International Finance Discussion Papers

Number 334

OCTOBER 1988

DEVALUATION, EXCHANGE CONTROLS, AND BLACK MARKETS FOR FOREIGN EXCHANGE IN DEVELOPING COUNTRIES

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ABSTRACT

This paper considers how exchange controls, black markets, and forward-looking expectations condition the impact of exchange rate devaluations in developing countries. A model incorporating these features is developed to analyze the response of key external balance indicators to anticipated devaluations. The model is driven by the movements of black market exchange rates in perfect foresight equilibrium, which in turn force changes in export under-invoicing and official trade statistics. The predicted movements in all measureable variables, both before and after devaluation, closely mirror those historically associated with devaluation episodes. The analysis is then extended to the case of 'devaluation cycles' to examine the paths of the black market rate and official trade statistics in the face of persistent inflation which over-values the real exchange rate and motivates periodic devaluations. Statistical analysis of a multi-devaluation data set strongly supports some of the most important predictions of the model: black market exchange rates typically depreciate in response to official devaluation, and all else equal, increases in the black market rate reduce official measures of dollar value exports.

Devaluation, Exchange Controls, and Black Markets for Foreign Exchange in Developing Countries

Steven B. Kamin[1]

I. **Introduction**

While an extensive theoretical literature has focused upon the efficacy of exchange rate devaluation as a stabilization instrument, a number of important considerations associated with the devaluation process have not been fully addressed. First, most developing countries initiating stabilization programs already have in place extensive exchange controls which may significantly alter the impact of devaluation.[2] Second, most analyses have ignored the role of black markets for foreign exchange in conditioning the impact of devaluation.[3] Finally, devaluations have often been modeled as exogenous, unanticipated events, even though considerable evidence confirms that devaluations are almost always implemented in response to pressing real and financial problems.

This paper presents an analysis of the effects of devaluation which takes into account all three of these factors: 1) exchange controls

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1/ The author is a staff economist in the Division of International Finance. This paper represents the views of the author and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or other members of its staff. An earlier version of this paper appeared as a chapter in the author's doctoral dissertation. I would like to thank Rudiger Dornbusch, David Gordon, Ann Helwege, Dale Henderson, David Howard, Paul Krugman, and Lance Taylor for useful comments and suggestions.

2/ The multi-volume NBER study of foreign trade and exchange regimes, summarized in Krueger (1978) and Bhagwati (1978), does focus on the effects of such restrictions.

3/ Pick's Currency Yearbook provides one of the few comprehensive sources of black market exchange rate data. Bhagwati, Krueger, and Wibulswasdi (1974) and McDonald (1985) verify the existence of widespread black market transactions through statistical analysis of unreported trade flows.

(to contain reserve losses stemming from an overvalued exchange rate), 2) the black markets for foreign exchange engendered by these controls, and 3) the response of these markets to anticipations of devaluation. The analysis is intended not only to close the theoretical gaps described above, but also to explain some of the findings of previous empirical research into the effects of devaluation. In a recent study of more than 60 devaluations, Kamin (1988) found that even prior to the typical devaluation, sharp declines in the growth rates of exports and imports occur while the current account balance and reserve levels deteriorate markedly. Immediately following the devaluation, exports rebound strongly and the current account recovers while imports continue to sag, albeit less quickly, until bouncing back sharply in the second year after devaluation.

The conventional theory of devaluation cannot easily explain why imports slacken in the face of the appreciation of the real exchange rate which typically precedes devaluation, nor why they rebound following the exchange rate adjustment. At the same time, the sharp post-devaluation surge in exports is at variance with the traditional 'J-curve' story of slow export response to price incentives.

This paper explains these anomalies by developing a model in which continuous inflation and hence appreciation of the real official exchange rate lead to increases in the black market premium, increases in export under-invoicing, and reductions in officially measured exports. These shortfalls in export revenues, in turn, lead to reserve losses and declines in imports as the authorities tighten foreign exchange rationing. The expectation that the deteriorating external balance will prompt an official devaluation induces a speculative rise in the black market rate

which further reinforces the need for official exchange rate adjustment. Following devaluation, the black market premium drops, reducing under-invoicing and increasing officially measured exports. Improved reserves inflows allow the central bank to expand sales of foreign exchange, so imports rebound as well. In the extension of this scenario to the case of a 'devaluation cycle', these effects are eventually reversed by continued inflation and renewed real exchange rate appreciation, so that the economy eventually slides into a succeeding devaluation crisis.

