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Box 1987, Yale Station
New Haven, Connecticut 06520

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# TERMS OF TRADE, COMMERCIAL POLICY, AND THE BLACK MARKET FOR FOREIGN EXCHANGE: AN EMPIRICAL MODEL OF REAL EXCHANGE RATE DETERMINATION

Ibrahim A. Elbadawi

University of Gezira, Sudan

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## Abstract

### Terms of Trade, Commercial Policy, and the Black Market for Foreign Exchange: An Empirical Model of Real Exchange Rate Determination

A model of real exchange rate (RER) determination is presented. The model permits long run equilibrium movements in RER to be distinguished from its short run disequilibrium dynamics. An important aspect of the model is that it explicitly considers the black market premium as one of the fundamental determinants of RER. Especially in economies plagued with persistent excess aggregate demand, and rapidly depreciating domestic money under a regime characterized with currency inconvertibility and highly regulated current account transactions, the black market is usually a persistent and a growing part of the economy. The model is then applied to the case of the Sudan, a less developed country which approximates the economic environment described above.



Ibrahim A. Elbadawi, Department of Economics, University of Gezira, Wad Madani, P.O. Box 20, SUDAN.

## 1. Introduction

The concept of real exchange rate (RER) has assumed a central position in the past and current debates in the literature on economic development and growth strategies and the more recent literature on structural adjustment and economic stabilization. The RER which is generally defined as the relative price of tradables to nontradables is taken to be the most important relative price signalling for intersectoral growth in the long run. The relevence of RER to export promotion and generation of optimal output and employment path can easily be shown in rigorous behavioral models of utility and expenditure function, example of such literature includes: Edwards (1986a, 1987b), Edwards and van Wijnbergen (1986a, 1987), Mussa (1974, 1978), and Pinto (1988) to mention a few.[1] In the context of his insightful work in the area of trade liberalization and development strategy, Diaz-Alejandro drew from the experience of Latin America to argue that RER misalignment and especially RER overvaluation, (with respect to the equilibrium RER), can be detrimental to an export-oriented development strategy, Diaz-Alejandro (1984).

There is more than one definition for equilibrium RER (ERER). According to Edwards (1987a) for example, ERER is the relative price of tradables to nontradables which, for a given sustainable value of other relevent variables such as terms of trade, commercial policy, capital and aid flows, and technology, results in the simultaneous attainment of <u>internal</u> and <u>external</u> equilibrium. A similar view of ERER is taken in the empirical part of this paper, where the ERER is consistent with the simultaneous equilibriums in the asset and home goods markets. The above two views of ERER emphasize adjustment in the internal and external sectors as the most immediate issue of concern. From the foregoing discussion, it is clear that, modelling the

process of ERER determination is an issue of great concern to both academic and policy makers alike. This exercise, however, is rather nontrivial. As noted by Edwards (1987a), the ERER is not a fixed immutable number. The RER experiences two types of movements: short run disturbances around its equilibrium and long run movements between equilibrium points. The nature of ERER movement is determined by the path of immediate determinants of the ERER referred to as the ERER "fundamentals," Domowitz and Elbadawi (1987b). Also, since the notion of equilibrium is "intertemporal" in nature, the path of the ERER will not only be affected by the current values of the fundamentals, but also by the expected future evolution of these variables, e.g. Edwards (1987a).

More recently an important two sector model of tradables and nontradables due to Dornbusch (1974) has been extended by Sjaastad (1980) to a three sector model of exportables, importables, and home goods; this later model has subsequently been employed to study RER determination and intersectoral growth prospects with special emphasis on the agricultural sector. Authors such as Valdes (1985, 1986), Mundlak and Cavallo (1987), and Garcia (1981), used the rather strong evidence generated by the model to argue against RER overvaluation as a major factor retarding the growth of LDCs' agriculture. Since agriculture in most LDCs is the main comparative advantage of their economy, it is argued therefore, that LDCs that adopt policies leading to RER overvaluation will be pursuing an inoptimal growth path. The above studies which drew heavily from Latin American experience has been remarkably matched by equivalent evidence from Africa and Asia as in the work of Bautista (1985), Elbadawi (1987), Oyejide (1986), and Tshibaka (1986).

The study of RER determination has traditionally been confined to the literature on pure trade, hence only the real determinants of RER such as

terms of trade and commercial policies were considered. In the context of the small country assumption, analytical models of trade theory predicted real appreciation as a result of TOT improvement or restrictive trade policies, see for example Balassa (1982), Bacha and Taylor (1977) and Johnson (1966). More recent development in RER modelling included more general equilibrium models that tend to emphasize the importance of intermediate goods and the home goods' sector to RER determination. These recent models substantially qualified the clear-cut predictions of the traditional literature in international trade and economic liberalization. The impact on RER of TOT improvement or higher tariff rates can no longer be signed a priori, even though an RER appreciation may be more likely than RER depreciation; Edwards (1987a, 1987b), and Edwards and van Wijnbergen (1987). In addition to the long run real determinants of RER, impacts on RER of short run disequilibrium in the economy and the money market have also been explicitly addressed in recent models. The theoretical and empirical examples in this tradition include: Edwards (1985, 1986b, 1987a), Mundlak and Cavallo (1987), and Elbadawi (1987).

In this paper we present a model of RER determinantion which accounts for the long run real determinants of RER as well as the short run disequilibrium influences on RER. The main contribution of this paper is that it explicitly models the impact on RER of the existence of a large black market for foreign exchange in the economy. The phenomenon of the black market for foreign exchange has been typical of many LDCs which are maintaining some forms of currency inconvertibility, while their domestic currencies were experiencing rapid depreciation. In the black market, domestic residents can acquire foreign exchange at a premium. Especially in the case of major labor-exporting countries where it may be difficult to control the supply of

foreign exchange to the black market; the latter can be quite large and the black market dollars may end up being used to finance current account transactions.[2] We will show that the black market premium can be a major source of RER appreciation. By solving for the premium as a function of the exogenous variables in the asset market, the model also provides some useful insight on the dynamic behavior of RER. In Section (2) of this paper the model is presented and the issues discussed in this section were developed in a more rigorous fashion. In Section (3) this model is applied to the case of the Sudan which is a major labor-exporting country, with an economy dominated by the exports of primary agricultural goods and imports of manufactures and intermediate goods. In the Sudan taxes on foreign trade is the main source of government revenue. The Sudanese economy has also been plagued by an expanding aggregate excess demand and a rather substantial black market for foreign exchange. In Section (4) we will use the econometric analysis of Section (3) to solve for the estimates of the structural parameters of the model and then the estimated ERER reduced form equation. Finally some concluding remarks follow in Section (5).

## 2. The Model

In this section a model of RER determination is developed. This model accounts for both the traditional long run real determinants such as the terms of trade and commercial policy. The model also incorporates the short run disequilibrium effects of excess aggregate demand in the economy. Another attractive aspect of this model is that it explicitly considers the impact on RER when conditions of excess domestic demand for foreign exchange under currency inconvertibility give rise to the emergence of a black market for foreign exchange where domestic residents can acquire foreign currency at a

premium rate.[3] Also in this model, a discussion of the channels through which both the real and monetary factors may impinge on the RER and the extent to which they are interrelated is provided in some detail.

The model is composed of four major building blocks. The first is concerned with the definition of RER and the price of tradable goods. In the second part of the model we derive a formula for the price of nontradables when equilibrium in the nontraded goods market is maintained. At this stage a semi-reduced form equation for RER can be derived. This equation will reflect the influences on RER of the terms of trade, commercial policy, the black market premium, and the impact of excess aggregate demand in the economy. In the last building block of the model we bring the conditions of the money and the asset markets into the picture. This will permit an explicit representation of the black market premium as a function of other exogenous determiants of RER. By substituting for the premium in the RER semi-reduced form equation and also by endogenizing the real income variable, we can ultimately obtain a full reduced form equation for RER that satisfies equilibrium in the home goods markets but may also be consistent with a potential disequilibrium in the asset market.

