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Response of the Equilibrium Real Exchange Rate to Real Disturbances in Developing Countries

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Abstract

Using a simple dependent-economy framework, this paper outlines the links between the equilibrium real exchange rate and some of its fundamental exogenous determinants, mainly terms of trade movements and commercial policy changes. Drawing on existing studies of trade flows in developing countries, it is possible to derive plausible quantitative ranges for the response of the equilibrium real exchange rate to both external and policy-induced shocks. The results should be particularly relevant in designing real exchange rate targets and rules that allow for movements in the equilibrium real exchange rate in response to various shocks.

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I. Introduction

In recent years, the persistence of relatively high rates of inflation in many developing countries has led to an increased use of exchange rate depreciation as a means of containing losses in international competitiveness. In particular, the adoption of real exchange rate rules, according to which the nominal exchange rate is continuously adjusted by the difference between the rates of growth of domestic and partner-country price levels, has become more widespread among developing countries. Simply put, these real exchange rate rules, which are based on the notion of purchasing power parity (PPP), typically aim to keep the real exchange rate constant at a level that prevailed in some base period--the target real exchange rate--when macroeconomic balance was thought to obtain. 1/

A well-known problem with such rules, however, is that they fail to take into account that the equilibrium real exchange rate, defined as the price of tradable goods relative to nontradable goods that is consistent with both internal and external balance, is itself an endogenous variable that is likely to change through time in response to a variety of disturbances. 2/ The attempt to maintain the real exchange rate at a constant level, say at the level in the base period, may therefore lead to adverse movements in an economy's underlying competitiveness, and hence promote rather than prevent the emergence of macroeconomic disequilibrium. This could occur, for example, if some shock to the economy caused the equilibrium real exchange rate to depreciate, but the PPP rule attempted to keep the real exchange rate constant. In this case, the actual real exchange rate would be appreciated relative to the equilibrium rate, and this would be reflected in a loss of competitiveness for the country in question. To prevent such an outcome, the policymakers would have to alter the target real exchange rate to make it coincide with the movements in the equilibrium real exchange rate.

In recent years, a variety of theoretical models have attempted to analyze how the equilibrium real exchange rate responds to its fundamental determinants. The common thread of these models is that, in order to simultaneously maintain both internal and external balance in the face of exogenous disturbances, some change in the real exchange rate is generally required. In these models, internal balance is usually interpreted as the absence of excess demand or supply in the domestic market for nontradable goods, while by external balance is usually meant that the current account is in balance or, more generally, that any deficit can be financed by sustainable capital inflows. Examples of such models may be found in the recent book by Edwards (1989), and in the papers by Harberger (1985), Khan (1986), and Khan and Montiel (1987).

1/ For an analysis of such PPP-type exchange rate rules, see Dornbusch (1982).

2/ Other problems with such rules are discussed in Dornbusch (1982) and Adams and Gros (1986).

While analytical research has proceeded steadily, empirical evidence on the impact of exogenous disturbances on the equilibrium real exchange rate in developing countries is relatively rare and even then fairly limited in scope. Simple regressions or correlations between the real exchange rate and its exogenous determinants may not provide reliable information on this issue for at least two reasons. 1/ First, the equilibrium real exchange rate is in general unobservable and one may reasonably expect significant departures of the actual rate from its equilibrium level. 2/ Thus, empirical work focusing on correlations between the actual real exchange rate and its determinants would not generally provide the policymaker following a real exchange rate rule with reliable information on how to adjust the real exchange rate target in response to real shocks. A second point, which is related to the first, is that the estimates obtained from simple regressions or correlations between the real exchange rate and (a subset of) its exogenous determinants will generally embody a combination of policy reactions and endogenous private sector behavior. 3/ Yet, from the perspective of a country following a real exchange rate rule that involves adjusting the rate of devaluation in order to take account of the changing level of the equilibrium real exchange rate, it is of primary importance to have quantitative information on how the equilibrium rate adjusts in the face of exogenous shocks, for a given set of policies.

