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INDIRECT SPECULATIVE ATTACKS AND THE BLACK MARKET FOR FOREIGN EXCHANGE: THE EXAMPLE OF SUDAN*

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Abstract:

The paper extends the recent literature on collapsing exchange rates and balance of payment crises to the case when currency inconvertibility gives rise to the emergence of an "illegal" black market. The presence of the black market generates indirect speculative attacks on the official reserves because, due to inconvertibility, agents cannot directly buy official reserves. The paper derives several conditional probability statements regarding the likelihood of successful devaluation as a way to unify the official and black market exchange rates and achieve economic stabilization.

I. Introduction

The purpose of this paper is to extend the recent literature on collapsing exchange rates and balance of payments crises to the case when currency inconvertibility gives rise to the emergence of an 'illegal' black market for foreign exchange. The presence of the black market provides the environment for indirect speculative attacks on the official reserves. These attacks are indirect in that agents cannot directly buy off official reserves because of currency inconvertibility. In the absence of the black market, however, the foreign exchange channeled through the black market can either be a potential increment to the official reserves or be used to finance current account transactions thus relieving official reserves from being depleted.[1]

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Under currency inconvertibility, we interpret the existence of a black market for foreign exchange as a necessary and sufficient condition for indirect speculative attacks on the official reserves. The presence of the black market transactions imply, therefore, a continuous decline in the foreign exchange resources under the control of the central bank. This definition of the indirect speculative attack may seem to be assuming rather than deriving the conditions for the speculative attack. However, the model of this paper goes beyond that by deriving the equation for parallel premium and using it in conjunction with market characteristics to derive precise conditions for the speculative attack.

Under full currency convertibility, the eventual speculative attacks and the collapse of a fixed parity regime is demonstrated by the pioneering work of Salant and Henderson (1978) for the case of a scheme aimed at pegging the price of gold by maintaining a stockpile. Subsequently, Krugman (1979) applied the idea on a version of Kouri's (1976) exchange rate model to analyze, in a macroeconomic setting, the problem of defending a fixed exchange rate parity and the balance of payment crisis. Important theoretical extensions and elaborations of this literature are found in Flood and Garber (1983, 1984), Obstfeld (1984a, b; 1986), Grilli (1986a), and Buiter (1986a, b). This literature analyzed, among other things, the viability of a variety of managed exchange rate regimes, the timing and the likelihood of speculative attacks, and the nature of the post-attack equilibria. The empirical work in this tradition includes the works of Cumby and Van Wijnbergen (1983), Grilli (1984, 1987), Collins (1984), Blanco and Garber (1986), and Garber and Grilli (1986).

The aforementioned literature assumes full exchange convertibility. This assumption is critical to analyze direct speculative attacks on official reserves and the consequent collapse or forced devaluation of managed exchange rates in the case of structurally weak currencies. In the case of strong currencies, in addition to floating, a potential revaluation as a result of a selling attack may materialize (Grilli, 1986). A more prevalent situation, however, at least for the case of less developed and semi-industrialized countries, arises when countries do in fact institute capital controls of varying degree.[2] The motivation for the exchange control may be to insulate the domestic economy from disturbances originating in international financial markets (Dornbusch, 1986). More importantly, in the case of structurally weak and inconvertible currencies and when no developed markets for financial assets exist, the objective behind capital controls is to prevent individuals using these currencies in domestic transactions from building up foreign exchange balances in their asset portfolios at the expense of domestic money.

The conditions of vastly depreciating domestic currencies provide a high, albeit illegal, incentive for domestic residents to hold foreign exchange. These transactions are conducted through the black market for foreign exchange. The foreign exchange resources of this market can come from the illegal current account transactions of smugglings, overinvoicing of imports and underinvoicing of exports or from worker remittances and tourist services. Especially in the case of major labor-exporting countries where the remittances may be both quite substantial and difficult to control, there is usually a tendency for the black market for foreign exchange to expand quite rapidly and to become a major market in the economy. Examples include the cases of Sudan, Bangladesh, and Turkey, to mention a few. In such cases developments in the black market may have important implications for the macroeconomy. For example, the black market premium can provide relevant information about the balance of payment problems of the country in question. The premium is also central to the analysis of

indirect speculative attacks under currency inconvertibility referred to earlier. In the context of a real exchange rate analysis, Elbadawi (1987) argued that when the black market economy is relatively large, a high premium can be presumed to have deleterious effects on agricultural exportables. Pinto (1988) provides formal support to this argument.

Other work in the black market for foreign exchange includes Blejer (1978) who studied black market rates in a monetarist model of exchange rate determination. The work of Dornbusch *et al.* (1983) and De Macedo (1983) studied the black market rate in models that combine both the modern theory of asset markets and the current account approach to the exchange rate as in Kouri (1976), and the literature on dual exchange rates, especially Flood (1978). In the context of the Sudanese economy, Ali and Hussain (1986) and Elbadawi and Hussain (1988) analyzed the structure and performance of the black market.

In this paper we will integrate the two strands of literature: the one on the black market for foreign exchange, and that of speculative attacks and balance of payment crises. To do this we model the black market premium using a simple dual exchange rate version of the asset markets approach to exchange rate determination similar to the one employed in De Macedo (1983) and Dornbusch *et al.* (1983). The black market premium is linked to the macroeconomy through the usual framework employed in the collapsing exchange rate literature, especially Flood and Garber (1984). Our model permits an explicit representation of the premium, the expected premium and the related probability statements regarding the likely behavior of the level and rate of change of the premium. The above variables are shown to depend on the parameters of the government exchange rate and monetary policy, the threshold levels of official reserves and private holdings of foreign exchange, the real growth in the economy, as well as the characteristics of the relative demands for foreign and domestic money. This model is used to analyze the Sudanese black market premium and to examine the evidence on the indirect speculative attacks through the black markets. The model is also used to assess the viability of maxi-deviations as a tool for exchange rate unification and economic stabilization strategies.