## (2.1) The RER and the Price of Tradables

Let the (dollar) denominated international prices of exportables and importables be given by $P_x^*$ and $P_m^*$ respectively. By invoking the small country assumption, $P_x^*$ and $P_m^*$ can be considered as exogenous variables. Therefore for a given set of exchange rate and commercial policy, $P_x$ and $P_m$, the domestic prices of exportables and importables will be determined respectively by $P_x^*$ and $P_m^*$. Let $e$ and $\tilde{e}$ be respectively the official and the black market rates of exchange where the exchange rate is given in terms of units of domestic

currency per unit of the foreign currency (dollar). Also let $t_x$ be the net export tax rate, and $t_m$ be the net tax rate on imports which may also include non-tariff implicit taxes such as quota rationing. The domestic prices of exportables and importables can then be defined as in equations (1) and (2) below:

$$P_x = e(1-t_x)P_x^* \tag{1}$$

$$P_m = e^{\beta}\tilde{e}^{1-\beta}(1+t_m)P_m^* , \quad 0 < \beta < 1 \tag{2}$$

The presence of the black market rate $\tilde{e}$ in equation (2) reflects the increasing reliance on the black market dollars to finance some key import categories in many LDCs.[4]

Letting the shares of exportables and importables in the tradable goods' sector be $\alpha$ and $1-\alpha$ respectively, the domestic price of tradables, $P_T$, is simply:

$$P_T = P_x^{\alpha}P_m^{1-\alpha}, \quad , \quad 0 < \alpha < 1 \tag{3}$$

using (1) and (2) on (3) we obtain $P_T$ in the following logarithmic form:

$$\log P_T = \log e + (1-\alpha)(1-\beta)\log q + \alpha \log(1-t_x)$$

$$+ (1-\alpha)\log(1+t_m) + \alpha \log P_x^*$$

$$+ (1-\alpha)\log P_m^* \tag{4}$$

and $q = \tilde{e}/e$ is the black market premium. Equation (4) above shows $P_T$, as expected, to depend on foreign prices, exchange rate and foreign trade policy. But $P_T$ is also shown to depend on q the black market premium. The extent of the premium influence on $P_T$ will depend on the share of importables, $1-\alpha$, in the tradable sector, and on the extent of black market's current account link, $1-\beta$. Finally, in this block we introduce the RER definition. The definition which we will use is that of the dependent economy type such as in Dornbusch (1974, 1980) for example.[5] Letting $P_N$ stand for the price of nontradables, we have:

$$RER = \frac{eP_x^{*\alpha} P_m^{*1-\alpha}}{P_N} = \frac{eP_T^*}{P_N} \tag{5}$$

(2.2) The Nontradables' Sector

This part of the model draws on the literature which originated with the work of Dornbusch (1974), and Sjaastad (1980) who extended the Dornbusch model to three sectors, namely, exportables, importables, and home goods or nontradables. The demand and supply functions for nontradables are represented, respectively, by the following two equations:

$$D_N = D_N\left[\frac{P_x}{P_N}, \frac{P_m}{P_N}, y, f(\cdot)\right]$$

and

$$S_N = S_N\left[\frac{P_x}{P_N}, \frac{P_m}{P_N}, C_P\right]$$

where real income y is used as a proxy for total expenditure in terms of home goods; $f(\cdot)$ is a measure of excess aggregate demand with $f(0) = 0$, and $f' > 0$; and $C_P$ is the productive capacity of the economy presumed to be determined by the existing domestic resources and technology. The exportables and importables' prices, $P_x$ and $P_m$, are taken to be exogenous to the nontraded goods' market because they are determined by government foreign trade and exchange rate policy, and international market conditions. Also, the demand and supply homogeneity properties were exploited to represent the prices in relative terms.

We now make a simplifying assumption by holding $C_P$ fixed.[6] Then we differentiate the above two equations logarithmically to obtain:

$$\hat{D}_N = \epsilon_x(\hat{P}_x - \hat{P}_N) + \epsilon_m(\hat{P}_m - \hat{P}_N) + \epsilon_y \hat{y} + \epsilon_f \hat{f}(\cdot)$$

and

$$\hat{S}_N = \eta_x(\hat{P}_x - \hat{P}_N) + \eta_m(\hat{P}_m - \hat{P}_N)$$

where the hat ($\hat{}$) over a variable denotes a proportionate change; and the $\epsilon$'s are the demand elasticities for home goods with respect to the exogenous variables; the $\eta$'s are the corresponding supply elasticities. While the $\epsilon$'s are expected to be positive, the $\eta$'s are expected to be negative. Assuming static equilibrium in the nontraded goods' market, we have:

$$0 = (\epsilon_x - \eta_x)\left(\frac{P_x}{P_N}\right)\hat{} + (\epsilon_m - \eta_m)\left(\frac{P_m}{P_N}\right)\hat{} + \epsilon_y \hat{y} + \epsilon_f \hat{f}(\cdot)$$

We can now obtain the following formula for $P_N$ which is the equilibrium condition in the home goods' market:

$$\hat{P}_N = w\,\hat{P}_x + (1-w)\,\hat{P}_m + w_y\hat{y} + w_f\,\hat{f}(\cdot) \qquad (6)$$

where

$$w = \frac{\epsilon_x - \eta_x}{(\epsilon_x-\eta_x) + (\epsilon_m-\eta_m)}, \quad 0 < w < 1$$

$$w_y = \frac{\epsilon_y}{(\epsilon_x-\eta_x) + (\epsilon_m-\eta_m)}, \quad w_y > 0$$

$$w_f = \frac{\epsilon_f}{(\epsilon_x-\eta_x) + (\epsilon_m-\eta_m)}, \quad w_f > 0$$

In order to have an explicit measure of excess aggregate demand, we assumed that $\hat{f}$ is equal to $(\hat{DC} - \hat{e} - \hat{Y})$ which is the rate of growth in domestic credit in excess of real growth in income or output plus the rate of official devaluation. This measure of excess aggregate demand emphasizes the importance of domestic credit expansion in ratifying excess aggregate demand. The measure also recognizes the sluggishness in real growth as a major factor in accentuating excess aggregate demand.[7]

Using the above definition of $f(\cdot)$, and equations (1) and (2) in (6) we obtain the following equation for $P_N$ in logarithmic form:

$$\log P_N = w_0 + \log e + (1-w)(1-\beta)\log q + w\log(1-t_x)$$

$$+ (1-w)\log(1+t_m) + w\log P_x^* + (1-w)\log P_m^*$$

$$+ w_y \log y + w_f \log\left[\frac{DC}{ey}\right] \qquad (7)$$

(2.3) Semi-Reduced Form Equations for RER

Using equations (5) and (7) above we obtain a reduced form equation for RER (indexed over time) in equation (8) below:

$$\log RER_t = -w_0 - w \log(1-t_x)_t - (1-w) \log(1+t_m)_t$$

$$- (w-\alpha) \log\left(\frac{P_x^*}{P_m^*}\right)_t - w_y \log y_t - w_f \log\left(\frac{DC}{ey}\right)_t$$

$$- (1-w)(1-\beta) \log q_t \qquad (8)$$

Now we will assume the following path for real income y similar to the one proposed by Edwards (1986b):

$$\log y_t = g_0 + g_1 t + g_2 \log\left(\frac{P_x^*}{P_m^*}\right)_t \qquad (9)$$

Equation (9) assumes that the rate of growth in real income y, is formed of two components: a term of trade component and an independent term given by $g_t$ which is set equal to $g_1 t$ for simplicity.

Using (9) in equation (8) above we obtain another semi-reduced form equation for RER:

$$\log RER_t = -[w_0 + g_0(w_y - w_f)] - g_1(w_y - w_f)t - (1-w) \log(1+t_m)_t$$

$$-w \log(1-t_x)_t - [(w-\alpha) + g_2(w_y-w_f)] \log\left(\frac{P_x^*}{P_m^*}\right)_t$$

$$- w_f \log\left(\frac{DC}{e}\right)_t - (1-w)(1-\beta) \log q_t \qquad (10)$$

Equations (8) and (10) above are semi-reduced form equations because the potentially endogenizable variables y and q were treated as exogenous in (8), while q was taken to be exogenous in (10). Equation (8) is confined to the first round effects of the determinants of RER. For example the first round effects of commercial policy is given by the coefficients of $\log(1-t_x)$ and $\log(1+t_m)$. According to equation (8) a decrease in export or import taxes will cause an RER depreciation. The extent of such depreciation will depend on the respective relative elasticities, w, and 1-w, of the price of exportables and importables in the home goods market. This clear cut result is generated by our model because we assumed that the substitution effects between tradables and nontradables (w and 1-w) dominate any potential income effect due to commercial policy. Especially for the case of importables, it is argued that if initially there was a large tariff in place, the reduction in tariffs may increase welfare and the demand for nontradables, thus leading to an upward pressure in their prices, Edwards (1987b). Should this income effect dominate, we may have an RER appreciation rather than depreciation as a result of tariff liberalization; contrary to what is predicted by our model. The model, however, can easily be extended to accommodate for this channel by adding the term $\log(1+t_m)$ to the right hand side of equation (9) above.