With these issues in mind, this paper has a twofold purpose. The first is to review, with the help of a very simple model, the main parameters on which the response of the equilibrium real exchange to changes in its fundamental determinants depends. Two such determinants are given special attention in this paper because of their practical relevance to developing countries in recent years. These are exogenous terms of trade shocks, which many developing countries are frequently subjected to 4/, and commercial policy changes, particularly variations in tariffs, which often are an integral component of adjustment programs. 5/ Simple extensions of the model can, however, be used to infer which additional parameters are important for determining the response of the equilibrium real exchange rate to other disturbances, including domestic fiscal policy changes and shifts in world interest rates.

1/ For examples of the use of simple regressions between the real exchange rate and some of its exogenous determinants, see Diaz-Alejandro (1980, 1984), Edwards (1988), and van Wijnbergen (1986).

2/ See Edwards (1989).

3/ In other words, if the reduced form fails to take into account the policy reactions of the authorities, the resulting estimates will not reflect the structural relationship between the equilibrium real exchange rate and its exogenous determinants.

4/ For example, the terms of trade of all developing countries declined by an average of 2 percent per year during the period 1980-89.

5/ See IMF (1987) and Papageorgiou, Choksi and Michaely (1990).

The second purpose of the paper is to determine, based on existing empirical research on the developing countries, plausible values for the relevant parameters. 1/ Given such estimates, one is able to determine how the real exchange rate would need to respond in order to maintain macroeconomic equilibrium in the face of terms of trade movements and commercial policy changes. Such information should be of interest to developing countries which follow PPP-type exchange rate rules but which, in setting changes in the nominal exchange rate, wish to allow for the impact on the equilibrium real exchange rate of changes in its fundamental determinants. The analysis in this paper should thus be helpful in providing a simple way of incorporating the effects of real shocks in the design of exchange rate policy, and furthermore, in indicating some basic idea of the magnitude of such effects.

The remainder of this paper is structured as follows. In Section II, we briefly lay out the model which is then used, in Section III, to derive the main comparative statics results. It is shown that such results depend only upon a limited number of parameters, on which empirical evidence for a variety of developing countries currently exists. Section IV uses these parameter values to obtain a plausible range of quantitative responses of the equilibrium real exchange rate to changes in the terms of trade and commercial policies. Section V summarizes the main results and presents some possible extensions.

II. The Theoretical Model

We model a hypothetical small open developing economy in which there are three goods: an import good; an export good; and a nontradable good. It is assumed that only two of these goods are consumed domestically (the import and nontradable) and two are produced domestically (the export and the nontradable). This structure is rich enough to capture the idea that many commodities that are consumed in developing countries may not be tradable internationally (because, say, of transport costs, quotas or prohibitive tariffs) and also that there are at least two distinct tradable goods, one (possibly, but not necessarily, a primary commodity) that is produced in the developing country and exported to the rest of the world, the domestic consumption of which is negligible; the other (possibly manufactures), where the majority of domestic consumption is met by imports from abroad. 2/

1/ These parameters are essentially elasticities of trade flows with respect to relative prices and income. We assume that the parameter estimates are "structural" in the sense that they follow from the specification of simple structural models of consumption and production behavior (see, for example, Goldstein and Khan, 1985).

2/ It should be noted that this is the simplest commodity structure in which the connection between the terms of trade (the relative price between the two tradable goods) and the real exchange rate (the relative price between one of the tradable goods and the nontradable good) may be analyzed. It is of course straightforward to expand the commodity

Producers use factors of production in fixed supply to maximize their profits from sales of the export and nontradable goods. Consumers in turn use their income to buy combinations of the import and home goods that maximize their utility. No specific assumptions are made regarding the production technologies of firms (beyond the assumption that production functions have standard "neoclassical" properties), or about the mobility of factors of production across sectors (some factors may be mobile while others may not be).

