*\tilde{T} \tag{2.47''}$$

Equation (2.47′) is period 1's fiscal deficit, defined as the difference between real expenditure (in terms of tradables) and taxes. Equation (2.47″) says that the discounted value of period 2's revenue from taxes ($\delta^*\tilde{T}$) has to be enough to cover period 2's expenditure (in discounted value) plus the deficit. It is clear from these two equations that in order to assure that the fiscal budget constraint will actually hold, either government expenditure or tax revenue in period 2 will now have to be endogenous. In this section we will assume that period 2's tax revenue $\tilde{T}$ takes whatever value is required to assure government's solvency.

Equations (2.48) and (2.49) are the equilibrium conditions for nontradables in each period. Notice that total demand for N by the private sector plus the government has to equal output of nontradables in each period.

Increase in Period 1 Borrowing Due to Tax Cut

Consider first the case where the government implements a tax cut in period 1 which results in an increase in its borrowing needs. Naturally, given the government budget constraint, this means that taxation in period 2 will have to go up in order for the intertemporal budget constraint to be satisfied. Given the perfect foresight assumptions of our model, households and firms will internalize this change in the timing of taxes and react accordingly. Taxation in period 2 will increase by $-(1/\delta^*)dT$, exactly the same amount by which household's disposable income will go down. In this case we have perfect Barro-Ricardo equivalence, where the current tax cut has no effect on the equilibrium path of the real exchange rate:

$$\frac{df}{dT} = \frac{d\hat{f}}{dT} = 0 \tag{2.51}$$

This result is by no means surprising. In fact it has been built into the model through two key assumptions: (1) individuals and the government have the same rate of discount δ^*; and (2) taxes are nondistortionary.

Changes in Government Consumption

Any change in the level of government consumption will impact the equilibrium path of real exchange rate. The intuition behind this is very simple. Imagine, for example, an increase in the government's consumption of nontradables in period 1, which is financed by an increase in public debt. This will affect the path of equilibrium real exchange rates through two channels. First, the increased demand for N in 1 will tend to generate, on its own, a higher equilibrium relative price for those goods -- or equilibrium real appreciation -- in that period. Second, the higher level of government borrowing in period 1 will require a hike in taxes in period 2. This will reduce available income, tending to reduce the demand for N in periods 1 and 2. Whether as a result of the higher consumption of N by the government in period 1 there will be an equilibrium real appreciation in that period or not, will depend on the relative forces of the substitution and income effects. In the most plausible case where the substitution effect dominates there will be an equilibrium real appreciation in period 1.

An increase in the government's demand for tradables in period 1 financed by additional borrowing can be analyzed in a similar way; this time, however, there will be no direct pressure of the market for nontradables. Naturally, the indirect pressure via changes in the private sector disposable income will still be present. Formally, equation (2.52) gives us the effect of a temporary increase in the government's consumption of tradables in period 1 on the equilibrium of the (inverse of the) real exchange rate.

$$\frac{df}{dG_T} = - \frac{\delta*}{\Delta''} \left\{ E_{ff} E_{\tilde{\pi}} \tilde{\pi}_{\tilde{f}} \, \delta* + \left(\tilde{R}_{\tilde{f}\tilde{f}} - E_{\tilde{f}\tilde{f}} \right) \pi_f E_{\pi W} \right\} < 0 \tag{2.52}$$

where Δ'' is the determinant from the system (2.46)-(2.49) and is positive. Equation (2.52) is negative indicating that a temporary increase in the demand for tradables by the government will result in an equilibrium real depreciation in period 1. It is easy to show that a temporary increase in government consumption of tradables in period 1 only will also result in an equilibrium real depreciation in period 2.

Distortionary Taxes

A simplifying feature of our analysis in this section is that we have assumed that all of the government's revenue is obtained via nondistortionary taxes. A relaxation of this assumption will affect some of the results discussed above in several ways. In the general model of Section 2.2 we discussed two possible ways of introducing distortionary taxes: import tariffs and taxes on foreign borrowing. By combining the positive tariffs analysis of Section 2.3 with the discussion in this section, we can formally find out how changes in fiscal policy will affect the equilibrium paths of RERs. Frenkel and Razin (1987) discuss some of the ramifications of government deficits financed with distortionary taxes in open economies.