Equation (8) also depicts the first round effects on RER due to expenditure, aggregate excess demand and the premium. An increase in

expenditure or in aggregate excess demand will cause the price of nontradables (equation (7)) to rise, thus leading to an RER appreciation. The extent of this appreciation is given by the respective elasticities $w_y$ and $w_f$. A rise in the black market premium is also predicted to cause an RER appreciation. The extent of the premium effect will depend, however, on both the elasticity due to the price of importables in home goods market (1-w), as well as the share of imports financed through the black market, $1-\beta$.

Finally for the case of terms of trade, equation (8) predicts that a TOT improvement cannot cause an RER appreciation, as predicted by the classical theory of real trade; only if the exportables price elasticity, w, exceeds the share of exportables in the tradable goods group can an RER appreciation take place. This implies that the effect on RER due to TOT is not a priori determined even when we confine ourselves to the first round effects as in equation (8) above. The picture for the TOT effects will be even more ambiguous in the context of equation (10) when the second round effects were brought into the picture. These TOT second round effects were provided by two opposing channels. A TOT improvement will lead through (9) to an increase in real income and a consequent rise in $P_N$ (equation (7)) thus leading to an RER appreciation of magnitude $g_2 w_y$; a rise in real income (output) on the other hand, will lead to a declining aggregate excess demand, causing a decline in $P_N$ and ultimately an RER depreciation of magnitude, $g_2 w_f$. This aspect of the model is quite attractive since it accommodates the recent theoretical results in the literature of RER determination, Edwards and van Wijnbergen (1986a).

## 2.4 The Monetary and Asset Markets

This block of the model is built around the following set of equations:

$$\log M_t = m \log DC_t + (1-m) \log e_t R_t \tag{11}$$

$$\log\left(\frac{eR}{\tilde{e}F}\right)_t = \theta_1 \log\left(\frac{P_x^*}{P_m^*}\right)_t + \theta_2 \left[\log\left(\frac{M^d}{\tilde{e}F}\right)_t - \log\left(\frac{M}{\tilde{e}F}\right)_t\right] \tag{12}$$

$$\log\left(\frac{M^d}{\tilde{e}F}\right)_t = a_0 - a_1 \hat{\tilde{e}}_t^e + a_2 \log y_t \tag{13}$$

$$\hat{\tilde{e}}_t^e = E_t \log \tilde{e}_{t+1} - \log \tilde{e}_t \tag{14a}$$

and

$$\hat{e}_t^e = E_t \log e_{t+1} - \log e_t \tag{14b}$$

Equation (11) is the money supply identity, where M is the stock of money, DC is domestic credit, and R is the official foreign reserves which is denominated in the foreign currency. Equation (12) depicts the domestic currency denominated stock of official reserve relative to the domestic value of private holdings of foreign money, as a function of the foreign TOT and the equilibrium conditions in the asset market. The potential positive impact on reserves as a result of TOT improvement is obvious. The inclusion of the other term in equation (12) provides a direct link between the asset market and the foreign balance. Subsequently this will generate very interesting channels in the ultimate RER reduced form equation. This idea was used by Edwards (1985, 1987a) where the equilibrium condition in the money market was introduced in a similar fashion. In our case, however, where the black market for foreign exchange is an important phenomenon, and the choice between the two currencies is important, the asset market equilibrium condition is more

relevent. Equation (13) describes the demand for domestic money relative to foreign money. the effect of real income is expected to be positive; while the effect of $\hat{\tilde{e}}$, the opportunity cost of holding domestic money relative to the foreign money, is expected to be negative. The opportunity cost of holding domestic money is given by the expected rate of depreciation of the black market rate, and expectations are assumed to be rational as in (14a) above. Expectations of official devaluation is also assumed to be rational as in (14b).

From equations (14a) and (14b) it follows that:

$$\hat{\tilde{e}}_t = E_t \log q_{t+1} - \log q_t + E_t \log\left(\frac{e_{t+1}}{e_t}\right) \tag{15}$$

From equations (11)-(13) we can derive the following equation for relative money supply:

$$\log\left(\frac{M}{\tilde{e}F}\right)_t = \frac{\theta_z(1-m)a_0}{1+\theta_2(1-m)} + \frac{m}{1+\theta_2(1-m)} \log\left(\frac{DC}{\tilde{e}F}\right)_t$$

$$+ \frac{\theta_1(1-m)}{1+\theta_2(1-m)} \log\left(\frac{P_x^*}{P_m^*}\right)_t$$

$$+ \frac{\theta_2(1-m)a_2}{1+\theta_2(1-m)} \log y_t$$

$$- \frac{\theta_2(1-m)a_1}{1+\theta_2(1-m)} \hat{\tilde{e}}_t$$

which we will simply write in the following unconstrained form:

$$\log\left(\frac{M}{\tilde{e}F}\right)_t = \gamma_0 + \gamma_1 \log\left(\frac{DC}{\tilde{e}F}\right)_t + \gamma_2 \log\left(\frac{P_x^*}{P_m^*}\right)_t + \gamma_3 \log y_t - \gamma_4 \hat{\tilde{e}}_t \qquad (16)$$

(2.5) The RER Reduced Form and the Working of the Model

Using equations (9) and (15) on (16) above we can obtain the following martingale structure:

$$\log q_t = \lambda E_t \log q_{t+1} + h_t \qquad (17)$$

where $\lambda = \gamma_4/(1 + \gamma_4 - \gamma_1)$, and

$$h_t = \frac{-\gamma_0 - \gamma_3 g_0}{1 + \gamma_4 - \gamma_1} + \frac{m - \gamma_1}{1 + \gamma_4 - \gamma_1} \log\left(\frac{DC}{eF}\right)_t$$

$$+ \frac{1 - m}{1 + \gamma_4 - \gamma_1} \log\left(\frac{R}{F}\right)_t - \frac{\gamma_2 + \gamma_3 g_2}{1 + \gamma_4 - \gamma_1} \log\left(\frac{P_x^*}{P_m^*}\right)_t$$

$$- \frac{\gamma_3 g_1}{1 + \gamma_4 - \gamma_1} t + \lambda E_t \log\left(\frac{e_t + 1}{e_t}\right) \qquad (18)$$

or

$$h_t = \lambda_0 + \lambda_1 \log\left(\frac{DC}{eF}\right)_t + \lambda_2 \log\left(\frac{R}{F}\right)_t - \lambda_3 \log\left(\frac{P_x^*}{P_m^*}\right)_t$$

$$- \lambda_4 t + \lambda E_t \log\left(\frac{e_{t+1}}{e_t}\right) \qquad (19)$$

Using the method of undetermined coefficients a particular forward solution of the above problem is obtained as follows[8]:

$$\log q_t = \sum_{j=0}^{\infty} \lambda^j E_t h_{t+j} \tag{20}$$

In the event that asset market equilibrium is imposed or the impact of asset market disequilibrium on reserves is deemed to be insignificant, the following representation for the premium will be obtained:

$$\log q_t = (m+a_1)^{-1} \sum_{j=0}^{\infty} \left(\frac{a_1}{m+a_1}\right)^j E_t\left[m \log\left(\frac{DC}{eF}\right)_{t+j} - \left[a_2 g_2 - \theta_1(m-1)\right] \log\left(\frac{P_x^*}{P_m^*}\right)_{t+j}\right.$$

$$\left. + a_1 \log\left(\frac{e_{t+1}}{e_t}\right) - a_2 g_1 (t+j) - (a_0 + a_2 g_0)\right] \tag{21}$$

Equation (21) describes the rational expectation equilibrium in the asset market, while equation (20) is consistent with disequilibrium in the asset market. Both of the two equations are important equations in their own right in the context of the asset market approach to the black market for foreign exchange, see Elbadawi (1988a). More importantly to our present analysis, any of the above two equations permits in a natural way, the incorporation of the dynamic aspects of RER determination. By using (19) and (20) in (10) we obtain the ultimate dynamic reduced form RER equation in (22) below. Should we use (21) instead of (20), the solution will be a special case of (22) where the resulting RER solution will be consistent with equilibriums in both the asset and home goods' markets.