Because the country is assumed to be small in world markets, it takes the price of the two tradable goods as given. Therefore, the terms of trade, defined as the world price of the import good relative to the world price of the export good, is exogenous to the country. However, the relative price of the nontradable good and, hence, the equilibrium real exchange rate (defined as the relative price of one of the tradable goods in terms of the home good), are endogenous in the model, being determined by the interaction of domestic demand and supply for the home good. 1/

2/ (Cont'd from p. 3) structure further without substantially altering any of the theoretical results, see e.g., Dixit and Norman (1980). It should be noted, however, that the ultimate aim of the model is to use the existing empirical research on developing countries to obtain quantitative estimates for the response of the real exchange rate to various disturbances. In this regard, the cost of an expanded commodity structure would be the increased difficulty in obtaining empirical counterparts to many of the parameters of interest for a wide range of developing countries. The type of model developed here has been used fruitfully to analyze real exchange rate issues by, among others, Khan (1986), Khan and Montiel (1987), and Neary (1988).

1/ Because there are two tradable goods in the model, there are theoretically two possible definitions of the real exchange rate: the price of importables relative to nontradables (referred to as the importables real exchange rate, or the consumption real exchange rate); and the price of exportables relative to nontradables (referred to as the exportables real exchange rate, or the production real exchange rate). In addition, it may be noted that a common definition of the real exchange rate used both in policy analysis and in monetary models of exchange rate determination, is the ratio of the foreign price level to the domestic price level, when both are expressed in a common currency (sometimes referred to as the PPP real exchange rate). In the context of the real model developed in this paper, however, if we identify the foreign price level with the (world) price of the imported tradable good (in terms of the numeraire good), then it can be shown that the ratio of the foreign to the domestic price index (also in terms of the numeraire) may be expressed as a function of: (i) the importables real exchange rate; (ii) the exportables real exchange rate; and (iii) the world terms of trade. Therefore, given changes in world prices and the endogenous response of the importables and exportables real exchange rates, it is straightforward, using the methodology outlined in this paper, to compute the effect on the ratio of the domestic to the foreign price index.

Equilibrium in this economy requires first, that aggregate expenditure equal aggregate income--external balance--and second, that aggregate demand for nontradables equals aggregate supply--internal balance. 1/ At the level of generality of the discussion, that is without specifying technologies or preferences, it proves convenient to analyze the model's properties using simple duality theory (see Dixit and Norman, 1980). Under the dual approach, the external balance condition may be written as:

$$(1) \qquad R(1,q) + (T-p)E_T = E(T,q;u)$$

where R is the economy's revenue function, which yields the maximized value of GDP given the prices that appear as arguments in the function; 2/ E is the economy's expenditure function which gives the minimum level of expenditure necessary, given prices, to achieve utility level u; and a subscript denotes a partial derivative. The export good is taken as the numeraire and its price is accordingly set equal to unity. The import good sells domestically at price T, where $T = p(1+t)$, p is the world price of the good, and t represents the ad valorem tariff rate. The relative price of the nontradable good is denoted by q. Production decisions, and hence the revenue function, depend on the price of exports (unity) and the price of home goods (q), while consumption decisions, and hence the expenditure function, depend on the price of imports (T) and the price of home goods (q).

Equation (1) is in effect the economy's aggregate budget constraint between income and expenditure. Income in turn is equal to the sum of income from production (which is equal to the value of the revenue function), and transfers from the government which take the form of redistributed tariff revenues. Using the property that the volume of imports is equal to the partial derivative of the expenditure function with respect to the domestic price of imports, T, it is readily verified

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1/ In models that allow for intertemporal trade, external equilibrium need not imply the equality of income and expenditure in every period, provided that the present value of within-period imbalances sum to zero. In adopting the framework of this paper (which ignores intertemporal considerations), we follow much of the recent literature on real exchange rate determination, e.g., Edwards and van Wijnbergen (1987) and Neary (1988). For an analysis of some of the issues in this paper using an intertemporal model, see Ostry (1988) and Edwards and Ostry (1990). These papers also allow one to address the additional issues surrounding the different effects on the equilibrium real exchange rate of disturbances that are perceived to be temporary versus those that are regarded as permanent. The main reason for eschewing the intertemporal approach in this paper is that, at present, reliable empirical estimates of intertemporal models for the developing countries do not exist.