In Section II, the model of black markets is developed to analyze the effects of both anticipated and unanticipated devaluations on the black market rate, exports, imports, and the current account. Section III analyzes the path of these indicators over the course of a 'devaluation cycle'. Section IV presents empirical research that evaluates some of the major predictions of these theoretical models. Section V summarizes the main findings of this paper.

II. The Black Market for Dollars

Consider a small open economy trading in two goods, a non-domestically consumed export good with world price P_X and a non-domestically produced import good with world price P_M; both prices are fixed and set to unity. Both the non-traded goods price P_N and aggregate output (or income) are also considered to be fixed.

The official rate E is pegged at an over-valued rate, that is, a rate at which the flow demand for dollars (to be elaborated below) exceeds their flow supply. Exporters are required to surrender their dollar earnings to the central bank at the official rate E (expressed in units of domestic currency per dollar). Importers must apply to purchase dollars from the central bank. Given the excess demand for these funds at the

over-valued rate, the central bank must ration dollar sales. The central bank's function for determining official dollar sales OS is specified:

$$OS = OS' + \beta * OX \qquad \beta \leq 1 \qquad (1)$$

OS' represents some fixed level of non-discretionary import dollar sales. OX represents officially measured exports, the remittance of export earnings to the central bank, while β is a fixed parameter representing the central bank's marginal propensity to resell dollars out of export remittances. Sufficiently high levels of exports are associated with reserve accumulation, low levels with reserve loss.[4]

In response to the prevailing excess demand for dollars, a black market for dollars priced at the black market rate E^b emerges. In long-run equilibrium, this rate equates both stock supplies with portfolio demands for dollars, as well as flow demands by importers with flow supplies of dollars by exporters. We assume no capital account transactions take place, so that changes in the stock of dollars outstanding occur exclusively through imbalances in the private sector's current account.[5]

4/ In their treatment of this issue, both Sheikh (1976) and Nowak (1984) assume the central bank to retain a fixed level of reserves, so that period by period, all dollars purchased from exporters are resold to importers. This specification precludes the reserve losses which typically motivate devaluation in the first place, as well as the reserve accumulation which often follows the successful devaluation. (See Kamin, 1988) In the more general rationing formula presented here, a fixed reserve target emerges as a special case with $OS' = 0$, $\beta = 1$.

5/ In the short run, the black market rate is assumed to move exclusively to set portfolio demands equal to the stock of dollars

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(Footnote continues on next page)

By assumption (see Culbertson, 1975, Nowak, 1984) all dollars purchased from the central bank may be risklessly resold on the black market. Arbitrage ensures that the premium on black market dollars is equated to that on rationed imports sold to the final purchasers of imports. Hence, the private sector's demand for dollars is determined by the black market rate on dollars alone; the privilege of buying dollars from the central bank at the cheap official rate confers a monopoly rent on the licensee but does not alter final dollar demands. Total supplies of dollars to the black market, in consequence, originate not only from under-invoicing by exporters, but from official dollar sales as well. Note that while holders of import licenses have an incentive to over-invoice, this does not add to the total supply of dollars to the black market from official sources, which is fixed by OS', OX, and β.

II.1 The determination of private current account equilibrium

We now analyze the determination of the black market rate in private current account balance, that is to say, in long-run equilibrium when flow demands and supplies for foreign exchange in the black market are equated. The private sector current account is defined as the difference between black market dollar inflows or supplies S and outflows

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(Footnote continued from previous page)

outstanding, so that at any given moment flow import demands and export supplies may diverge. The restriction that changes in the stock of dollars occur only through current account imbalances prevents instantaneous convergence of the stock of dollars and the black market rate to their long-run equilibrium values. (The distinction between short-run portfolio equilibrium and long-run current account equilibrium follows that presented in Kouri, 1976, and Dornbusch, et.al., 1983.)