$$\log RER_t = -[w_0 + g_0(w_y - w_f)] - g_1(w_y - w_f)t$$

$$-(1-w)\log(1+t_m)_t - w\log(1-t_x)_t$$

$$-\left[(w-\alpha) + g_2(w_y - w_f)\right]\log\left(\frac{P_x^*}{P_m^*}\right)_t - w_f \log\left(\frac{DC}{e}\right)_t$$

$$-(1-w)(1-\beta)\left(\sum_{j=0}^{\infty}\lambda^j E_t\left[\lambda_0 + \lambda_1 \log\left(\frac{DC}{eF}\right)_{t+j}\right.\right.$$

$$\left.\left.+\lambda_2 \log\left(\frac{R}{F}\right)_{t+j} - \lambda_3 \log\left(\frac{P_x^*}{P_m^*}\right)_{t+j} - \lambda_4(t+j) + \lambda \log\left(\frac{e_{t+1}}{e_t}\right)\right]\right) \qquad (22)$$

Besides showing the current impacts on RER of its exogenous determinants as in equation (10) above; equation (22) which satisfies equilibrium in the nontraded goods market, also includes the impact on RER of the expected behavior of its determinants. The channel through which expectation about the exogenous variables impinges on RER is the black market premium. The impact on RER of a given $E_t h_{t+j}$ will therefore depend crucially on the size of the black market, $1-\beta$; and the extent of the imported goods' intensity of the home goods, 1-w. The magnitude of the innovation $E_t h_{t+j}$ itself will depend of course on the relative changes among the exogenous variables as well as the elasticities pertaining to the asset market, the foreign reserve equation, and the money market identity. $E_t h_{t+j}$ will lead to an RER appreciation through three determinants. The first is given through an expectation of higher level of domestic credit relative to the private holding of foreign money denominated in domestic currency using the official exchange rate,

$E_t \log\left(\frac{DC}{eF}\right)_{t+j}$; this clearly shows the importance of unchecked domestic credit expansion in accentuating RER appreciation. Thus, besides its current impact on RER through the aggregate excess demand, the current and expected levels of DC may also cause further RER appreciation through the premium channel. The second effect that may cause an RER appreciation is the expected level of official reserves relative to the private holding of foreign money, $E_t \log\left(\frac{R}{F}\right)_{t+j}$. In cases when the economy is characterized by a structurally weak currency and a relatively large black market for foreign exchange, R may in fact be very small relative to F. The impact of $E_t \log\left(\frac{R}{F}\right)_{t+j}$ on RER therefore, may, in fact, ameliorate the appreciationary effect due to domestic credit expansion. Finally, expectations of accelerated rates of official devaluation will also cause RER appreciation. This result has very important implications for the debate related to the effectiveness of nominal exchange rate devaluation as a tool of economic stabilization and export promotion, when the economic environment is dominated by speculative behavior and expectations. The final term in $E_t h_{t+j}$ of interest to our discussion is $E_t \log\left(\frac{P_x^*}{P_m^*}\right)$. An expected improvement in the terms of trade will unambiguously lead to an RER depreciation. Within the black market channel, the expected TOT will operate through two further sub-channels. The first is the effect of income in the demand for money and the other is the direct effect of TOT on foreign reserves.

## 3. An Application to the Sudan

### (3.1) The Sudan's RER and Its Determinants: A Preliminary Analysis

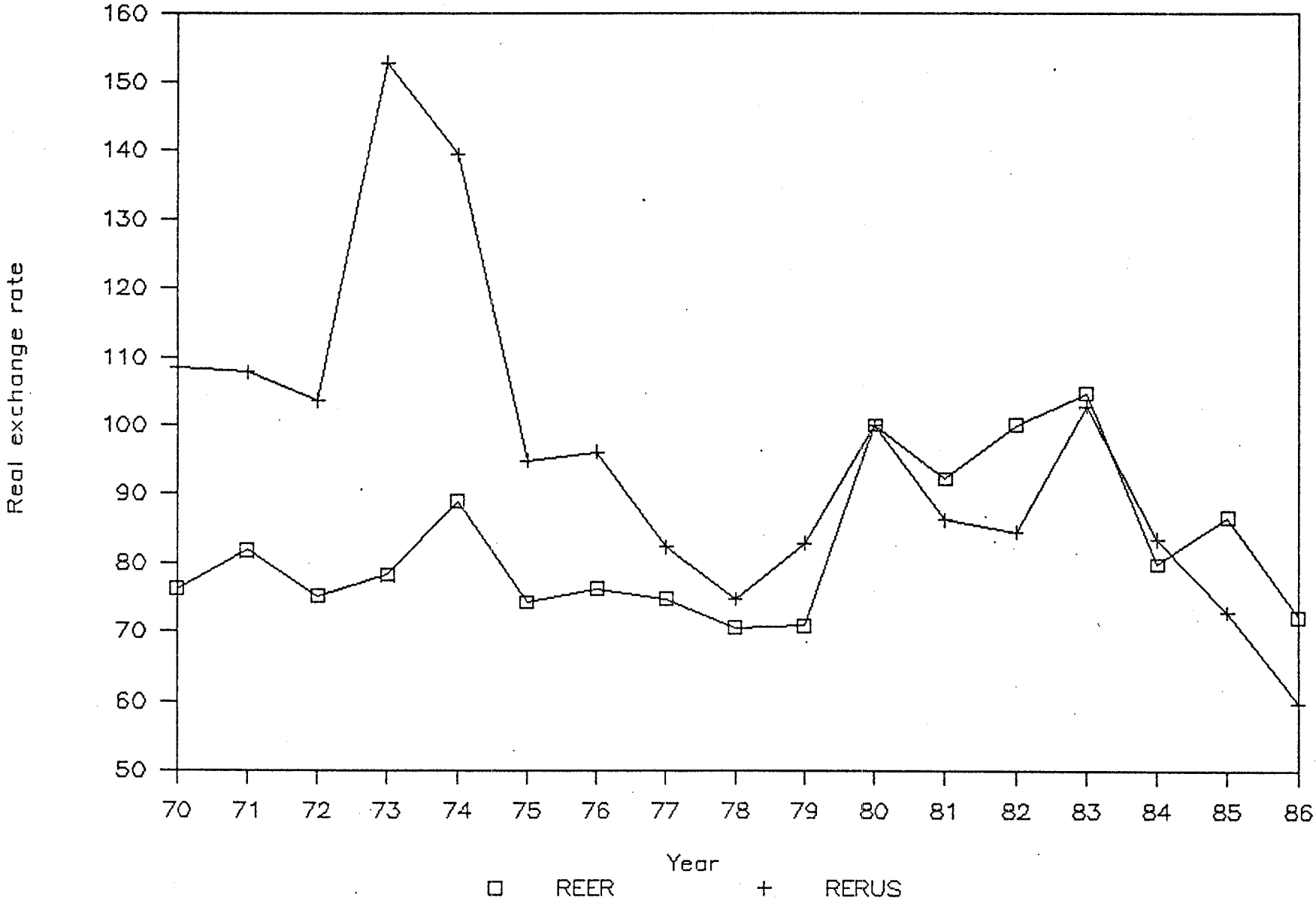
In this section we will apply the above model to analyze the determinants of the Sudanese RER. The Sudan economy provides an interesting case study to discuss the type of issues considered in the model of Section (2). The mainstay of the Sudan economy is provided by its agricultural sector which provides for more than 90% of total foreign exchange earnings out of exports. The domestic industry and a significant portion of the agricultural sector, on the other hand, depend heavily on imported capital and intermediate goods. Despite an increasing share for the nontradable service sector in the GDP, the Sudanese economy remains highly tradable with the combined share of agriculture and industry in GDP in excess of 50%. Figure (1) depicts two alternative definitions of the Sudan RER. Another view of the Sudan's RER and its potential determinants is provided by Table (1) and (2). One such determinant is TOT which has been averaging more than 90% except for the years 1975 and 1979 which came immediately ater two major oil price hikes. The Sudan's economy has also been characterized by an extensive system of import restrictions and fixed multiple exchange rates. This type of regime which is generally considered typical of most LDCs, is presumed to have its intellectual motivation in a development doctrine bent on "Industrial Import Substitution" as the main strategy. In the case of the Sudan, however, other goals such as balance of payment, and government revenue considerations, encouragement of remittances from Sudanese nationals working abroad (SNWA)[9] and to some extent export promotion, seem to be the key factors shaping the Sudan's foreign trade and payment regime, Elbadawi (1987). As the Sudanese economy started to assume crisis proportions by the mid seventies and the domestic and foreign balances continued to worsen, the need to check excess

aggregate demand and to maintain government revenues ensures the maintenance of the above system. The attempted foreign trade liberalization that came with an IMF-inspired package could not, therefore, be sustained. The figures on Table (1) attest to the above description.