The rest of the paper is organized as follows. In section 2 we provide a brief review of the recent development in the Sudanese macroeconomic scene. In section 3 the model is introduced, solved, and discussed. In section 4 we derive the functionals of interest such as the probability statements regarding the speculative attacks and the likelihood of successful stabilization. We apply the model to analyze the observed behavior of the Sudanese black market premium in section 5. Some policy implications of the analysis are also pursued. Finally, section 6 concludes.

2. An Overview of the Recent Macroeconomic Development in the Sudan

Since prior to its independence in 1956 and until September 1979, Sudan's foreign trade and payment regime was one on full exchange controls and highly regulated current account transactions. Also the exchange rate was fixed at LS .35/US$. This arrengement, however, was overwhelmed by drastic macroeconomic developments during the 1970s when the government embarked on a massive economic development program. With government revenues barely meeting current expenditure and no financial markets available, the government relied heavily on currency issuing and external financing. As a result of such policies the money supply (M_2) increased from

LS 28 million in 1970/71 to a staggering LS 877 million in 1978/79. Also during this period the economy experienced the adverse stagflationary shocks of the 1973/74 oil price hike and its aftermath. The combined effects of the above developments were reflected in mounting inflationary pressures and a deteriorating external balance. The deficit in the resource balance as a ratio to GDP deteriorated form 0.34% in 1970-73 to 7.89% in 1974-77. Also the relatively negligible domestic inflation up to 1972/73 exploded to reach an annual average of 20% for the rest of the decade.

The combination of an inflationary environment and a highly repressed demand for imported goods paved the way for the emergence and subsequent expansion of the black market for foreign exchange. Also during this decade, the Sudan turned into a major labor-exporting country and the remittances sent home by Sudanese nationals working abroad (SNWA) started to become the major source of foreign exchange for the country.[3]

In recognition of the increasing importance of these remittances as a source of much needed foreign exchange, the authorities amended the foreign trade and payment regime by introducing a premium exchange rate for SNWA remittances and a new import system, the "nil-value" system.[4] 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. Even though the premium exchange rate was set at LS .45/US$ in 1973 (and reached LS .67/$ in March 1979) it could not keep pace with the black market premium, 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– turned into a current account link to the black market.

Before the 1970s were over and as a result of the continued reliance on domestic money creation and external debt to finance an expanding excess demand, economic imbalances assumed crisis proportions. The government, therefore, finally accepted the IMF-inspired stabilization package starting September 1979. The main stated objective of the program was to remove price distortions deemed to be a bias against production in general and exportables in particular, and in favor of excessive consumption and imports. The package included a devaluation of the Sudanese pound with an eye toward a gradual but complete unification of the exchange rate. On the trade side, the policy called for a gradual trade liberalization by abolishing administrative import control measures and giving more weight to tariffs and the newly set "scarcity" value for foreign exchange to rationalize imports. The package also included some reforms on the supply side, concentrated on irrigated agriculture. The central policies emphasized by the package, however, were twofold: successive devaluations and continuous shifting of import categories from the official market of foreign exchange to the parallel market.

Specific measures of the package included a devaluation of the official rate to the level of LS .50/$ and the introduction of the so-called parallel rate which was set at LS .80/$. The new measures also included the abolishing of the "nil-value" system. Despite the latter, the creation of the parallel market insured the current account link for the black market and by September 1980 about 60% of total imports were channeled through the parallel market which obtained all its foreign exchange from the black market (Hussain, 1986). This amounts to "quasi-legalizing" the black market on the part of the authorities.[5] By July 1981 the black market was fully legalized and licenses were issued to foreign exchange dealers. The free market rate depreciated from LS 1.08/$ in July 1981 to LS 4.90/$ in February 1985.

As the free rate started to depreciate, speculative holdings of foreign exchange by private dealers continued. In an attempts to reduce the black market premium (among other things), the government devalued and unified the official and the parallel rates at LS .90/$ in November 1981. Further unsuccessful government interventions aimed at increasing its share of the SNWA foreign exchange included attempts to enforce maximum buying and selling rates. The government also allowed banks to buy foreign exchange at a fixed rate. Finally the government revoked the dealers's licenses in May 1983. The licenses were reissued in January 1984 but trading during this period continued unimpeded in the black market.

Also during this period the free rate depreciated from LS 2.04/$ to LS 3.20/$. By February 1985 the free rate reached LS 4.90/$, triggering a major response from the government. It banned all foreign exchange transactions outside the banking system, devalued the official rate of LS 2.5/$, and introduced a new crawling rate for SNWA remittances to be operated exclusively by the banking system. This bank rate rose from LS 3.00/$ in 1985 to LS 4.10/$ in 1986.

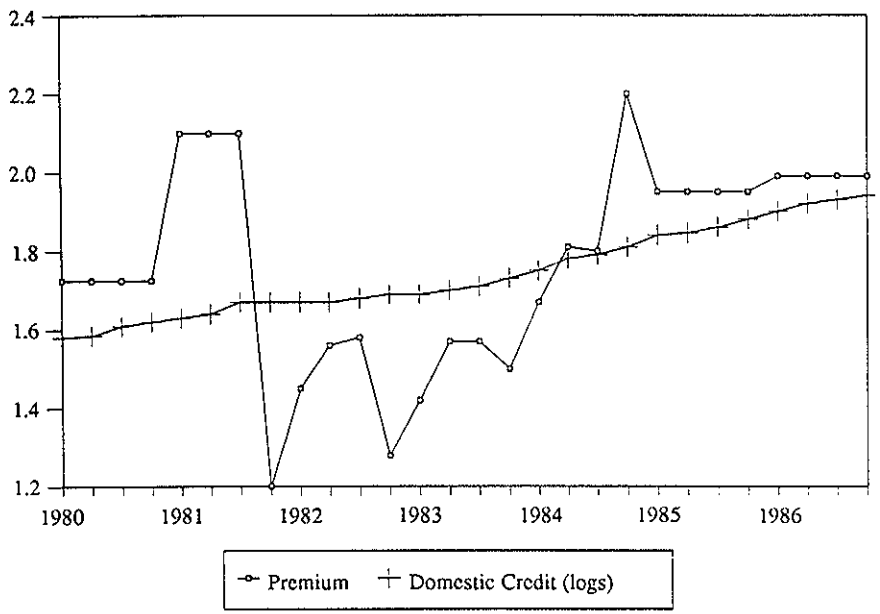
These measures, however, turned out to be inadequate to attract SNWA remittances and the black market continued in full swing operating at a rate of about LS 5.00/$ in 1986. SNWA remittances through official channels were estimated at an annual average of $ 400 million for the years 1981-84. This amounted to about 20% of total remittances which averaged more than $ 2 billion a year. I order to cut the current account link for the black market for foreign exchange, the government reimposed a virtually total import ban in 1986. With inflation running at 36% per year after a decade of failed stabilization attempts the black market was no longer a reflection of trade policy above. Demand for foreign exchange was increasingly influenced by asset market conditions. The combination of rapid monetary expansion and repeated devaluations served nothing but to raise expectations of future currency depreciations.