2.7 Technological Progress

David Ricardo (1821) is considered to have been the first to explicitly postulate the existence of a negative relation between economic growth and the equilibrium relative price of tradables to nontradables. Later a number of authors, including Pigou (1922), pointed out within the context of the PPP debate that there is a tendency for the relative prices of tradables to nontradables to differ across countries; higher-income countries would tend to have a lower relative price between these two groups of goods. However, it was only in Balassa's (1964) reinterpretation of the PPP theory that the theoretical foundations of this proposition were clearly set forward. According to Balassa, the rate of productivity improvements are higher in countries with higher rates of growth than in countries with lower rates of growth. Moreover, the rate at which productivity improves is not uniform across sectors within each country; gains in productivity are larger in the tradable than in the nontradable goods sector in all countries. This means that in each country the equilibrium relative price of tradables to nontradables will tend to decline through time. Since the prices of tradable goods will move together across countries, the differential in productivities improvements across countries and sectors will result in an appreciation of the PPP defined real exchange rate. While sometimes this argument is presented in a dynamic form (i.e., growth of output rather than levels of income per capita), in Balassa's (1964) original article the analysis was presented from a static perspective.

The effects of productivity gains on the path of equilibrium real exchange rates can be analyzed formally using the model of Section 2.2. Possibly the easiest way of incorporating technological progress is by adding a shift parameter ϕ in the revenue functions $R(\ )$ and $\tilde{R}(\ )$.[23] Depending on how the rate of technological progress affects the different sectors and the type of progress considered -- product augmenting or factor augmenting -- we will have different effects on the equilibrium RERs. Any type of productivity shock will have a positive income effect, generating positive demand pressure on the nontradables market in both periods. As a result, there will be a tendency for the equilibrium price of N to go up in both periods.

Technological progress will also result in supply effects. If this progress is of the general factor augmenting variety, the results will be equivalent to those of an exogenously driven increase in factor availability and will be governed by the well known Rybczinsky principle. Under some conditions it is possible that the supply effects of technological progress more than offset the demand effects, generating an equilibrium real depreciation. This would be the case, for example, of product augmenting technological improvement that increases the availability of N sufficiently to the point of generating an incipient excess supply, which will have to be resolved through an equilibrium real devaluation.

2.8 Credit Rationing, Price Rigidities, Unemployment and Other Extensions

Intertemporal effects have played an important role in our discussion up to this point. We have shown that the effects of both anticipated and temporary disturbances are spread out throughout time via changes in the consumption rate of interest and in investment. Of course, this optimal intertemporal smoothing is possible due to our assumption that the nationals of this country can borrow internationally as much as they want at the exogenously given rate of interest, only subject to the constraint that the debt is paid.

The assumption of perfect access to foreign borrowing in some way reduces the need for making a distinction between short term and long term disturbances. With foreign borrowing and perfect foresight, agents react optimally and the resulting movements of equilibrium prices are "optimal." If, however, we assume that there is credit rationing, it will be important to make a distinction between _short_ and _long-term_ equilibrium RERs. For example, in the extreme case of _no_ foreign borrowing a temporary terms of trade shock will affect the equilibrium RER in period 1 only; in period 2, when the terms of trade return to their "long run equilibrium," so will the RER. Moreover, if there are rigidities or transaction costs it may not be completely desirable for a country to allow the actual real exchange rate to move towards its short-run equilibrium value for a very short period of time. This is because this move would then have to be reversed, generating additional potential costs (see Edwards 1986b). Also, if we assume that there is uncertainty (i.e., we relax the perfect foresight assumption) observed price movements -- that is observed RER adjustments -- will not be necessarily optimal.