Also, as can be seen from Table (2), the turbulant developments in the Sudanese macroeconomic science after the mid seventies have included massive monetary expansion with the money supply ($M_1$) and domestic credit growing, respectively, at an average annual rate of 27%, and 26% during 1975-1986. The official reserves which have been stagnant or at times growing at a negative rate has only partially moderated the overall growth rate in the money supply, see Table (2). The combination of monetary expansion and highly anticipated maxi-devaluations has accelerated domestic inflation which rose from a single digit by 1972/73 to more than 37% by 1985.[10] Such conditions of inflationary environment and highly suppressed aggregate demand, especially the one for imported goods, have paved the way for the emergence and subsequent expansion of the black market for foreign exchange. In recognition of the increasing importance of SNWA remittances as a source of much needed foreign exchange, the authorities have introduced a premium exchange rate for SNWA remittances and a new import system, the 'nil-value' system. These two measures were designed to encourage the transfer of remittances through the regular banking system and the use of SNWA savings to finance imports to the country. The offical exchange rate, however, could not keep pace with the black market rate, see Table (1); and therefore the lion share of SNWA remittances were channeled through the black market. On the other hand, the 'nil-value' system of imports - being largely financed by black market dollars - were turned into a current account link for the black market. For example by 1980 about 60% of total imports were financed through the black market, Hussain (1986). Due to

Figure (1)

# Real Exchange Rates in the Sudan




*See footnote of Table (1) for the definitions of REER and RERUS

Table 1

The Sudan's Real Exchange Rates and Its Determinants

| Year | REER | RERUS | TOT | TX | TM | Black Market Premium |
|---|---|---|---|---|---|---|
| 1970 | 76.2 | 108.4 | 98.0 | .052 | .658 | 1.200 |
| 1971 | 81.9 | 107.7 | 85.3 | .057 | .663 | 1.200 |
| 1972 | 75.1 | 103.6 | 87.3 | .059 | .627 | 1.200 |
| 1973 | 78.3 | 152.8 | 83.3 | .057 | .530 | 1.200 |
| 1974 | 88.9 | 139.4 | 89.2 | .066 | .564 | 1.200 |
| 1975 | 74.3 | 94.8 | 69.6 | .095 | .443 | 1.200 |
| 1976 | 76.3 | 96.1 | 89.2 | .089 | .515 | 1.333 |
| 1977 | 74.8 | 82.2 | 98.0 | .098 | .815 | 1.833 |
| 1978 | 70.6 | 74.7 | 83.3 | .094 | .649 | 2.233 |
| 1979 | 70.8 | 82.8 | 77.5 | .074 | .598 | 2.286 |
| 1980 | 100.0 | 100.0 | 100.0 | .105 | .521 | 1.740 |
| 1981 | 92.2 | 86.3 | 88.2 | .172 | .551 | 1.862 |
| 1982 | 100.1 | 84.5 | 98.0 | .066 | .218 | 1.800 |
| 1983 | 104.7 | 102.8 | 94.1 | .012 | .219 | 1.616 |
| 1984 | 79.8 | 83.4 | 93.4 | .028 | .621 | 1.877 |
| 1985 | 86.6 | 72.8 | 96.9 | .013 | .679 | 2.579 |
| 1986 | 72.1 | 59.7 | -- | -- | .680 | 2.381 |

Note: The real effective exchange rate (REER) was computed as: a weighted sum of the exchange rates multiplied by WPI's for Sudan's major trading partners, divided by the Sudan's CPI. The CPI, the only price series available for the Sudan, is used as a proxy for the price of nontradables, see Elbadawi (1987) for discussion on this. The partners (and weights) are: Egypt (.03), Saudi Arabia and rest of the Middle East (.32), USA (.06), West Germany (.11), France (.06), UK (.12), Italy (.10), India (.06), Japan (.09), Romania (0.01), Yugoslavia (.04). The RERUS index is obtained by multiplying the bilateral Sudan-US exchange rate with the World Price Index for Manufactures and dividing by the Sudanese CPI. An increase in any of the two RER indices reflects real depreciation whereas a decrease in RER is appreciation. The black market premium is obtained as a ratio of the black market rate to the official rate.

Sources: The data on prices, exchange rates and taxes are obtained from IFS and Elbadawi (1987).

Table (2)

Rates of Change in Some of Sudan's Key Macroeconomic Indicators (%)

| Year | Money Supply (M1) | Official Reserves ($) | Domestic Credit | INF (%ΔCPI) | Real GDP | Depreciation in the Black Market: Official Devaluation | Depreciation in the Black Market: Market Rate | Real Depreciation: REER | Real Depreciation: RERUS |
|---|---|---|---|---|---|---|---|---|---|
| 1971 | 6.8 | 25.1 | 15.6 | 1.2 | 3.5 | 00.0 | 00.0 | 7.1 | -0.6 |
| 1972 | 15.4 | 24.1 | 18.1 | 7.9 | 9.6 | 00.0 | 00.0 | 8.6 | -3.9 |
| 1973 | 19.6 | 54.6 | 11.1 | 14.6 | 3.0 | 00.0 | 00.0 | 4.1 | 38.9 |
| 1974 | 30.1 | 70.7 | 26.1 | 21.6 | 11.3 | 00.0 | 00.0 | 12.7 | -9.2 |
| 1975 | 17.1 | -122.8 | 46.1 | 19.1 | 0.2 | 00.0 | 00.0 | -18.0 | -38.5 |
| 1976 | 21.9 | -43.3 | 24.8 | 2.0 | 18.2 | 00.0 | 10.5 | 2.6 | 1.3 |
| 1977 | 35.0 | -2.1 | 27.5 | 16.1 | 7.5 | 00.0 | 31.8 | -2.0 | -15.5 |
| 1978 | 24.3 | 20.6 | 21.5 | 18.2 | 2.5 | 00.0 | 19.7 | -5.8 | -9.6 |
| 1979 | 27.8 | 86.4 | 20.5 | 29.0 | -16.7 | 15.4 | 17.7 | 0.3 | 10.3 |
| 1980 | 27.1 | -32.5 | 19.6 | 24.2 | -5.9 | 35.7 | 8.4 | 34.5 | 18.9 |
| 1981 | 33.3 | -105.2 | 29.6 | 12.4 | 5.9 | 14.8 | 21.6 | -8.1 | -14.7 |
| 1982 | 31.2 | 18.7 | 14.9 | 31.9 | 6.2 | 32.2 | 28.8 | 8.3 | -2.1 |
| 1983 | 11.1 | -21.1 | 25.8 | 27.6 | 3.6 | 40.5 | 29.8 | 4.4 | 19.6 |
| 1984 | 16.8 | 3.6 | 17.8 | 26.8 | -7.9 | 8.0 | 22.9 | -27.1 | -20.9 |
| 1985 | 40.5 | -34.3 | 31.1 | 22.2 | -1.7 | 37.9 | 69.7 | 8.1 | -13.6 |
| 1986 | 36.1 | 156.8 | 31.6 | 35.5 | 4.1 | 10.0 | 2.0 | -18.2 | -19.8 |

Sources: IFS, Bank of Sudan, and World Currency Year Book, (various issues).

the existence of such a large black market for foreign exchange, the black market premium can be a major factor causing RER appreciation.

(3.2) The Econometric Model

In this sub-section we will conduct an econometric analysis of RER in the Sudan based on the model of Section (2) above. Sufficies to estimate equations (9), (10), (12), (13), and (16) in order to identify the structural parameters of the model. Variants of the above equations were estimated using annual Sudanese data for the period 1970-1987. The regressions' results are reported in the following equations:

$$\log \hat{y}_t = \underset{(.005)}{-.01}\ \text{TREND} + \underset{(.17)}{.46}\ \Delta\log\left[\frac{P_x^*}{P_m^*}\right]_t + \underset{(.09)}{1.25}\ \log\left[\frac{P_x^*}{P_m^*}\right]_{t-1}$$

$$+ \underset{(.16)}{0.56}\left[\log y_{t-1} - \log\left[\frac{P_x^*}{P_m^*}\right]_{t-1}\right]$$

$$R^2 = 0.52 \cdot\ ,\ DW = 1.54\ \ ,\ Q(7) = 6.96 \qquad (9')$$

$$\log \hat{RER}_t = 4.51 + \underset{(.007)}{0.01}\ \text{TREND} - \underset{(.14)}{0.91}\ \Delta \log\left[\frac{DC}{e}\right]_t$$