The liberalization attempt widely exposed the credibility problem of the government and widened the parallel economy. Public deficit financing was a usual at the heart of the problem. The domestic money supply rose from LS 1825 million at the end of 1981/82 to LS 9011 million at the end of 1986/87, with a 40% annual average rate of monetary expansion over this period. Borrowing by the private sector also grew massively, from LS 937 million in 1981/82 to LS 3460 million in 1986/87, amounting to an increase of 270%. Due to the high returns of black market dealings, most of these funds are believed to have been used to finance black market operations (Ali and Hussain, 1986). The size of this market was estimated at $ 800 million and $ 1.1 billion in 1981 and 1984, respectively. Despite a devaluation in 1987 which brought the official rate to LS 4.5$, only $ 40 million of a total of $ 3.0 billion SNWA remittances were estimated to flow through the official channels, while all the rest ended up in the black market. Also in 1987 the government once again "quasi-legalized" the black market by reintroducing an import system similar to the revoked "nil-value" system of imports. As mentioned above, the black market premium is the central important concept in the analysis of the black market for foreign exchange and the broader issue of economic stabilization.

Figure 1 shows an association between the black market premium and domestic credit expansion. Also anticipation of maxi-devaluations, such as the ones in 1981:IV, 1982:IV, and 1985:I, are reflected in increasing premia prior to the devaluation. However, the decline in the premium caused by devaluations was very short lived. The premium was also consistently larger than 1.0, suggesting the ineffectiveness of controls imposed on black market dealers. Such a situation could occur either as a

FIGURE 1

THE SUDANESE BLACK MARKET
Black Market Premium and Domestic Credit



result of a tight monetary policy or an enormous perceived risk for holding the "illegal" foreign money.

3. The Model

The economic environment we will model is that of a small economy under exchange control and currency inconvertibility. Domestic residents can "legally" hold only the inconvertible domestic money. This system is assumed either to be difficult or expensive to enforce and a black market for foreign exchange freely operates with little risk involved. Due to the lack of developed financial markets, only foreign money (the dollar) is exchanged for the Sudanese pound at a premium rate. This black market is assumed to be sizable and strongly linked to the rest of the economy. This description closely approximates the case of the Sudan and other major labor-exporting countries.

The model is built around the following seven equations:

$$\log\left[\frac{M_t}{e_t F_t}\right] = a_0 - a_1 \psi_t + a_2 \log y_t \qquad (1)$$

$$M_t = DC_t + eo_t R_t \qquad (2)$$

$$\psi_t = E_t \log e_{t+1} - \log e_t \qquad (3)$$

$$q_t = e_t/eo_t \qquad (4)$$

$$\log y_t = \log y_0 + \delta t \qquad (5)$$

$$\log DC_t = \log \overline{DC}_0 + \mu t + v_t, \mu > 0 \qquad (6)$$

$$v_t = \rho v_{t-1} + \varepsilon_t \qquad (7)$$

where $0 \le \rho < 1$, $E_t \varepsilon_{t+j} = 0$, $E_t v_t \varepsilon_{t+j} = 0$, for $j \ge 1$, $\varepsilon_t \sim$ iid $N(0, \sigma_\varepsilon^2)$, and $v_t \sim N(0, \sigma_v^2)$.[6]

The variables M, DC, and y are, respectively, the domestic money stock, domestic credit, and real income. F and R represent the dollar-denominated private holdings of foreign money and official reserves, respectively. The fixed official exchange rate in LS/$ is eo while e represents the black market free rate. Finally q is the black market premium.[7]

In equation (1), which reflects the asset market equilibrium, the effect of log y is expected to be positive; while the effect of ψ, the opportunity cost of holding domestic money relative to the foreign money, is expected to be negative. The equilibrium in (1) also assumes that total wealth (M + eF) enters symmetrically in both of the two separate demand functions fot the two monies. Equation (2) dfines the money supply. The opportunity cost of holding domestic money is given by the expected rate of depreciation in the black market rate,[8] and expectations are assumed to be rational as in (3) where E is the conditional expectations operator. Equation (4) defines the black market premium. In equation (5), real income is assumed to grow at a rate δ. Domestic credit is specified by equation (6) to be growing at a constant rate μ. The exogenous component of domestic credit is assumed to be a non-explosive first-order serially correlated normal random variable, as reflected by equation (7). Both real income and domestic credit assume, respectively, fixed initial values y_0 and $\overline{DC}_0$ at the base period $t = 0$.

Assuming that the official exchange rate eo_t is fixed at $\overline{eo}$ and using equations (3) and (4) in (1) we get:

$$\log\left[\frac{M_t}{\overline{eo}F_t}\right] - \log q_t = a_0 - a_1 (E_t \log q_{t+1} - \log q_t) + a_2 \log y_t$$

or:

$$\log\left[\frac{DC_t + \overline{eo}R_t}{\overline{eo}F_t}\right] - a_0 - a_2 \log y_t = -a_1 E_t \log q_{t+1} + (1 + a_1) \log q_t \qquad (8)$$

Since the premium, q, is assumed to be freely floating, the above difference equation can be solved for the equilibrium value of log qt, as below:

$$\log q_t = (1 + a_1) - 1 \quad \sum_{j=0}^{\infty} \left(\frac{a1}{1 + a_1} \right)^j E_t \left[\log \left(\frac{DC + \overline{eo}R}{\overline{eo}F} \right)_{t+j} - a_0 - a_2 \log y_{t+j} \right] \quad (9)$$