Factor Price Rigidities

The exercises performed above have assumed that all prices, including those of factors, are fully flexible. Although this is a useful assumption for our benchmark analysis, it is not completely realistic for the case of the developing countries. Rigidities in some factor prices can be easily introduced into the analysis. Assume, for example, that the (real) wage rate (w) is fixed at a level $\bar{w} \geq R_L$, where R is the unconstrained revenue function, and L is the labor force. In this case, then, we have to define a constrained revenue function (RR) (Neary 1985):

$$RR(w,p,q,K) = \max_{Q,L} \{(Q^X+qQ^N+pQ^M) - \bar{w}L\}, \tag{2.53}$$

where Q^i, $i = X,M,N$ refers to output of exportables, importables and nontradables. Also, the nontradable market equilibrium conditions are replaced by:

$$R\tilde{R}_q = E_q; \quad R\tilde{R}_q = E_{\tilde{q}} \tag{2.54}$$

where RR_q is the partial derivative of the constrained revenue function (2.53) with respect to the price of nontradables in period 1. Neary (1985) has shown that under fixed factor prices the following relation exists between restricted and unrestricted revenue functions:

$$RR = R[q,p,\hat{L}(\bar{w},q,p,K)] - \bar{w}L(\bar{w},q,p,K) \tag{2.55}$$

where $\hat{L}$ is the amount of labor employed in the constrained case. Once the revenue functions have been redefined in this way it is easy to find how the relative price of nontradables reacts to a tariff reduction in an economy with fix real wages.

In this case with wage rigidity there will not be full employment; some of the labor force is unemployed. For a number of years trade theorists have been preoccupied with the relation between tariffs and employment (Mundell 1961; Eichengreen 1981; Kimbrough 1984; van Wijnbergen 1986). In the model developed in this paper, if wages are flexible, tariffs have no effects on aggregate employment. However, if there is real wage rigidity of the type described above, tariffs will indeed have an effect on the level of total employment in the economy. For example, equation (2.56) gives the response of labor employed in period 1 to a temporary tariff in that period.

$$\frac{d\hat{L}}{d\tau} = -(RR_{Lp}/RR_{L\hat{L}}) - (RR_{Lq}/RR_{L\hat{L}})\frac{dq}{d\tau} \tag{2.56}$$

where the term $(dq/d\tau)$ captures the change in the relative price of N in period 1 to tariff increase. Both RR_{Lp} and RR_{Lq} are Rybczinski type terms whose signs will depend on factor intensities. Depending on the sign of $dq/d\tau$ and on factor intensities in the different sectors $(d\hat{L}/d\tau)$ can be positive or negative.

Intermediate Inputs and Import Quotas

The intertemporal duality approach used here can be easily extended in order to incorporate import quotas and intermediate inputs. First, the case of import quotas can be analyzed in a quite straightforward fashion by defining "virtual prices" as in Neary and Roberts (1980). The use of virtual prices, of course, assumes that the quota is allocated competitively via an auction mechanism.

Intermediate goods can also be incorporated quite easily through the definition of net-outputs as in Dixit and Norman (1980). In this case an additional source of ambiguity with respect to the sign of $dq/d\tau$ emerges.

2.9 Summary

In this chapter a benchmark optimizing intertemporal real model of a small open economy has been developed to investigate how various exogenous changes in the real fundamental determinants of the equilibrium real exchange rate affects its path through time. This analysis is a fundamental step in any discussion dealing with issues related to real exchange rate misalignment. The model assumes that firms produce competitively three goods -- exports, imports and nontradables. Households maximize the present value of utility, and consume all three goods. They have access to the international capital market, where they can borrow or lend at the given world interest rate. The only constraint they face is that the present value of the current account balances has to be zero. The model uses duality theory and exploits the properties of exact price indexes as developed by Svensson and Razin (1983).

The effects of changes in real exchange rate fundamentals, such as import tariffs and international terms of trade were investigated, with emphasis placed on the distinction between temporary, permanent and anticipated disturbances. In this setting a crucial channel through which exogenous shocks are transmitted is the consumption rate of interest (CRI). Changes in tariffs or in the international terms of trade will affect the CRI, intertemporal expenditure decisions, and consequently the equilibrium vector of RERs and the current account.