$$- \underset{(.42)}{1.25}\ \log\left[\frac{1-t_x}{1+t_m}\right]_t - \underset{(.43)}{1.35}\ \log(1+t_m)_t$$

$$+ \underset{(.20)}{0.13} \log\left(\frac{P_x^*}{P_m^*}\right)_t + \underset{(.04)}{0.18}\left[\log RER_{t-1} - \log\left(\frac{DC}{e}\right)_{t-1} - \log q_{t-1}\right]$$

$$R^2 = 0.94, \quad DW = 2.19, \quad Q(7) = 10.99 \qquad (10')$$

$$\log\left(\frac{\hat{eR}}{\tilde{eF}}\right)_t = -.87 + \underset{(0.116)}{0.098}\left[\log\left(\frac{\hat{M^d}}{\tilde{eF}}\right)_t - \log\left(\frac{M}{\tilde{eF}}\right)_t\right]$$

$$+ \underset{(0.50}{0.31}\ \Delta \log\left(\frac{P_x^*}{P_m^*}\right)_t + \underset{(.79)}{1.15} \log\left(\frac{P_x^*}{P_m^*}\right)_{t-1}$$

$$+ \underset{(.11)}{0.94}\left[\log\left(\frac{eR}{\tilde{eF}}\right)_{t-1} - \log\left(\frac{P_x^*}{P_m^*}\right)_{t-1}\right]$$

$$R^2 = 0.96\ , \quad DW = 2.03\ , \quad Q(7) = 6.83 \qquad (12')$$

$$\log\left(\frac{\hat{M}}{\tilde{eF}}\right)_t = \underset{(.620)}{-1.96}\left[\log \tilde{e}_{t+1} - \log \tilde{e}_t\right] + \underset{(.023}{0.23} \log y_t - \underset{(.25)}{0.43}\ D$$

$$R^2 = 0.46\ , \quad DW = 1.83\ , \quad Q(7) = 3.08 \qquad (13')$$

$$\log\left(\frac{\hat{M}}{\tilde{eF}}\right)_t = \underset{(.056)}{0.84}\ \Delta \log\left(\frac{DC}{\tilde{eF}}\right)_t + \underset{(.11)}{0.75} \log\left(\frac{DC}{\tilde{eF}}\right)_{t-1} + \underset{(.034)}{.06} \log\left(\frac{P_x^*}{P_m^*}\right)_{t-1}$$

$$+ \underset{(.24)}{0.57}\left[\log\left(\frac{M}{\tilde{eF}}\right)_{t-1} - \log\left(\frac{DC}{\tilde{eF}}\right)_{t-1}\right]$$

$$R^2 = 0.98 \ , \ DW = 2.5 \ , \ Q(7) = 8.6 \qquad (16')$$

The estimation technique used is OLS and standard errors are in parantheses. Q(7) is the Box-Pierce statistics for residual autocorrelation to 7th order. The RER variable used in the econometric model is the REER as defined in the footnote of Table (1). D is a dummy variable for the post 1984 drought period which witnessed an even higher accelerated monetary expansion. The data on $\tilde{e}F$, the domestic currency denominated value of foreign currency held by the private sector, is proxied by the estimate of the income circulated in the black market.[11] Other variables in the above equations are defined as in Section (2) above. The above regression results may of course be subject to criticism perhaps due to the relatively short range of the estimation, or the not so high quality of the Sudanese data on $\tilde{e}F$ and y, see the data appendix for more details on this. Not withstanding the above criticism, no evidence of serious misspecification, however, can be detected. Also virtually all the elasticity estimates are statistically significant, and all of them are consistent with the theoretical model.

The variables involved in the above cited equations were found to be co-integrating;[12] this suggests the use of an error-correction model to estimate the equations.[13] Our error-correction estimating equations are consistent with a one period error-correction loss function similar to the one employed in Domowitz and Elbadawi (1987), and Elbadawi (1984).[14] The error correction, besides being a generalization to the partial adjustment type models, is advantageous in at least two counts. It provides a more general lag structure that does not impose too specific a shape on the model, Hendry (1980a). It also avoids the fundamental 'spurious' regression problem of Granger and Newbold (1974).

Equation (10') is the hallmark of the above system. It provides the elasticity estimates of the first and second order determinants of RER. The equation reveals strong evidence on the impact on RER of excess aggregate demand, $\log\left(\frac{DC}{e}\right)$, with short run elasticity at -0.91 and long-run impact elasticity at -0.18. While the premium, log q, does not have an impact in the short-run, it does have a significant long-run impact elasticity. Therefore, as expected for the Sudanese economy, excess aggregate demand and the black market premium can be major sources of real exchange rate appreciation. As we mentioned in Section (2), the impact on RER of the later determinant depends crucially on the import intensity of the home goods and the size of the black market, which are both quite substantial, see Section (3.1) above. The above equation also shows significant influence on RER for commercial policy. The elasticity estimates due to commercial policy were obtained subject to the parameteric restrictions of equation (10). The elasticity due to export taxes, $\log (1-t_x)$ is given by -1.25, while that due to tariffs and other implicit import taxes, $\log(1+t_m)$ is given by -0.10. To the extent that this result is robust, this finding has very important implications for the future direction of foreign trade and public finance policies in the Sudan. It is clear that Sudanese exports cannot remain competitive if it should sustain net foreign trade taxes. Import taxes on the other hand, were shown to be a less important factor in causing RER appreciation; thus suggesting that the cost in terms of export competitiveness may not be high as a result of taxing imports, especially final consumer goods. The positive impact on RER of the trend factor shows that the influence of income through the excess aggregate demand channel dominates its influence through the expenditure channel. Finally the impact on RER due to TOT is also positive, thus a TOT improvement will improve

the competitiveness of the economy. The effect due to TOT which encompasses the income, excess demand, and direct channels is not found to be statistically significant, however. The structural parameters of equation (10) of Section (2) above are consistent with long run equilibrium in the nontradable sector, the estimates of these parameters are obtained from (10) by setting $\Delta \log x_t = 0$, and $\log x_{t-1} = \log x_t$ for any variable x and then solving for $\log RER_t$ to obtain:

$$\log \hat{RER} = 5.5 + 0.01\ TREND - 1.52 \log(1-t_x)_t$$

$$-.12 \log(1+t_m)_t + 0.16 \log\left(\frac{P_x^*}{P_m^*}\right)_t$$

$$-.22 \log\left(\frac{DC}{e}\right)_t - .22 \log q_t \qquad (10")$$

Note that the presence of the term $\log\left(\frac{DC}{e}\right)$ in equation (10") implies that aggregate excess demand in the economy is allowed to persist in the long-run.

Secondly, we consider equation (9') which shows the TOT as having a significant impact on real income both in the short run and the long run with impact elasticity given by 0.46 and 1.25 respectively, the error correction term effect is also quite significant at 0.56. Real income in Sudan is also shown, as expected, to experience a declining trend with an annual percentage decline of 1%. The long run equilibrium equation consistent with (9') is obtained analogously by setting $\Delta \log\left(\frac{P_x^*}{P_m^*}\right)_t = 0$, $\log\left(\frac{P_x^*}{P_m^*}\right)_{t-1} = \log\left(\frac{P_x^*}{P_m^*}\right)_t$, $\log y_t =$

$\log y_{t-1}$, and solving for $\log y_t$ to obtain:

$$\log \hat{y}_t = -.02 \text{ TREND} + 1.57 \log\left(\frac{P_x^*}{P_m^*}\right)_t \qquad (9")$$

Equation (12′) also shows an important role for TOT as a determinant of official reserves accumulation relative to private holding of foreign money. This result is fairly consistent with the stylized facts of the Sudanese economy being highly dependent on the exports of primary agricultural goods and the imports of intermediate and manufactured goods. The equation, however, shows a rather insignificant impact for disequilibrium in the asset market. One explanation for this result is that the use of annual data in the estimation may have caused the model to fail to pick the essentially short run effect of the asset market disequilibrium. Another explanation is that the asset market may in fact be in equilibrium since the black market premium can move freely to ensure that.

The explanations of the above result be as they may be, based on the findings of equation (12′) we impose a zero coefficient for the term due to the disequilibrium in the asset market and we therefore rewrite equation (12) of Section (2) as:

$$\log\left(\frac{eR}{\tilde{e}F}\right)_t = \theta_1 \log\left(\frac{P_x^*}{P_m^*}\right)_t$$

Substituting the above equation in the monetary identity (11) of Section (2) we obtain a money supply equation which is equivalent to equation (16) of

Section (2) when equilibrium in the asset market is imposed. The corresponding regression estimates are provided in (16').