The authorities are assumed to maintain the official exchange rate fixed at $eo = \overline{eo}$ until the official holdings of foreign exchange hit the lower threshold $\tilde{R}$ for a given level of private holding $\tilde{F}$. The government reaction could include one or more of the following. A major foreign exchange reform such as a discrete devaluation, a float or a crawling peg may be effected. Other measures may include fiscal and monetary reforms in order to reduce monetary expansion and control bank lending. In the case of labor-exporting countries, non-exchange incentive packages may be considered as an instrument to encourage the transfer of worker remittances through the official channels. At the other extreme, legal and institutional measures may be introduced in order to tighten existing controls and to increase the risk for the black market transactions. To focus the discussion we will consider here only the measures that relate to monetary and exchange rate policies. Also for the particular case of the Sudan, except for the monetary and exchange rate policies, there is no evidence of a consistent and systematic set of policies adopted in the other options cited above.

Specifically we will analyze the impact on the premium of discrete devaluations under the assumed monetary rule and real income growth path described in equations (5) - (7).

The equilibrium solution for $\log q_t$ as shown in (9) above depends on the present and future values of the state variables $\left[\frac{DC}{\overline{eo}F}, \frac{R}{F}, y \right]$. This solution obviously rules out the existence of bubble equilibria determined by non-market fundamentals.[9] The paths of the state variables DC, eo and y are given by the above model; however, those for R and F need to be specified. Ideally, the above asset market model should be integrated into a flow account model giving the equilibrium conditions of the official and private foreign trade accounts. This extended model allows the determination of the stationary levels of R and F consistent with flow account equilibrium (*e.g.*, Elbadawi, 1992). To keep matters simple, we proxy the stationary levels of R and F by their average values during the period of analysis (1980:I-1986:IV). In the case of R, this amounts to setting the threshold level of the official reserve, $\tilde{R}$, to zero.[10] The assumption $\tilde{R} = 0$ will also turn out to be very critical for obtaining an explicit solution $\log q_t$. In addition to $\tilde{R} = 0$ we assume that any time $t = T$, $eo_T = \overline{eo}$ and $F_T = \tilde{F}$, and by using equations (5) - (7) in (9) we can obtain in equation (10) below an explicit solution for $\log q_T (\tilde{F}, \tilde{R}, \overline{eo})$, which we denote by $\log \tilde{q}_T$:

$$\log \tilde{q}_t = \log \left[\frac{\overline{DC}_0}{\overline{eo}\, \tilde{F} y_0^{-a2}} \right] + [(\mu - a_2\delta)(T + a_1) - a_0] + [1 + a_1 (1 - \rho)]^{-1} v_T \quad (10)$$

which can be compactly written as:[11]

$$\log \tilde{q}_T = \tilde{k}_{1,T} + \tilde{k}_2 v_T \quad (11)$$

where $\tilde{k}_{1,T}$ refers to the first two terms in the right hand side of (10) while $\tilde{k}_2$ is the coefficient of v_T in (10).

4. Black Market Configurations and the Efficacy of Exchange Rate Stabilization

In this section we will stipulate two types of black market structures. Depending on the assumed black market configuration, the necessary and sufficient conditions for the indirect speculative attack can then be established. Finally, the likelihood of a successful stabilization policy based on the official exchange rate devaluation and attempted unification of the two rates can ultimately be analyzed conditional on the threshold levels of F, R, and the assumed monetary and real income regimes.

The first black market type stipulated is the one denominated by a small number of large traders who buy foreign exchange from a large number of small sellers (as in the case of worker remittances). Also, traders are assumed to have very good access to market information. The implications of the above are that these black market traders can in fact influence the market quite substantially. The necessary and sufficient conditions for the existence of black market transactions in time t is given the following event:

$$A(v_t) = (v_t: q_t(v_t) > 1, \Delta q_t(v_t) \geq 0) \cup (v_t: q_t(v_t) > 1, \Delta q_t(v_t) < 0)^{12} \quad (12)$$

where $\Delta q_t = q_t - q_{t-1}$. The condition $q_t > 1$ is neccessary and sufficient for foreign exchange suppliers to be willing to sell on the black market. The condition $\Delta q_t \geq 0$ is a necessary condition for the transaction to be profitable to the dealers. If expressed in future expectations form and given that $eo = \overline{eo}$ for $t \leq T$, this condition is equivalent to stating that transactions are profitable to the dealers in the future provided that the black market exchange rate is expected to depreciate in the future.

The above condition is only a necessary condition for the buyers to be forthcoming because these dealers are assumed to be able to manipulate the market so that the event ($\Delta q_t < 0$) will be short-lived and q will rise again to hit a higher peak after a finite number of periods. In most of the economies experiencing the phenomenon of the black market, the Sudan included, there is usually a very high degree of excess aggregate demand, especially for imported goods and other capital and current account transactions. This situation will ensure that the traders can ultimately sell their foreign exchange to end users at profitable exchange rates. The union of the two disjointed events in (12) is simply $(v_t: q_t(v_t) > 1)$. Therefore,

$$A(v_t) = (v_t: q_t(v_t) > 1, \Delta q_t(v_t) \geq 0) \quad (13)$$

is the necessary and sufficient condition for the indirect speculative attack under the black market configuration A.