The formal analysis in this chapter showed that equilibrium real exchange rates can experience substantial, and some times even not easily predictable, changes as a result of disturbances to fundamentals. Given the very general nature of the model, in many cases it was not possible to establish unequivocally the direction in which the equilibrium real exchange rate will react. In most cases, however, it is possible to find definite signs under some plausible assumptions. The following is a very brief summary of our main results:

(1) With low initial tariffs the imposition of import tariffs (either temporarily or permanently) will usually generate an <u>equilibrium real appreciation</u> in the current and future periods. A sufficient condition is that we have (net) substitutability in demand among all three goods X, M and N. If initial tariffs are high, for this result to hold, we need, in addition, that income effects don't dominate substitution effects. If, however, there is complementarity in consumption it is possible that the imposition of import tariffs will generate a real equilibrium depreciation.

(2) If the income effect associated with a terms of trade deterioration dominates the substitution effect, a worsening in the terms of trade will

result in an <u>equilibrium real depreciation</u>.

(3) Generally speaking, it is not possible to know how the effect of import tariffs and terms of trade shocks on the ERER will be distributed through time.

(4) It is crucially important to distinguish between permanent and temporary shocks when analyzing the reaction of the equilibrium real exchange rate.

(5) A relaxation of exchange controls will always result in an equilibrium real appreciation in period 1. Moreover, in that period we will observe simultaneously a real appreciation and an increase in borrowing from abroad.

(6) A transfer from the rest of the world -- or an exogenously generated capital inflow for that matter -- will always result in an equilibrium real appreciation.

(7) The effect of an increase in government consumption on the equilibrium RERs will depend on the composition of this new consumption. If it falls fully on nontradables there is a strong presumption that the RER will experience an equilibrium real appreciation. If it falls fully on tradables there will be an equilibrium real depreciation.

The analysis in this chapter has ignored monetary considerations focusing exclusively on movements in the equilibrium real exchange rates. In reality, of course, not all RER movements are equilibria ones. In Chapter 3 we develop a model where macro disequilibria can indeed generate deviations between the actual and the equilibrium real exchange rate.

Appendix to Chapter 2

A. Notation

$$E_{pp} = E_{\pi} \pi_{pp} + \pi_p E_{\pi\pi} \pi_p$$

$$E_{pq} = E_{\pi} \pi_{pq} + \pi_p E_{\pi\pi} \pi_q$$

$$E_{p\tilde{p}} = \pi_p E_{\pi\tilde{\pi}} \tilde{\pi}_{\tilde{p}} \delta^*$$

$$E_{p\tilde{q}} = \delta^* \pi_p E_{\pi\tilde{\pi}} \tilde{\pi}_{\tilde{q}}$$

$$E_{\tilde{p}\tilde{p}} = E_{\tilde{\pi}} \tilde{\pi}_{\tilde{p}\tilde{p}} + \tilde{\pi}_{\tilde{p}} E_{\tilde{\pi}\tilde{\pi}} \tilde{\pi}_{\tilde{p}}$$

$$E_{qq} = E_{\pi} \pi_{qq} + \pi_q E_{\pi\pi} \pi_q$$

$$E_{qp} = E_{\pi} \pi_{pq} + \pi_q E_{\pi\pi} \pi_p$$

$$E_{\tilde{q}\tilde{q}} = E_{\tilde{\pi}} \tilde{\pi}_{\tilde{q}\tilde{q}} + \tilde{\pi}_{\tilde{q}} E_{\tilde{\pi}\tilde{\pi}} \tilde{\pi}_{\tilde{q}}$$

$$E_{q\tilde{q}} = \pi_q \delta^* E_{\pi\tilde{\pi}} \tilde{\pi}_{\tilde{q}}$$

$$E_{q\tilde{p}} = \pi_q \delta^* E_{\pi\tilde{\pi}} \tilde{\pi}_{\tilde{p}}$$

$$E_{\tilde{p}\tilde{q}} = E_{\tilde{\pi}} \tilde{\pi}_{\tilde{p}\tilde{q}} + \tilde{\pi}_{\tilde{p}} E_{\tilde{\pi}\tilde{\pi}} + \tilde{\pi}_{\tilde{p}} E_{\tilde{\pi}\tilde{\pi}} \tilde{\pi}_{\tilde{q}} \delta^*$$