or demands D; given the assumption of zero net capital flows, this equals the change in total private dollar holdings B:

$$dB = S - D \tag{2}$$

The current account (or flow) demand for dollars is a derived demand for imported goods. Since output is considered fixed, it is modeled as a function only of the real black market rate $e^b = E^b/P_N$:

$$D = D(E^b/P_N) = D(e^b) \qquad \partial D/\partial e^b < 0 \tag{3}$$

As noted above, the current account (or flow) supply of dollars derives from both official dollar sales OS and under-invoiced dollar earnings. Let X represent the quantity of total exports and total dollar revenues as well (since $P_X = 1$), while ϕ represents the share of total exports diverted to the black market. Then:

$$S = \phi X + OS = \phi X + \beta(1-\phi)X + OS' \tag{4}$$

X and ϕ are simultaneously determined by the export sector in response to the official exchange rate E, the black market rate E^b, and the non-traded goods price P_N. The representative firm in the export sector chooses X and ϕ to maximize domestic currency profits subject to rising marginal labor costs of production $P_N L(X)$ (wages and non-traded goods

prices are assumed to move in tandem) as well as rising marginal costs associated with the under-invoicing share ϕ:[6]

$$\begin{aligned} \max\ & \phi XE^{b} + (1-\phi)XE - P_N L(X) - P_N C(\phi)X \\ \text{s.t.}\quad & L(X) = aX^{\gamma} \quad \gamma > 1 \\ & C(\phi) = b\phi^{\lambda} \quad \lambda > 1 \end{aligned} \tag{5}$$

Solving this maximization problem, we find total exports X to be a function of the weighted average of the illegal and official real exchange rates e^{b} and e:

$$X = [(\phi e^{b} + (1-\phi)e - C(\phi))/(\gamma a)]^{1/(\gamma-1)} \tag{6}$$

The under-invoicing share ϕ is found to positively depend upon the real black market premium:

$$\phi = [(e^{b} - e)/(\lambda b)]^{1/(\lambda-1)} \tag{7}$$

Since $\phi \leq 1$, I impose the condition $e^{b} - e \leq \lambda b$.

We now address the impact of a devaluation of the official exchange rate on the black market rate in current account equilibrium. The private current account balance may be expressed:

6/ The rising marginal cost of under-invoicing may be thought of as reflecting increasing marginal probabilities of detection as the under-invoicing share grows larger. In the absence of this feature, there would be nothing to prevent exporters from under-invoicing 100 percent of their export receipts.

$$dB = \phi X + \beta(1-\phi)X + OS' - D \qquad (8)$$

$$\partial D/\partial e^b < 0,\ \partial X/\partial e^b > 0,\ \partial X/\partial e > 0,\ \partial \phi/\partial e^b > 0,\ \partial \phi/\partial e < 0$$

Given the value for the real official rate e, a unique real black market rate e^b will balance the current account. To determine the impact of an official devaluation on the black market rate in the long run, we set dB=0 and totally differentiate the resulting expression. This yields the following ambiguously signed derivative of the black market rate with respect to the official rate:

$$de^b/de = \frac{[\phi + \beta(1-\phi)]\partial X/\partial e + (1-\beta)X\partial\phi/\partial e}{\partial D/\partial e^b - [\phi + \beta(1-\phi)]\partial X/\partial e^b - (1-\beta)X\partial\phi/\partial e^b} \qquad (9)$$

For the black market rate to appreciate in response to an official devaluation ($de^b/de < 0$), the following condition must hold:

$$\partial X/\partial e[\phi + \beta(1-\phi)] > -X(1-\beta)\ \partial\phi/\partial e \qquad (10)$$

The left hand side of the equation represents the devaluation's positive effect on total exports, which for fixed ϕ will raise dollar supplies to the black market. The right hand side represents the effect of the fall in the premium, which reduces the under-invoicing share ϕ; for every dollar diverted to the central bank, $(1-\beta)$ of it is retained as reserves and lost to the private sector. Clearly, the greater the response of the under-invoicing share to devaluation, the smaller the central bank's marginal propensity to resell export remittances β, and the smaller the response of total exports, the more likely it will be that the black

market rate depreciates in response to official devaluation.[7] Evidence presented in Section IV strongly supports the presumption that the black market depreciates in response to official devaluation, and this presumption will be maintained for the rest of the paper.