2/ Revenue also depends on the economy's endowment of factors of production. This argument has been supressed in order to keep the notation as simple as possible.

that the second term on the left hand side of equation (1) is indeed the tariff revenue. 1/

The condition for internal balance is that supply and demand for nontradable goods be equal. Recalling that the supply of home goods is given by the partial derivative of the revenue function with respect to the relative price of nontradables (q), and similarly, that the demand for home goods is given by the derivative of the expenditure function with respect to q, in equilibrium we have

$$(2) \qquad R_q(1,q) = E_q(T,q;u).$$

Equations (1) and (2) together summarize equilibrium in this small open economy and optimizing behavior on the part of consumers and producers. While this is perhaps among the simplest models one can define, it nevertheless is sufficiently rich to be able to derive the effects of a variety of exogenous and policy-induced shocks on the equilibrium real exchange rate. Finally, as noted previously, there are two possible measures of the equilibrium real exchange rate in this model. Specifically, in terms of the notation used here, the exportables real exchange rate is defined as 1/q, while the importables real exchange as T/q.

III. Comparative Statics

The model of Section II may be used to analyze the effects on the equilibrium real exchange rate of, among others, terms of trade movements, trade policies, fiscal policies, and productivity shocks. Simple extensions of it may be used to consider the effects of changes in international interest rates. Here we concentrate on the effects on the equilibrium real exchange rate of commercial policy changes and shifts in the terms of trade. Focus on these particular shocks is justified both by their practical relevance for many developing countries, and because estimates of the parameters on which the main comparative static results depend are available for a number of these countries. Since the principal objective of this paper is to provide a plausible range of such parameter estimates (in order to obtain reasonable bands for the response of the equilibrium real exchange rate), it seems preferable to focus attention on those cases in which broad consensus on such a range exists. 2/

1. Commercial policies

Changes in tariff rates are an important aspect of economic policy in many developing countries. In this sub-section, we consider first how the equilibrium real exchange rate responds to the imposition of a tariff, and

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1/ This is the product of the tax base, E_T, and the tax rate T-p (= tp).

2/ In Section V, however, we discuss the additional information that is required in order to determine the real exchange rate effects of some of the other disturbances mentioned above.

second, how trade liberalizations affect the equilibrium real exchange rate. Practically speaking, the main difference between these two cases involves the income effect: in the case where the tariff is imposed from an initially small level, there is no income effect from the policy change, so that the response of the real exchange rate depends only on substitution effects. In the case of trade liberalization, however, we can no longer assume that tariff levels are initially small. In this case, therefore, both income and substitution effects will play a role.

a. Imposition of tariffs

Differentiating equation (1) around an initial equilibrium with T=p yields that the change in utility from a tariff change is equal to zero. Differentiating equation (2), setting du = 0, using the Slutsky decomposition and the homogeneity property of demand and supply functions, and converting to elasticities, yields

$$(3) \quad d\log(1/q)/dt = -(\eta - \alpha\beta)/(\varepsilon + \eta - \alpha\beta)$$

where η is the price elasticity of demand for imports (defined positive); α is the income elasticity of demand for imports; β is the share of the import good in total consumption; and ε is the price elasticity of supply of exports. Finally, from the Slutsky decomposition, $\eta - \alpha\beta$ is positive, being equal to the compensated own-price effect in the demand for imports.

Equation (3) shows that the price of home goods, q, necessarily rises (relative to the unchanged price of exports) when a tariff is imposed. This is because, in response to higher import prices, demand for home goods increases. Since there is no income effect, the relative price of nontradables depends only on the substitution effect, which contributes to an increase in q. 1/ Moreover, it is easily verified that the magnitude of this increase depends positively on the price elasticity of demand for imports and negatively on the export supply elasticity and the income elasticity of demand for imports. Therefore, as shown in equation (3), the counterpart to the rise in the relative price of home goods is an appreciation of the real exchange rate in production--a fall in 1/q.