The other black market configuration, B, is based on the assumption that the black market dealers are of small size, large in numbers and do not operate in a coordinated fashion. The necessary and sufficient condition under configuration B is therefore given by:

$$B(v_t) = (v_t: q_t(v_t) > 1, \Delta q_t(v_t) \geq 0) \quad (14)$$

Now we can evaluate the likelihood of the indirect speculative attacks under black markets A and B. Conditional on the previous assumptions that $eo = \overline{eo}$, $F = \tilde{F}$, and $\tilde{R} = 0$ at time T and using equation (11) above, we can derive the probability $P(A_T)$ as follows:

$$\Pr(\tilde{A}_T) = \Pr(\tilde{q}_T > 1) = \Pr(\tilde{k}_{1,T} + \tilde{k}_2 v_t > \log_e 1)$$

$$= \Pr\left[v_T > \frac{\log_e 1 - \tilde{k}_{1,T}}{\tilde{k}_2} \right] = \Pr\left[v_T > \frac{-\tilde{k}_{1,T}}{\tilde{k}_2} \right]$$

since the log function is monotonic and $\tilde{k}_2 > 0$. Also since $v_T \sim N(0, \sigma_v^2)$, we have:

$$\Pr(\tilde{A}_T) = \Phi\left[\frac{\tilde{k}_{1,T}}{\tilde{k}_2 \sigma_v} \right] \tag{15}$$

For the computation of $\Pr(\tilde{B}_T)$ we consider first the derivation of an expression for Δq_T which can be obtained easly from (11) above:

$$\Delta \log \tilde{q}_T + (\mu - a_2\delta) + \tilde{k}_2 \Delta v_T \tag{16}$$

which we will write compactly as:[13]

$$\Delta \log \tilde{q}_T = \tilde{k}_3 + \tilde{k}_2 \Delta v_T \tag{17}$$

Now:

$$\Pr(\tilde{B}_T) = \Pr(\tilde{q}_T > 1, \Delta\tilde{q}_t \geq 0)$$

$$= \Pr(\Delta\tilde{q}_T \geq 0 \mid \tilde{q}_T > 1) \Pr(\tilde{q}_T > 1)$$

$$= \Pr\left[\frac{\Delta\tilde{q}_T}{\tilde{q}_{T-1}} \geq 0 \mid \tilde{q}_T > 1 \right] \Pr(\tilde{q}_T > 1)$$

$$= \Pr(\log \tilde{q}_T - \log \tilde{q}_{T-1} \geq 0 \mid \tilde{q}_T > 1) \Pr(\tilde{q}_T > 1)$$

$$= \Pr\left[\tilde{k}_3 + \tilde{k}_2 \Delta v_T \geq 0 \mid v_T > \frac{-\tilde{k}_{1,T}}{\tilde{k}_2} \right] \Pr\left[v_T > \frac{-\tilde{k}_{1,T}}{\tilde{k}_2} \right]$$

$$= \Pr\left[\Delta v_T \geq \frac{-\tilde{k}_3}{\tilde{k}_2} \right] - \Pr\left[\Delta v_T \geq \frac{-\tilde{k}_3}{\tilde{k}_2} \mid v_T < \frac{-\tilde{k}_{1,T}}{\tilde{k}_2} \right] \Pr\left[v_T < \frac{-\tilde{k}_{1,T}}{\tilde{k}_2} \right]$$

$$= \Pr\left[w \geq \frac{-\tilde{k}_3}{\tilde{k}_2} \right] - \Pr\left[\frac{-\tilde{k}_{1,T}}{\tilde{k}_2} - v_{T-1} \geq \frac{\tilde{k}_3}{\tilde{k}_2} \right] \Pr\left[v_T < \frac{-\tilde{k}_{1,T}}{\tilde{k}_2} \right]$$

or

$$\Pr(\tilde{B}_T) = \Phi\left[\frac{\tilde{k}_3}{\tilde{k}_2 \sigma_w} \right] - \Phi\left[\frac{\tilde{k}_3 - \tilde{k}_{1,T}}{\tilde{k}_2 \sigma_v} \right] \Phi\left[\frac{-\tilde{k}_{1,T}}{\tilde{k}_2 \sigma_v} \right] \tag{18}$$

where $\sigma_w^2 = \dfrac{2\sigma_\varepsilon^2}{1+\rho}$

Note that as expected $\Pr(A_T) \geq \Pr(B_T)$.

In order to analize the likelihood of a successful government stabilization policy aimed at exchange rate unification through maxi-devaluation we need to take the model of the determination of the premium and derive the consequences of changing the official exchange rate. The above framework contains the required ingredients for this analysis. The events $\tilde{A}_T$ and $\tilde{B}_T$ permit the calculation of the probabilities of non-converging exchange rates ($\tilde{q}_T > 1$) under specific market configurations. Therefore, to assess the likelihood of successful exchange rate unification, we simply need to consider the complements of the above two events ($\tilde{A}_T^c$ and $\tilde{B}_T^c$);

$$\tilde{A}_T^c = (\tilde{q}_T > 1)^c = (\tilde{q}_T \leq 1) \tag{19}$$

and

$$\Pr(\tilde{A}_T^c) = 1 - \Pr(\tilde{A}_T) = 1 - \Phi\left[\frac{\tilde{k}_{1,T}}{\tilde{k}_2 \sigma_v} \right] \tag{20}$$

Also

$$\tilde{B}_T^c = (\tilde{q}_T > 1, \Delta\tilde{q}_T \geq 0)^c \tag{21}$$

$$= (\tilde{q}_T \leq 1) \cup (\Delta\tilde{q}_T < 0)$$

and

$$\Pr(\tilde{B}_T^c) = 1 - \Pr(\tilde{B}_T) = 1 - \left\{ \Phi\left[\frac{\tilde{k}_3}{\tilde{k}_2 \sigma_w} \right] - \Phi\left[\frac{\tilde{k}_3 - \tilde{k}_{1,T}}{\tilde{k}_2 \sigma_v} \right] \Phi\left[\frac{-\tilde{k}_{1,T}}{\tilde{k}_2 \sigma_v} \right] \right\} \tag{22}$$

From (19) and (21) it follows that the set $\tilde{A}_T^c$ is contained in the set $\tilde{B}_T^c$ for any given point in time. This implies, as is clear from (20) and (22), that $\Pr(\tilde{A}_T^c) \leq \Pr(\tilde{B}_T^c)$ will always hold. This means that under the condition of the assumed monetary and real sector regime and the threshold levels $\tilde{F}$ and $\tilde{R}$, successful stabilization aimed at exchange rate unification is less likely under black market A than under B.