B. Stability

The dynamic behavior of nontradable prices are depicted by equations (B.1) and (B.2), where $\lambda_1, \lambda_2 > 0$.

$$\dot{q} = \lambda_1 [E_q - R_q] \tag{B.1}$$

$$\dot{\tilde{q}} = \lambda_2 [E_{\tilde{q}} - \tilde{R}_q] \tag{B.2}$$

Using Taylor expansions of (B.1) and (B.2) around equilibrium prices, and dropping second and higher order terms, we obtain

$$\begin{pmatrix} \dot{q} \\ \dot{\tilde{q}} \end{pmatrix} = \begin{pmatrix} \lambda(E_{qq}-R_{qq}) & \lambda_1 E_{qq} \\ \lambda_2 E_{\tilde{q}q} & \lambda_2(E_{\tilde{q}\tilde{q}} - \tilde{R}_{\tilde{q}\tilde{q}}) \end{pmatrix} \begin{pmatrix} q-q^* \\ \tilde{q}-\tilde{q}^* \end{pmatrix}$$

Denoting the RHS matrix as A, stability of the system requires

$$\text{Det } A > 0$$

$$\text{tr } A < ;0$$

This means that:

$$\{(E_{qq}-R_{qq})\ (E_{\tilde{q}\tilde{q}}-\tilde{R}_{\tilde{q}\tilde{q}}) - E_{\tilde{q}q}E_{q\tilde{q}}\} > 0$$

and

$$\{(E_{qq}-R_{qq}) + (E_{\tilde{q}\tilde{q}}-\tilde{R}_{\tilde{q}\tilde{q}})\} < 0.$$

These requirements can then be used to sign the determinant of the system of equations in the text. Also, it follows directly from these requirements that the $\tilde{H}\tilde{H}$ schedule is steeper than the HH schedule.

FOOTNOTES

[1]As pointed out in Chapter 1, there is still disagreement among economists on how to define "the" real exchange rate. These discussions are mainly semantic and do not affect in any fundamental way the analytics. Once the behavior of the relative price of tradables -- our definition of RER -- is known, all that is required are algebraic manipulations to find how any other definition of "the" real exchange rate reacts to a particular shock.

[2]This intertemporal budget constraint can be written in the following way: $\Sigma_i (1+r)^{-i} C_{t+i} = 0$, and states that this country cannot be a net lender or net borrower forever. Eventually it has to pay its debts. See also the discussion in Williamson (1983). Naturally here we are assuming that the initial stock of foreign debt is zero. If this is not the case, the intertemporal budget constraint will have to be rewritten.

[3]Although the use of duality implies some setup costs such as the mastering of new notation, its simplicity and elegance pay off, quite handsomely. Dixit and Norman (1980) use duality in static trade models. Svensson and Razin (1983), Edwards and van Wijnbergen (1986), and van Wijnbergen (1986) use duality theory to analyze intertemporal problems.

[4]For further details on revenue and expenditure functions see Dixit and Norman (1980).

[5] See however, Chapter 8 for a model with imported intermediate inputs. If any of our goods is an input into another good some of the cross derivatives can be positive.

[6] Notice that Equations (2.9) and (2.10) imply that the government is not subject to import taxes.

[7] The weights γ and $(1-\gamma)$ can be related to the relative importance of imports and exports either in consumption <u>or</u> in production. In the former case they can be derived by using the properties of the exact price indexes.

[8] The proposition that a reduction (or elimination) of tariffs will necessarily result in an equilibrium real depreciation has also been made in the developing countries shadow pricing literature. Some authors have proposed that the shadow exchange rate should be computed as the equilibrium real exchange rate under conditions of free trade (Bacha and Taylor 1971). It has then been postulated that an elimination of existing trade impediments will result in a higher equilibrium real exchange rate (i.e., in a real depreciation). For example, for the case of a small country which faces initial trade equilibrium, Bacha and Taylor (1971, p. 216) proposed the following expression for the free trade real exchange rate: $e^F = e(1+t)^\gamma$, where e^F is the free trade equilibrium (real) exchange rate, e is the (real) exchange rate prior to the elimination of tariffs, t is the level of the tariffs and $\gamma = \eta_M/(\epsilon_X+\eta_M)$, for η_M elasticity of demand for imports and ϵ_X elasticity of supply for exports.