One may also be interested in the consumption real exchange rate, i.e., the price of the tradable consumption good relative to the home good (T/q). Using equation (3), one obtains

$$(4) \quad d\log(T/q)/dt = 1 + d\log(1/q)/dt = \varepsilon/(\varepsilon + \eta - \alpha\beta).$$

Equation (4) shows that the imposition of a tariff leads to a depreciation of the consumption-based measure of the real exchange rate. This is simply the counterpart of the fact that, in response to a tariff, the

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1/ Allowing for domestic production of import substitutes would reinforce this effect if all goods are substitutes on the supply side, a reasonable assumption at this level of aggregation.

price of home goods rises less than one for one with the tariff rate (i.e., the expression on the right hand side of equation (3) is necessarily less than unity in absolute value). Finally, it is seen from equation (4) that the effect on the consumption real exchange rate is decreasing in the price elasticity of demand for imports, but increasing in the supply elasticity and the income elasticity.

b. Trade liberalization

To analyze the impact on the real exchange rate of trade liberalization, it is no longer reasonable to assume that in the initial equilibrium, T = p. Differentiating equation (1) and solving for du (which is different from zero in this case because T > p), then substituting the expression for du into the total differential of equation (2), using the homogeneity and Slutsky properties of the various derivatives, and converting to elasticities, yields

$$(5) \quad d\log(1/q)/dt = -\bar{\eta}(1-\gamma)/[\varepsilon(1-\alpha\beta\gamma) + \bar{\eta}]$$

where $\bar{\eta} > 0$ is the absolute value of the compensated price elasticity of demand for imports, i.e., $\bar{\eta} = \eta - \alpha\beta$; and $\gamma = t/(1+t)$ is a measure of the initial distortion. A comparison of equations (5) and (3) reveals that the expressions for the change in the production real exchange rate, 1/q, are identical if the initial distortion, γ, is zero. However, with t, and hence γ, positive, changing the tariff rate also affects the level of real income in the economy, which in turn affects aggregate demand for nontraded goods and hence the response of the equilibrium real exchange rate. To take a concrete example, a reduction in t tends to lower demand for nontraded goods via the standard substitution effect described in the previous sub-section. This tends to reduce the price of home goods, and hence favors a depreciation of the production real exchange rate (a rise in 1/q). However, the reduction in t also tends to raise real income levels in this economy (by reducing an initial distortion) and this causes demand for all goods, including nontradables, to increase, which tends to lower the production real exchange rate, 1/q. But, as long as all goods are normal, the income effect cannot outweigh the substitution effect and the expression on the right hand side of equation (5) must be negative, although it will be smaller (in absolute value) than the corresponding expression in equation (3) with $\gamma = 0$. 1/ What this tells us is that reducing the tariff on imports ($dt < 0$) necessarily raises 1/q--i.e., causes a depreciation in the equilibrium real exchange rate in production--but the magnitude (in percentage terms) of the increase is smaller the larger is the level of the tariff that initially prevails in the economy. Finally, it is straightforward to show that the effect on the consumption-based measure of the real exchange rate is given by

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1/ The expression on the right hand side of equation (5) is negative because, if all goods are normal, $\alpha\beta$ must necessarily be less than one; and since γ is also a fraction, the product, $\alpha\beta\gamma$ is also less than unity.

(6) $\text{dlog } (T/q)/dt = \varepsilon(1-\gamma)(1-\alpha\beta\gamma)/[\varepsilon(1-\alpha\beta\gamma) + \bar{\eta}]$

which is positive under the assumption that all goods are normal. Clearly, a liberalization ($dt < 0$) appreciates the consumption real exchange rate but the degree of appreciation (in percentage terms) is decreasing in the initial level of the tariff.

2. Terms of trade shocks

Shifts in the world terms of trade affect the economy's aggregate budget constraint, and hence exert an income effect on spending decisions that is similar to the income effect resulting from tariff changes when trade flows are initially distorted. To determine the effect on the price of nontradables of a change in the terms of trade, differentiate equation (1) and solve for the effect on utility, du, substitute this expression into the differential of equation (2), and convert into elasticities to obtain