Finally, for $eo_T = \bar{eo}$, we will evaluate the expected value of the premium at time $t = T$ for any future period $t = T + J$. We use the expression for $\log \tilde{q}_T$ given in (11) to obtain:

$$E_T \log \tilde{q}_{T+J} = E_T(\tilde{k}_{1,T+J} + \tilde{k}_2 V_{T+J})$$

$$= \tilde{k}_{1,T+J} + \tilde{k}_2 \sigma^J v_T$$

$$= (\tilde{k}_{1,T} + \tilde{k}_2 v_T) + (\mu - a_2\delta) J + \tilde{k}_2 v_T (\rho^J - 1)$$

or

$$E_T \log \tilde{q}_{T+J} - \log \tilde{q}_T = (\mu - a_2\delta)\, J + \tilde{k}_2 v_T\, (\rho^J - 1) \qquad (23)$$

This above equation shows the Jth period rate of change in $\tilde{q}$ to be composed of a deterministic and a stochastic component. To the extent that the constant rate of growth in domestic credit exceeds the multiple of the constant rate of growth in real income and the real income elasticity in the asset market equation, the Jth period forward premium, $E_T\tilde{q}_{T+J}$), is expected to exceed the spot premium, ($\tilde{q}_T$), by the deterministic quantity exp $(\mu - a_2\delta)J$. The stochastic part exp $(\tilde{k}_2 v_T\, (\rho^J - 1))$ being less than 1 will tend to moderate the deterministic increments. This result, which is quite plausible for the case of structurally weak currencies, is analogous to that of the forward discount obtained in the standard speculative attack literature, as for example Flood and Garber (1984b) and Grilli (1986).

5. An Application to the Sudan

In this section we will use the Sudanese data to compute the functionals derived in the previous section. Here we will also briefly discuss some implications of our results for the viability of the devaluation-centered type of stabilization strategies, like the one pursued in the Sudan for the last decade.

The parameter estimates needed for the exercise are provided in the Appendix. It also contains a discussion of the estimation procedures and the quality of the Sudanese data. In addition, the following two points need to be made explicit. First, and as stated in section 3, to the extent that there were no swamp agreements available to the government on a consistent basis –that would enable the authorities to go beyond the assumed $\tilde{R} = 0$ level in order to defend the exchange parity– our choice of $\tilde{R}$, *ceterus paribus*, is likely to understate the true probabilities of the speculative attacks. Second, the same effect is likely to be caused by our choice of the value for $\tilde{F}$ which was given by the estimates of the SNWA remittances per quarter. F_t at any quarter during the period considered, is likely to be less than the figure cited above. Two factors are behind that. The first is private capital flight, estimated at an average annual rate of S 1.8 million for the 1978/79-1985/86 period (Ali, 1987). The other factor is the rather heavy reliance on black market dollars for financing of both legal and illegal imports, as discussed in section 2. From the above discussion, it appears that our estimates of $P(\tilde{A}^c)$ and $P(\tilde{B}^c)$ may tend to exaggerate the chances for successful stabilization in the sense described above.

Table 1 shows the estimates for $P(\tilde{A}^c)$, $P(\tilde{B}^c)$ and $E_T\tilde{q}_{T+J}$ for each of the devaluation quarters 1981:IV, 1982:IV, and 1985:I, and for four quarters that followed each of the above devaluations. Figure 2 below contains plots of $P(\tilde{A}^c)$ and $P(\tilde{B}^c)$ over the period considered while Figure 3 shows the plots of q_T and $E_T\tilde{q}_{T+J}$ over the same period. It is quite clear that under both markets A and B the effects of the devaluation of 1 is not sustainable. The probability of successful devaluation tends to collapse dramatically after the first quarter following of devaluation. This story –reflected clearly by both Table 1 and Figure 2– bodes quite well with the observed premium in Figure 1, which shows that the low levels of q achieved as a result of the devaluation are completely reserved in the following quarters. The main factors behind this are the higher rate of growth in domestic credit relative to that of real output; and the low income elasticity in

TABLE 1

SUDAN: ESTIMATED PROBABILITIES OF SUCCESSFUL DEVALUATIONS AND THE SPOT AND FORWARD PREMIA

	qT	ETqT+J	Pr (AcIT)	Pr (BcIT)
1981:IV Devaluation:				
1981:IV	1.20001	1.20001	0.857218	1.00000
1982:I	1.44444	1.27214	0.247589	0.26539
1982:II	1.56667	1.35850	0.007506	0.05671
1982:III	1.58889	1.44153	0.000014	0.05493
1982:IV Devaluation:				
1982:IV	1.27344	1.27344	0.997976	1.00001
1983:I	1.42187	1.37204	0.869581	0.92257
1983:II	1.57031	1.47222	0.265794	0.28427
1983:III	1.57031	1.58545	0.008761	0.05717
1983:IV	1.50781	1.70183	0.000018	0.05493
1985:I Devaluation:				
1985:I	1.96000	1.96000	0.999943	1.00000
1985:II	1.96000	2.09677	0.982546	1.03517
1985:III	1.96000	2.24513	0.640358	0.68322
1985:IV	1.96000	2.40206	0.082176	0.10658
1986:I	2.00000	2.57182	0.000843	0.05577

FIGURE 2

SUDAN: PROBABILITY ESTIMATES OF SUCCESSFULL DEVALUATIONS
Under Black Markets A and B