[9]The analysis of the effects of tariff changes on the equilibrium RER is highly relevant in the developing countries. Many LDCs have historically gone through major processes of trade liberalization and of trade restrictions. In the case of trade controls, there is a two way relation that goes from tariff changes to the equilibrium RER and from the actual (as opposed to equilibrium) RER to changes in tariffs. In particular, if as a result of inconsistent macroeconomic policies the RER becomes overvalued, the authorities will usually hike tariffs. In the present chapter we will only deal with the former effect: the implications of exogenous tariff changes on the equilibrium RER. In Chapter 3 and in Part III we discuss in detail the second aspect of this relation.

[10]The exact expression for $E_{q\tilde{q}}$ is obtained after taking the derivative of $E_q = E_\pi \pi_q$.

[11]Point C in Figure 2.2 is the new equilibrium under the assumption that nontradables and importables are complements in consumption in period 2, and that this effect dominates. In this case the $\tilde{H}\tilde{H}$ schedule has shifted to the left. A possible outcome is the one described in Figure 2.2 where as a result of an anticipated tariff the equilibrium path of the real exchange rate will be characterized by wide swings: it will increase in period 1, and it will decline in period 2 below its initial (pre-tariff) level. Although this path is clearly characterized by equilibrium movements in each period, observers may think that the RER has moved in the "wrong direction" in period 1. Although this movement in the equilibrium RER in different directions is theoretically possible it is not not too likely in reality.

[12]In Edwards (1989) the effect of temporary import tariffs on the current account is analyzed in detail.

[13]See Edwards (1986d) for a more detailed discussion.

[14]See Edwards (1989) for a detailed discussion on the effects of temporary shocks to the terms of trade on equilibrium real exchange rates and the current account.

[15]It is also possible to analyze the effects of terms of trade disturbances on the current account. This, in fact, constitutes an extension of the analysis of Svenson and Razin (1983), to the case with nontradable goods. In the current setting, however, changes in equilibrium real exchange rates constitute an additional channel through which terms of trade disturbances get transmitted to the current account. For this, see Edwards (1989).

[16]On "Dutch-Disease" see the volume edited by Neary and van Wijnbergen (1986).

[17]There are, however, alternative ways of modeling capital controls. Edwards and van Wijnbergen (1986), for example, assume that there is a quantitative restriction that determines the maximum a country could borrow in any period of time. The domestic interest rate, then, adjusts to the level required.

[18]The caveats mentioned in the case of tariffs should be kept in mind when analyzing the role of capital controls as real exchange rate fundamentals. Only long run changes in capital controls that respond to structural motives are relevant. The imposition of capital controls to avoid (or delay)

a balance of payments crisis do not constitute a change in a "fundamental". On the Southern Cone liberalization attempts see Edwards and Cox-Edwards (1987), Corbo (1985), Corbo and de Melo (1985) and Calvo (1986).

[19]Part of this section is based on Edwards (1989?)

[20]Notice, however, that it is also possible that the capital account liberalization will result in massive capital outflows. See Edwards (1984). In this model the tax on borrowing is a policy variable. Alternatively one can assume, as in Edwards and van Wijnbergen (1986) that there is a quantitative limit to foreign borrowing. In that case δ becomes an endogenous variable.

[21]This assumes that the transfer is made in the form of tradable goods. If actual capital is transferred, however, the results may be different.

[22]The fact that transfers from abroad generate an equilibrium real appreciation has some important policy implications. In particular, it means that foreign aid will generally discourage tradable activities including agriculture. Foreign aid, by increasing real income, will generate an "equilibrium overvaluation", that will squeeze profitability out of the exports and import competing sectors.

[23]For a detailed analysis of technological progress using duality in a static general equilibrium model of trade see Dixit and Norman (1980, pp. 137-142).