(7) $\text{dlog } (1/q)/\text{dlog } p = -(\eta - 1)/(\varepsilon + \eta - \alpha\beta)$

which is positive or negative depending on whether the price elasticity of demand for imports is less than or greater than one. Like a tariff, a deterioration in the terms of trade (a rise in p) raises demand for home goods according to the substitution effect, given by η. However, the terms of trade shift also lowers real income by reducing the relative price of domestically-produced tradable goods on world markets. Only if the substitution effect is sufficiently large (i.e., $\eta > 1$) will q rise (and hence 1/q fall) in response to a rise in p. Thus, if the price elasticity is small, the terms of trade deterioration leads to a depreciation of the production real exchange rate (a rise in 1/q), and conversely if $\eta > 1$, a real appreciation (a fall in 1/q) results. Finally, the change in the consumption-based measure of the real exchange rate is given in this case by

(8) $\text{dlog } (T/q)/\text{dlog } p = (1 + \varepsilon - \alpha\beta)/(\varepsilon + \eta - \alpha\beta)$.

Equation (8) shows that, as long as all goods are normal, a deterioration in the terms of trade depreciates the consumption-based measure of the real exchange rate. 1/ Moreover, the real depreciation is larger than in the case of a tariff owing to the real income effect which depresses the relative price of home goods.

IV. Some Quantitative Estimates

In this Section, we use existing evidence on the values of import demand and export supply elasticities to compute plausible ranges for the response of the equilibrium real exchange rate to commercial policy and terms of trade shocks. From the analysis of Section III, the main

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1/ As previously mentioned, normality implies $\alpha\beta < 1$.

parameters of interest are: the price elasticity of import demand; the price elasticity of export supply; and the income elasticity of import demand. In addition, some assumption must be made concerning a plausible value for β, the share of expenditure on importables. 1/

The empirical estimates of the various elasticities that are used below are taken from a recent study of import demand and export supply for 15 developing countries (Khan and Reinhart, 1990). 2/ As the results reported in that study fall within the range of those reported in a variety of other studies of developing country trade flows (e.g., Khan, 1974; Khan and Knight, 1988; and Haque, Lahiri, and Montiel, 1990), they should provide a plausible range of parameter values for many developing countries. Of course, if reliable estimates of the relevant elasticities are available for a specific country, it would be straightforward to apply the analysis of the previous section to the country in question.

Khan and Reinhart (1990) report the following ranges for the parameters of interest. For the income elasticity of import demand, the estimates fall in the range of 0.9 to 1.3. For the price elasticity of import demand, the range is 0.4 to 0.7. Finally, the price elasticity of export supply falls within the range 0.7 to 1.3. 3/ Together, the price and income elasticities of import demand imply a band for the compensated price elasticity, $\bar{\eta}$, from 0.1 to 0.5.

In Table 1, we report results for the response of the equilibrium real exchange rate as a function of the export supply price elasticity, ε, and the compensated import demand elasticity, $\bar{\eta}$. 4/ The (absolute value of the) percentage change in the internal terms of trade, T, is the same in both panels of the Table. Panel a considers the effects of a 10

1/ For β, we take a value of 0.2, which is the approximate value of the share of imports in GDP over all developing countries for the period 1980-89 (the actual value being 0.174). There are two possible biases in using the import/GDP ratio as a proxy for β. On the one hand, if there is significant domestic production of importables, then the import/GDP ratio will tend to underestimate β. On the other hand, it is well known that a significant proportion of developing country imports are investment and intermediate goods (see Thomas, 1989). This would imply that the import/GDP ratio will tend to overestimate the expenditure share of consumption of importables. In using a value for β of 0.2, we are implicitly assuming that these two biases are (approximately) offsetting.

2/ The sample was for the period 1966-87 on an annual basis.

3/ Formally, these bands are centered at the mean value of the elasticity over the 15 countries of the sample and their total width is equal to one standard deviation.

4/ Results are given in terms of the exportables real exchange rate, 1/q. The corresponding effects on the importables real exchange rate, T/q, are straightforward to calculate using the results from the previous section, specifically equations (4), (6), and (8). These latter results are available from the authors on request.