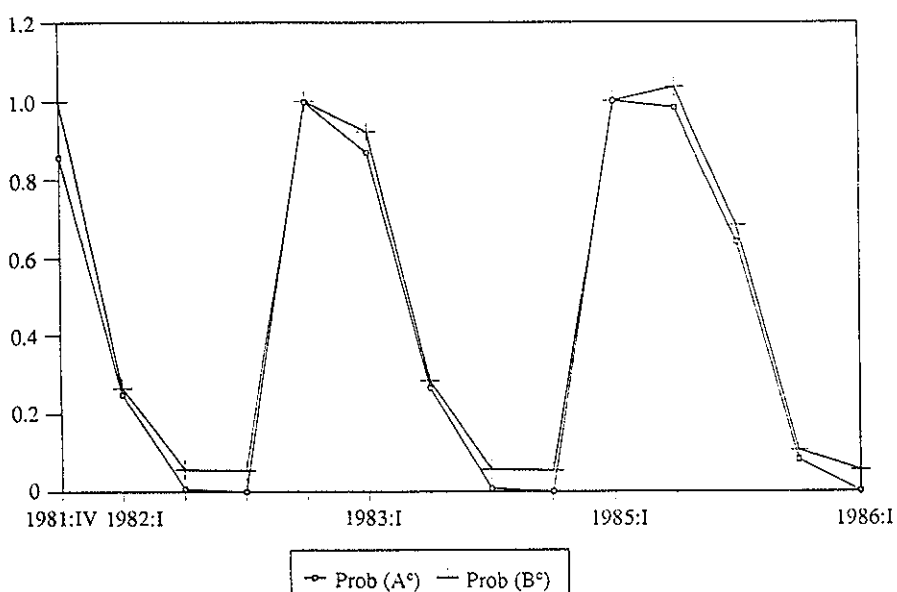
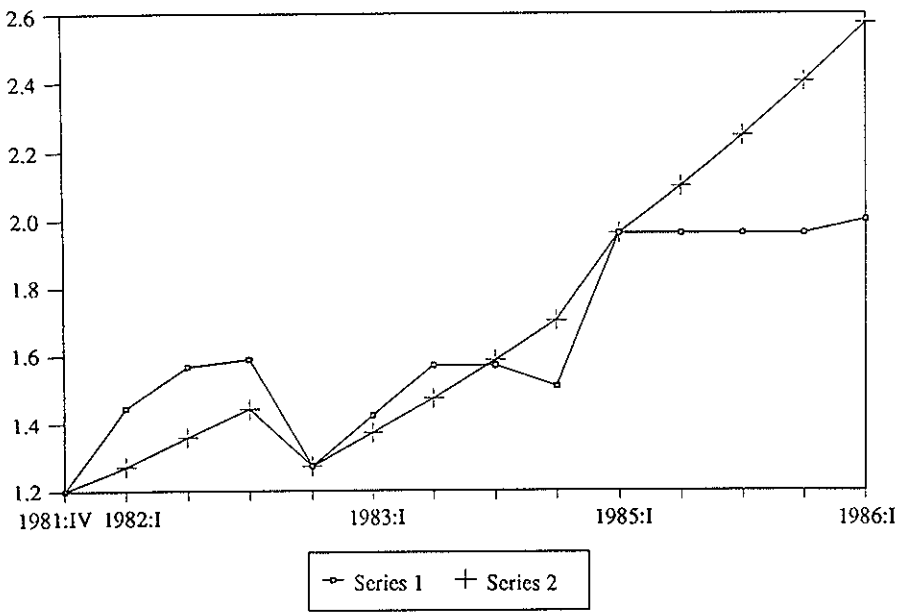


FIGURE 3

SUDAN: SPOT AND FORWARD BLACK MARKET PREMIA
Devaluations in 1981:IV, 1982:IV, and 1985:I



the asset market equation relative to the elasticity of the expected depreciation in the black market rate. While domestic credit grew at an average quarterly rate of 7% during the 1980:I-1986:IV period, average quarterly growth of real output was a meager 0.5% during the period. The real output elasticity is also relatively small at .25 compared to the elasticity of the expected depreciation in the free rate which is equal to 1.83. These parameter estimates and the consequent results reported in Table 1 are entirely consistent with the environment described in section 2 above, where domestic credit expansion was the main source of financing an expanding fiscal deficit at times of low real growth.

The results in Table 1 and Figure 2 also show the importance of the specific configuration regarding the black market for foreign exchange. Even though the effects of devaluations are short-lived in market B also, it nevertheless provides a better chance for successful devaluations compared to market A. Subscribing to this result, one can therefore argue that, even if the rate of monetary expansion were moderated, the chances for successful devaluations remain specific to the structure of the black market for foreign exchange. For the case of the Sudan, which resembles black market A, the dismal failures of such devaluations are therefore not surprising. Finally, our estimates of the forward premium undershoot the spot premium during the first half of the period before overshooting the spot rate in the second half. However, even though

the undershooting is not consistent with prior expectations, the two rates are fairly close.

6. Concluding Remarks

In this paper I have extended the literature on collapsing exchange rates and the speculative attacks on official reserves to the case when currency inconvertibility gives rise to a black market for foreign exchange. The presence of such a black market provides the necessary and sufficient conditions for an indirect speculative attack on official reserves. This structure permits and explicit representation of the black market premium, which was subsequently used to derive probability statements regarding the likelihood of successful devaluation as a means to unify the two rates and achieve global economic stabilization. The model was applied to the case of the Sudan.

The main conclusions are the following. To the extent that the rate of domestic credit expansion substantially exceeds the rate of real growth in the economy, the chances for successful devaluations are quite remote. The outcome is also affected by the relative influences of real income and of expectations about exchange rate depreciation on asset markets. Conditional on the assumed monetary and real output regimes, the efficacy of exchange rate stabilization is also shown to depend on the nature of the black market for foreign exchange. The chances for successful devaluations are less likely when the black market is less competitive and tends to be denominated by a small number of dealers.

Perhaps the most important contribution this paper can hope to make is to the current debate on LDC stabilization and the order and sequencing of liberalization. The main policy recommendation of this paper is that fiscal deficits lie at the heart of macro instability and that the structure of foreign exchange markets matters.

Appendix

The regression estimates of equations (1) and (6) of section 3 are reflected by the two following equations:

$$\text{Log}\left[\frac{M}{eF}\right]_t = \underset{(.53)}{0 - 1.83\,\Delta\log e_t} + \underset{(.02)}{0.25}\ \log y_t + \underset{(.24)}{0.48}\ D_t \qquad \text{(A.1)}$$

$R^2 = 0.51$, DW = 1.89, Q(7) = 2.6.

$$\text{Log}\,DC_t - \hat{\rho}\,\log DC_{t-1} = \underset{(0.02)}{2.15} + \underset{(0.0009)}{0.02t} \qquad \text{(A.2)}$$

$R^2 = 0.94$, DW = 2.13, Q(13) = 14,23,

$\sigma_\varepsilon = 0.04$, $\hat{\rho} = 0.71$.