The implications of the above are that the resulting long run black market premium will be consistent with equilibrium in the asset market as in equation (21) of the model, also the ultimate RER solution will be consistent with equilibriums in both of the asset and home goods markets. In equation (16') above, the supply of domestic money relative to foreign money is shown to be accounted for by domestic credit expansion and TOT. While both of the two factors have significant long-run impacts on relative money supplies, only domestic credit has a significant short run effect. Also, as expected, the direct impacts on $\frac{M}{\tilde{e}F}$ due to domestic credit expansion is much higher than the indirect effects of TOT channeled through the official reserves. The equation analogous to (16') describing the equilibrium determinants of the relative money supply is given in (16") below.

$$\log\left(\frac{\hat{M}}{\tilde{e}F}\right)_t = 0.42 \log\left(\frac{DC}{\tilde{e}F}\right)_t + 0.13 \log\left(\frac{P_x^*}{P_m^*}\right)_t \qquad (16")$$

Finally we consider the relative demand for money equation, which is the only equation in the system estimated directly, see footnote (13). The estimates of the equation which are reported in (13') reflect a strong influence on relative money demand due to exchange rate expectations; the impact due to real income is also statistically significant albeit much smaller in absolute value.

4. The Equilibrium Premium and Equilibrium Real Exchange Rate in the Sudan

By equating the right hand sides of equations (13′) and (16") of the above section we can solve for the black market premium, $\log q_t^*$, which is consistent with equilibrium in the asset market. The formula for $\log q_t^*$ is provided in equation (21) of Section (2), and its estimate $\log \hat{q}_t^*$ is given in equation (21′) below:

$$\log \hat{q}_t^* = (1.96 + .42)^{-1} \sum_{j=0}^{\infty} \left[\frac{1.96}{1.96+.42}\right]^j E_t h_{t+j} \qquad (21')$$

and

$$h_t = 0.42 \log\left[\frac{DC}{eF}\right]_t - \left[(.23)(1.57) - (.22)(.58)\right] \log\left[\frac{P_x^*}{P_m^*}\right]_t$$

$$+ 1.96 \log\left[\frac{e_{t+1}}{e_t}\right] - (0.23)(-.02)\text{TREND}$$

Equation (21′) above provides a very useful insight of the equilibrium determination of the black market premium. The Sudanese black market premium has been consistently in excess of one despite repeated official exchange rate devaluations. As can be seen from the expression of h above, credit expansion and expectation of future devaluation are key factors behind the observed behavior of the premium. The effect of TOT on the premium works through two channels: the one through reserves is given by $\theta_1(1\text{-}m) = (.22)(.58)$ which has a positive effect on $\log q^*$, the other has a negative effect on $\log q^*$ and works through the income channel in the relative demand for money and is given by: (.23)(1.57). The net effect on $\log q^*$ is -.23 which tends to ameliorate the positive effects on q due to domestic credit expansion and speculative

environment. This TOT counter effect is relatively small being of only second order as compared to the other two first order; this finding, however, which reflects the importance of external factors may have important qualitative implications for domestic stabilization policy, see Elbadawi (1988d). Finally the effect due to TREND which can be construed as aproxy for technological progress or growth in real output (or income) due to non-price factors. Since the real growth in output has been small and negative in the Sudan, the effectof TREND on log $q^*$ is small yet positive. Once again this result demonstrates the potential payoffs in terms of economic stabilization that can be generated from investment in aggregate output supply. The ultimate impact of $E_t h_{t+j}$ on log $q_t^*$ will be discounted by $(.42)(.82)^j$. If we assume specific time series structures for the elements of $h_{t+j}$ we can obtain the full effect of $E_t h_{t+j}$ on log $q_t^*$, we do this by assuming the following time series processes:

$$\log e_{t+j} = \log e_{t+j-1} + \phi + \epsilon_{1,t+j} \qquad (21.1')$$

$$\log F_{t+j} = \log F_{t+j-1} + \epsilon_{2,t+j} \qquad (21.2')$$

$$\log DC_{t+j} = \log DC_{t+j-1} + \mu + \epsilon_{3,t+j} \qquad (21.3')$$

$$\log\left(\frac{P_x^*}{P_m^*}\right)_{t+j} = \log\left(\frac{P_x^*}{P_m^*}\right)_{t+j-1} + \epsilon_{4,t+j} \qquad (21.4')$$

where the $\epsilon$'s are white noise disturbances. Equation (21.2') and (21.4') state that each of TOT and stock of foreign money held by domestic residents

follows a random walk. According to equations (21.1') and (21.3') on the other hand, the official exchange rate is expected to experience a constant devaluation rate $\phi$, while the expected growth rate in domestic credit is $\mu$. Now using (21.1') - (21.4') on (21') we obtain the following operational equation for log $\hat{q}_t^*$:

$$\log \hat{q}_t^* = \log\left[\frac{DC}{eF}\right]_t - .56 \log\left[\frac{P_x^*}{P_m^*}\right]_t + 4.67\ \mu$$

$$+ 17.11\ \phi + 0.01\ \text{TREND} + 0.05 \qquad (21")$$

Finally we use equation (21") in the semi reduced form equation for log $RER_t$ given in (10") above to obtain the estimate of log $RER_t^*$ the equilibrium RER (ERER). The results are provided in Table (3) below:

Table (3)

The Determinants of ERER in the Sudan

| Determinant | Channel: Direct | Income | Excess Aggregate Demand | Black Market | Total |
|---|---|---|---|---|---|
| $\log\left(\frac{P_x^*}{P_m^*}\right)$ | - - - - - - (0.16)[1] - - - - - - | | | 0.12 | .28(.12)[2] |
| $\log(1-t_x)$ | -1.52 | -- | -- | -- | -1.52 |
| $\log(1+t_m)$ | -.12 | -- | -- | -- | -.12 |
| $\log\left(\frac{DC}{e}\right)_t$ | -- | -- | -.22 | -.22 | -.44 |
| $\log F_t$ | -- | -- | -- | +.22 | +.22 |
| $\mu$ | -- | -- | -- | -1.03 | -1.03 |
| $\phi$ | -- | -- | -- | -3.76 | -3.76 |
| TREND | -- | 0.01 | -- | -.002 | .098 |

(1) Due to income, excess aggregate demand as well as the direct influence on tradables and nontradables.

(2) Since the direct effect due to TOT is not statistically significant, we might as well consider only TOT effect through the black market.

The results of Table (3) confirm our view that: in the Sudan the black market for foreign exchange can be a major channel of real exchange rate appreciation. Through the black market, the dollar denominated stock of domestic credit, $\left[\frac{DC}{e}\right]_t$, has a strong appreciationary effect on RER with an elasticity equal to -.22; $\left[\frac{DC}{e}\right]_t$ also exerts another effect on RER of the same order of magnitude through the direct channel of excess aggregate demand. The total effect of the initial or current stock of domestic credit $\left[\frac{DC}{e}\right]_t$ is therefore given by an elasticity of -.44. The other major cause of RER appreciation channeled through the black market is the rate of growth of domestic credit, $\mu$, with an elasticity of -1.03. In addition to the above causes of RER appreciation which were channeled through the black market, expectation of future devaluations stands to be recognized as the most important with an elasticity of -3.76. These factors and especially the last one, can explain a lot about the observed ineffectiveness of official nominal devaluation in bringing about reasonable levels of RER depreciation. Betweeen 1979 which marked the beginning of the major maxi-devaluations in the Sudan and 1987 the year of the last devaluation; the average annual rate of devaluation was 26% while the RER depreciated at a meager annual rate of 4%. Still operating through the black market channel, a decrease in F, the stock of foreign money privately held; will cause an RER appreciation with an elasticity of 0.22. This finding has very important policy implications for the Sudan. The recent trade policies in the Sudan aimed at utilizing black market dollars to finance imports, can be quite costly in terms of competitiveness of the economy. Such policy will first lead to enhancing the importance of the black market channel by increasing the factor, $1-\beta$, which is

the share of imports financed through the black market. This policy will also upset the asset market equilibrium by reducing the stock, F, thus leading to RER appreciation.

The other determinants of RER have already been discussed in the previous section, hence a summary statement is in order. The effect on RER due to commercial policy is consistent with prior expectation in that foreign trade taxes on exports or imports can lead to RER appreciation. The impact due to export taxes, however, is much stronger than that of import taxes. TOT improvement on the other hand, is shown to cause RER depreciation. This implies that just like domestic policy mistakes, adverse external factors can lead to deteriorating competitiveness in the Sudanese economy as well. And finally, if we identify the trend effect, though minimal, with productivity growth, the investment in output supply is shown to lead to enhanced competitiveness in the economy; this is of course a fairly classical result.