Table 1. Percent Depreciation in the Exportables Real Exchange Due To: 1/

a. A 10 percent deterioration in the terms of trade

	Compensated elasticity of demand for imports				
	0.1	0.2	0.3	0.4	0.5
Export supply elasticity					
0.7	8.8	6.7	5.0	3.6	2.5
0.8	7.8	6.0	4.5	3.3	2.3
0.9	7.0	5.5	4.2	3.1	2.1
1.0	6.4	5.0	3.8	2.9	2.0
1.1	5.8	4.6	3.6	2.7	1.9
1.2	5.4	4.3	3.3	2.5	1.8
1.3	5.0	4.0	3.1	2.4	1.7

b. A halving of the tariff rate to 12-1/2 percent

	Compensated elasticity of demand for imports				
	0.1	0.2	0.3	0.4	0.5
Export supply elasticity					
0.7	1.3	2.3	3.1	3.7	4.3
0.8	1.2	2.1	2.8	3.4	3.9
0.9	1.0	1.9	2.6	3.2	3.7
1.0	0.9	1.7	2.4	2.9	3.4
1.1	0.9	1.6	2.2	2.7	3.2
1.2	0.8	1.5	2.1	2.6	3.0
1.3	0.7	1.4	1.9	2.4	2.9

1/ In both panels, the (absolute value of the) change in the internal terms of trade, T, is equal to 10 percent. The calculations also assume an income elasticity of unity.

percent deterioration in the terms of trade (a 10 percent rise in p) while Panel b gives the effect of a reduction in the average tariff rate that lowers T by 10 percent. 1/

In both Panels of Table 1, the equilibrium real exchange rate depreciates. 2/ While the theoretical analysis showed that the equilibrium real exchange rate necessarily depreciates in response to a reduction in tariffs, the fact that it depreciates in response to a deterioration in the terms of trade reflects the empirical finding that, over a plausible range of the price elasticity of demand for imports in developing countries, the income effect from a change in world relative prices will outweigh the substitution effect. 3/

Panel a reveals that, for relatively high values of the compensated elasticity of demand for imports, the income and substitution effects associated with the deterioration in the terms of trade tend largely to offset one another. In this case, the required adjustment in the equilibrium real exchange rate is likely to be small, equal to perhaps one quarter to one fifth of the percentage movement in the terms of trade. On the other hand, if substitution possibilities are limited and the compensated price elasticity is correspondingly low, the required adjustment in the equilibrium real exchange rate is likely to be large. Specifically, for every percentage point deterioration in the terms of trade, a depreciation of the real exchange rate of as much as four fifths of one percent may be required in order to avoid losses in international competitiveness and maintain macroeconomic equilibrium. In this case, the effect of keeping the real exchange rate constant at its pre-terms-of-trade-shock level, may be a substantial loss of competitiveness for the country experiencing the adverse movement in the terms of trade.

1/ With the initial tariff rate assumed equal to 25 percent, a 10-percent reduction in T requires a reduction of $100(1+.25)(.1) = 12\text{-}1/2$ percent in the initial tariff rate, t (i.e., a halving of the initial rate). One could of course compute the effects of changes in the tariff around an initial equilibrium of free trade (equation 3). However, given that trade flows are frequently highly distorted in many developing countries, the case of tariff changes from an initially positive level has greater relevance.

2/ Of course, the effects of improvements in the terms of trade or increases in tariff rates are completely symmetric to the ones given here for deteriorations in the terms of trade or tariff reductions. For comparable magnitudes of the two shocks, therefore, the quantitative effects on the equilibrium real exchange rate would simply be equal and opposite in sign to those that appear in Table 1.

3/ It may be noted that the general conclusion that a deterioration in the terms of trade contributes to a depreciation of the real exchange rate is also reached in previous regression-based studies relating the terms of trade and the real exchange rate; see, e.g., Diaz-Alejandro (1980, 1984) and Edwards (1988).