Standard errors are in parentheses. Equation (A.1) was estimated using annual data for the period 1970-1987. Only annual data is available for real income y, proxied by real GDP (1970 = 100). D is a *dummy* variable for the post-1984 drought period which witnessed an even higher accelerated monetary expansion. Other variables in equation (A.1) are defined as in section 3. The date on eF, the domestic currency denominated value of foreign currency held by the private sector, is proxied by the income circulating in the black market. This 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 $\hat{Y}_u = M\hat{V} - Y$, where $\hat{V}$ is an estimate of V. The estimation of equation (A.2) is based on quarterly data covering the period 1980:I-1986:IV. The above regression results may of course be subject to criticism derived from the relatively short estimation periods or the low quality of the Sudanese data for F and y. Not with standing these possible limitations, no evidence of serious misspecification can be detected, however.

Equations (A.1) and (A.2) provide directly the estimates for a_0, a_1, a_2, ρ, σ_ε, and $\log \overline{DC}_0$ for equations (1) and (6). The estimates of equation (A.2) can also be used to calculate $\hat{\mu}$, $\hat{\sigma}_v$, and $\hat{\sigma}_w$, where $\hat{\sigma}_w^2 = \frac{2\sigma_\varepsilon^2}{1+\rho}$. The above estimates are reported below in the matrix equation (A.3). Other inputs used in the analysis include: $\hat{\delta}$, the estimate of the quarterly constant growth rate in GDP (1980 = 100) $\log \bar{y}_0$, and $\log \tilde{F}$; where period zero is taken to be the first quarter of 1980. The level of $\tilde{F}$ is given by average SNWA remittances per quarter in $ million for the 1980:I-1986:IV period. Other variables in (A.3) are the official exchange rate and the estimated residuals.

(A.3)

$$\begin{bmatrix} \hat{a}_0 & \hat{a}_1 & \hat{a} \\ \hat{\mu} & \hat{\delta} & \hat{\rho} \\ \hat{\sigma}_\varepsilon & \hat{\sigma}_v & \hat{\sigma}_w \\ \log \overline{DC}_0 & \log \bar{y}_0 & \log \tilde{F} \\ \log eo_{81:3} & \log eo_{81:4} & \log eo_{82:4} \\ \log eo_{84:1} & \log eo_{85:1} & - \\ \hat{v}_{81:4} & \hat{v}_{82:4} & \hat{v}_{85:1} \end{bmatrix} = \begin{bmatrix} 0.0 & 1.83 & 0.25 \\ 0.07 & 0.005 & 0.71 \\ 0.04 & 0.06 & 0.043 \\ 7.56 & 6.83 & 6.62 \\ -0.693 & -0.105 & 0.247 \\ 0.247 & 0.916 & - \\ 0.057 & -0.038 & 0.007 \end{bmatrix}$$

Notes:

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

2 This may include a combination of two types of controls. First, the exchange rates for either or both current and capital account transaction may be managed (fixed as a special case). Second, capital and current account transactions, including holdings of foreign exchange or import and export transactions, may be completely disallowed or highly regulated.

3 These remittances reached $ 3 billion annually, almost three total times exports of goods and non-factor services.

4 For more details on this see Elbadawi (1992).

5 The term 'quasi-legalize' was used in Dornbusch *et al.* (1983) to describe a situation when the black market is theoretically 'illegal' but is not clandestine either.

6 More formally Var $(v_t) = \sigma_v^2 = \sigma_\varepsilon^2 (1 - \rho^2)$ for $t \geq 1$. As an approximation v_0 may be assumed to have a normal distribution with mean 0 and variance $\sigma_\varepsilon^2 (1 - \rho^2)$.

7 Strictly speaking q is equal to 1 plus the premium. But without ambiguity we will refer to the premium by q in this paper.

8 Conditional on eot fixed at $\overline{eo}$, the expected rate of exchange in the black market rate is equivalent to the expected rate of change in the premium *i.e.*, $\overline{eo}_t = eo$ implies that $E_t \log e_{t+1} = E_t \log q_{t+1} - q_t$.

9 A test of whether or not the equilibrium exchange rate follows a bubble is found in Flood and Garbre (1980).

10 For example the average annual size of the Sudan's official reserves for the 1980-1986 period is only $ 27.25 million, which accounts for barely 0.75% of the country's annual average domestic credit.

11 Equation (10) is obtained from (9) by utilizing the following relations:

$$\log DC_{T+j} = \log \overline{DC}_0 + \mu (T + j) + \rho^j v_T \qquad \log y_{T+j} = \log \bar{y}_o + \delta (T + j)$$

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

12 Strictly speaking, the condition Δq_t (v_t) should be expressed in terms of future expectations $({}_t\Delta q_{t+1})$ (v_{t+1})). However, for $t \geq T$, this will not change the final solutions (see equations (15), (18), and (23) below).

13 If $t = T$ is a devaluation quarter, $\tilde{k}_3$ will be equal to $(\mu - a_2\delta) + \Delta \log e_T$.

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RECENT CROSS-COUNTRY STUDIES OF GROWTH: A SURVEY*

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Abstract:

Over the last decade there has been a renewed interest for understanding the phenomenon of growth both at theoretical and empirical levels. At the time of this paper there is an enormous volume of literature that uses cross-country regressions to link convergence in per capita output with economic policies, human capital accumulation, externalities and increasing returns. This paper analyzes the econometric results of recent cross-country studies of growth. After a brief review of this empirical literature, a discussion on testing the theory of growth, interpretation of the coefficients, robustness, error in variables, and measurement of human capital is provided. The main conclusion is that this type of studies provide useful sets of correlations between variables that tend to affect growth and long-run growth rate of per capita GDP. But, these correlations are not a test of the theory and furthermore there is a lack of alternative hypothesis. Another main disappointment is that these coefficients are not constant across all the observations, and therefore, structural equations for these coefficients should be considered. Country-case type of studies and the analysis of other proxies for human capital are suggested as further researches.

Over the last decade there has been a renewed interest for understanding the phenomenon of growth at both theoretical and empirical levels. At the former level researchers have worked with certain stylized facts that the traditional neoclassical theory of growth apparently has left unexplained. Specifically, these new models are called endogenous growth models since they reproduce a theoretical structure where an

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