## 5. Concluding Remarks

The real exchange rate is increasingly recognized as the main policy variable in the academic and policy discussions in a wide range of issues such as indebtedness, stabilization, growth, food security and the role of agriculture in LDCs. RER misalignment, and especially overvaluation with respect to its equilibrium, is presumed to be a major impediment to achieving the above policy goals which are the hallmark of any potential economic achievement of a developing country. As such, therefore, modelling of RER behavior is a top priority in the research agenda from both the academic and policy oriented perspectives. Especially emphasized in this connection is the ability to develop models that permit distinction between the long run equilibrium behavior of RER and its short run disequilibrium dynamics.

In this paper I presented a model that addresses the above concerns. The model permits long run equilibrium movements in RER to be distinguished from the short run disequilibrium movements of the RER. An important aspect of the model is that it explicitly considers the black market premium as one of the fundamental determinants of RER. Especially in economies plagued with persistent excess aggregate demand, and rapidly depreciating domestic money under a regime characterized with currency inconvertibility and highly regulated current account transactions, the black market is usually a persistent and a growing part of the economy. The rational expectation solution of the equilibrium black market premium which reflects the equilibrium in the asset market allows for dynamic determinants of RER to be incorporated naturally in the ultimate ERER representation. This model is then applied to the case of the Sudan, an LDC which approximates the economic environment described above.

The findings confirm other evidence on the impact on RER of commercial policy. It is found that dependence on foreign trade taxes as the main source of government revenue may be costly in terms of the competitiveness of the Sudanese economy. The evidence, however, is much stronger for the case of export taxes than for import taxes. The TOT effect is such that a worsening in the TOT will lead to an RER appreciation rather than depreciation. This result is consistent with the structure of the Sudanese economy where the prime comparative advantage is provided by the export-oriented agricultural sector, especially the traditional subsector with its low intensity of imported inputs. The evidence also reflects an important effect on RER of domestic monetary expansion, it can cause both short-run and long-run RER appreciation. Domestic credit growth operates on RER through two channels: a direct one through the excess aggregate demand and the indirect channel of the

black market premium. The premium is an important channel which in addition to the above determinant also allows expectations about future devaluation to impinge quite significantly on RERE in the Sudan. Expectation of future devaluation is shown to be a major factor causing RER appreciation. This finding can at least partially explain the observed empirical regularity regarding the ineffectiveness of official devaluations in influencing real variables in a positive way in highly speculative environments such as the one in the Sudan. Finally the evidence also showed that a reduction in the stock of foreign currency privately held will lead to an RER appreciation. One implication of this finding is that any policy that leads to an enhanced current account role for the black market such as the 'nil' value system of imports in the Sudan,[16] can be presumed to have deleterious effects on the competitiveness of the economy.

In LDCs there is in general no distinction between monetary and fiscal policy. Strictly speaking, domestic credit expansion is basically determined by the fiscal deficit. This paper, however, did not consider such dependency. Endogenizing domestic credit, therefore, is an interesting extension to this work in the future.

# DATA APPENDIX

## A.1 Foreign Trade Taxes

Data on import and export taxes were obtained from Elbadawi (1987). The export tax rate was calculated as a weighted average of the individual tax rates for six of Sudan's major agricultural exports. The import tax on the other hand, accounts for the implicit effect due to QRs in addition to the average tariff rate, see Elbadawi (1987) for more detail.

## A.2 Exchange Rates and Prices

Data on exchange rates and prices for the Sudan and its trading partners are obtained from the IFS. The price data for the Sudan is the CPI, the only price available for the entire period. The prices of the Sudan's trading partners are WPIs. The black market exchange rate data on the Sudan is obtained from Elbadawi (1987), and World Currency Yearbook.

## A.3 Income

The income variable used in this study is the Sudanese GDP series, which is based on the national income accounts. There are some well known problems with such series. Such problems are due to changes in methodology used to assemble the accounting data, and to potentially large errors in the survey data. Nevertheless, these are the best income data available at this time, and are obtained from line 99b of the IFS and the Bank Al-Sudan reports.

The data on $\tilde{e}F$, the domestic currency denominated privately held stock of foreign money is proxied by the estimate of income circulating in the black market, see text and footnote (11) for more details.

A.4 Monetary Variables

This includes money, domestic credit, and official reserves. The data on all of the above variables is obtained from IFS. The definition of money taken in the study is the narrow one (M1).

A.5 Terms of Trade

The data on TOT is obtained from The World Bank (1982, 1985) and the last three years were estimated using data on developing countries TOT taken from IFS.

## Notes

1. Strictly speaking most of the above cited literature did not solve explicitly for exports, employment, or output, as functions of real exchange rate; the structure developed, however, can easily be adapted to do that.

2. In cases where substantial foreign exchange is channeled through the black market, the authorities may attempt to utilize those resources by initiating an import system, for example, where the use of the black market foreign exchange by importers to finance such imports though illegal in theory but nevertheless a common practice. For a discussion of the case of the Sudan on this issue see Umbadda (1984, 1986).

3. Examples of the literature in the black market for foreign exchange include: Blejer (1978), Culbertson (1975), Levy (1983), Dornbusch et. al. (1983), de Macedo (1983), Ali and Hussain (1986), Elbadawi (1988a), and Elbadawi and Hussain (1988).

4. See Footnote (2) above.

5. Edwards (1987) provides an interesting discussion on several real exchange rate definitions.

6. This assumption is justified on the account that productive capacity in LDCs tend to change over a much longer horizon than do relative prices and other demand variables.

7. In Edwards (1985, 1986b), $\hat{f}(\cdot)$ is set equal to $(\hat{M}_t - \hat{M}^d_t)$. This measure of excess aggregate demand recognizes the foreign reserves channel as a source of monetary disequilibrium in addition to domestic credit. The environment of interest to us in this paper, however, is one where monetary disequilibrium is dominated by movements in domestic credit.

8. See Pesaran (1987), for a useful and comprehensive discussion of rational expectation models such as the one in equation (17).

9. Currently these remittance flows are estimated at $3 billion annually, which is almost three times the foreign exchange earnings out of exports.

10. Unofficial, and possibly more reliable, estimates of inflation in the Sudan put the figure at a range of 50 to 60 percent.

11. Income circulating in the black market was estimated in Hussain and Elbadawi (1988) by using the identity MV = Y where M is money supply, V is the velocity of money, and Y is nominal income. The unreported black market income, $Y_u$, is then obtained as $\hat{Y}_u = \hat{MV} - Y$, where $\hat{V}$ is an estimate of V.

12. Engle and Granger (1987) shows that co-integrating time series are consistent with error correction representation. Engle and Granger (1987) also developed some tests for co-integrating series. One such test, which was used here in this paper, is based on running a regression of an equilibrium error-correction equation such as (9), (10), (12), (13), and (16) and testing a null hypothesis of the Durbin Watson

statistics equal to zero. A rejection of this hypothesis means that the series are co-integrating, hence error-correction is consistent with the data generating process.

13. Equation (13), however, was estimated directly since this provides better results than its corresponding error-correction counterpart both in terms of overall fit and other diagnostic properties.

14. Domowitz and Hakkio (1987), however, showed extimating equations such as the ones in (9') - (12') and (16'), are consistent with the following intertemporal error-correction loss function:

$$L_t = E_t \sum_{j=0}^{\infty} \rho^j [\lambda_1 (RER_{t+j} - RER^*_{t+j})2$$

$$+ (RER_{t+j} - RER_{t+j-1})^2$$

$$- 2\,\lambda (RER_{t+j} - RER_{t+j-1})(RER^*_{t+j} - RER^*_{t+j-1})]$$

provided that $RER^*$ (the equilibrium RER) follows any process more complicated than a random walk. other examples in the literature also includes Hendry (1980a, 1980b); Hendry, Pagan, and Sargan (1984), Nickell (1985), and Hendry and van Ungern-Sternberg(1981), to mention a few.

15. Equation (21") is obtained from (21') by utilizing the following relations:

$$\sum_{j=0}^{\infty} \ell^j = \frac{1}{1-\ell} \ , \ \ell < 1$$

$$\sum_{j=0}^{\infty} j\ell^j = \frac{\ell}{(1-\ell)^2} \ , \ \ell < 1.$$

16. See Section (3.1). See also Umbadda (1984, 1986) for more details on this.

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