Panel b considers the effect on the equilibrium real exchange rate of a reduction in trade taxes, specifically a halving of the tariff rate, beginning from an initial level of 25 percent. 1/ As can be seen there, the magnitude of the depreciation is increasing in the demand elasticity and decreasing in the supply elasticity. For low values of the former and high values of the latter, a halving of the tariff rate to 12-1/2 percent requires a real depreciation of about one percent in order to maintain macroeconomic equilibrium. In the case of large demand and small supply elasticities, however, the required depreciation is of the order of four percent. This shows that, as in the case of a terms of trade shock, adhering to a rigid real exchange rate policy over a period in which trade flows are being liberalized, may lead to considerable misalignment of the real exchange rate. Panel b gives some notion of how to adjust the real exchange rate target in order to avoid the loss of export competitiveness that is inherent in sticking to a PPP-based real exchange rate rule when there are commercial policy changes.

Finally, while the case presented in Panel b relates to a developing country in which trade flows are initially relatively highly distorted, it is of course possible (using equation 3) to consider the effects of commercial policy changes from an initial position of free trade. 2/ The results would, however, not be symmetric in the sense that raising the tariff from 0 to 10 percent would have slightly different effects from those that occur from a reduction in the tariff from 10 to 0 percent. This is simply a reflection of the fact that in the first exercise, the income effect in the initial equilibrium is zero, while in the second case, the income effect is positive. 3/ Notwithstanding these theoretical arguments, it appears that over a plausible range of the elasticities, the presence of income effects when trade flows are initially distorted, is not such as to give rise to quantitatively large differences with respect to the free trade case. For example, the case in which the tariff is raised from 0 to 12-1/2 percent (the same change in the tariff rate, in absolute value, as considered in Panel b of Table 1) produced percentage real appreciations that ranged from 0.9 to 5.2 percent. This compares with a range of depreciation, as reported in Panel b of Table 1, from 0.7 to 4.3 percent, which is based on the assumption of an initial tariff of 25 percent.

V. Conclusions and Extensions

This paper has analyzed a well-known version of the dependent-economy model in order to obtain simple formulas linking the equilibrium real

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1/ For the effects of a similar exercise in the context of a simulation model, see Khan and Zahler (1983).

2/ This case is arguably less relevant for a majority of developing countries, and hence the computations are not included in the paper, but are available from the authors on request.

3/ One way of avoiding this lack of symmetry would be to evaluate income effects in both cases at the midpoint tariff rate.

exchange rate to some of its fundamental determinants. Reasonable estimates of these formulas were obtained from the existing empirical literature on the determinants of trade flows (imports and exports) in developing countries. We were thus able to derive a plausible range of response for the equilibrium real exchange rate to terms of trade shocks and commercial policy changes.

From a policy perspective, the evidence presented in this paper should be of use to countries following PPP-type exchange rate rules in which nominal depreciations are used to offset differentials between national and partner-country inflation rates. In particular, using the nominal exchange rate to offset inflation differentials may result in losses in international competitiveness if the equilibrium real exchange rate depreciates because of changes in its fundamental determinants (e.g., trade liberalization or a deterioration in the terms of trade). The calculations in this paper should, therefore, provide useful rules of thumb on how to adjust the real exchange rate target in the face of real disturbances. If need be, country-specific estimates of the elasticities of trade flows with respect to prices and income may be used in conjunction with the simple formulas presented in this study.

While the analysis has concentrated only on two types of disturbance, the model outlined is quite general. 1/ The effect of changes in the composition of government spending and tax changes can easily be analyzed in the model without modification. Another disturbance that has practical relevance for many developing countries is changing levels of real interest rates in world capital markets. It is fairly straightforward to analyze the effects of exogenous changes in world real interest rates in a two-period extension of the model here (see, for example, Ostry, 1988, and Edwards, 1989). The main additional parameter on which real exchange rate responses depend in this case is the intertemporal elasticity of substitution between present and future consumption. An interesting extension of the model would involve using estimates of this parameter obtained from Euler equation estimations of consumption behavior in developing countries (Giovannini, 1985, Haque and Montiel, 1989, and Rossi, 1988) in order to determine some plausible range of response of the equilibrium real exchange rate to shocks in world interest rates.

In conclusion, the results provided in this paper can prove useful in the design of exchange rate policy in general, and in the formulation of real exchange rate rules in particular.

1/ Generalizing the commodity structure is also possible if one is willing to use parameter values from existing simulation models, e.g., Khan and Zahler (1983), rather than from econometric estimates.

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