While the response of the black market rate itself to official devaluation is a priori ambiguous, the premium must decrease; that is, e^b must rise by less than e. Intuitively, this is apparent because if the premium remained the same, ϕ would be constant so that not only total exports but total dollar supplies to the private sector would rise. At the same time, demand for dollars would fall in response to the increase in the black market rate. As this would result in an excess supply of dollars, it must be the case that e^b falls relative to e.

II.2 The determination of the official current account balance

The official current account balance, which in the absence of net capital flows equals the change in reserve holdings R, is determined:

$$\begin{aligned} dR &= \text{export remittances - dollar sales to importers} \\ &= (1-\phi)X - \beta(1-\phi)X - OS' \\ &= (1-\phi)(1-\beta)X - OS' \end{aligned} \qquad (11)$$

7/ Nowak (1984), who argues that official devaluation will appreciate the black market rate, assumes that the central bank does not accumulate reserves, so that $\beta = 1$. As we can see, this would ensure that the condition for the appreciation of the black market rate shown in (10) would hold; if the central bank retained none of the diverted dollars, there would be no 'dollar diversion' effect, only an 'export enhancement' effect. On the other hand, if the central bank is intent upon building up reserves following devaluation, the share of export remittances it retains may be quite large and the black market rate would depreciate.

The impact of a depreciation of the black market rate on the official current account, for fixed official rate, is a priori ambiguous:

$$\partial(dR)/\partial e^b = \partial X/\partial e^b(1-\beta)(1-\phi) - (1-\beta)X\partial\phi/\partial e^b \qquad (12)$$

The first term on the right hand side of (12) represents the positive 'export enhancement' effect from increasing the weighted-average return to exports, while the second term captures the negative 'dollar diversion' effect accompanying the rise in the premium and the under-invoicing share. The same conditions which result in a depreciation of the black market rate in response to official devaluation, the dominance of the 'dollar diversion' over 'export enhancement' effects, can also be shown to cause the official current account to deteriorate in response to a rise in e^b.

It is intuitively obvious that an official devaluation must raise official exports and reserve accumulation. If the black market rate depreciates, reserve accumulation benefits from increased total exports, and since the premium falls, it benefits from the diversion of export earnings to the central bank as well. On the other hand, if the black market rate appreciates, the 'dollar diversion' effects will be even more marked; at the same time, the appreciation of e^b must reflect increases in total exports, and that helps reserve accumulation as well.

II.3 The determination of short-run portfolio equilibrium

The private current account balance underlying the results discussed above is a long run condition which need not hold continuously. In the short term, during which time the entire stock of dollars available to the private sector is considered fixed, the black market rate is determined by the portfolio-based stock demand for dollars; the private

sector current account may therefore be out of balance in between different steady states. Private sector agents hold two assets in their portfolios, dollars and domestic currency. Closely following Dornbusch et.al. (1983), the desired ratio of the domestic currency value of private sector dollar holdings to the domestic money supply is modeled as a function of the expected rate of depreciation of the black market rate (the $\hat{}$ represents percentage change):

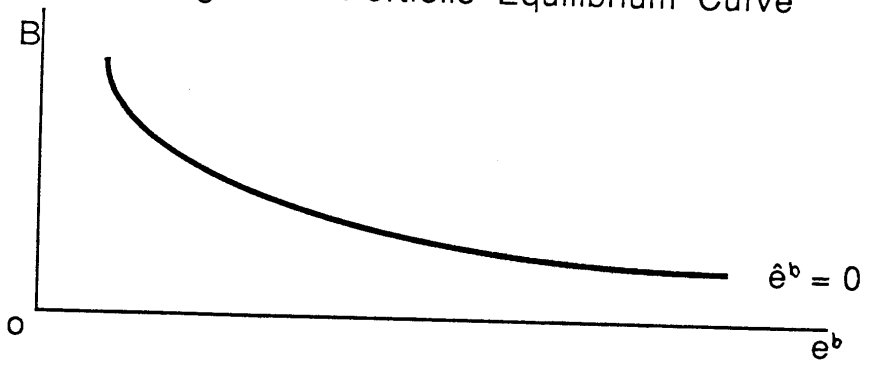
$$E^{b}B/M = \theta(\hat{E}^{b}) \ , \ 0< \theta( ) < 1, \quad \partial\theta/\partial\hat{E}^{b} > 0 \qquad (13)$$

or, dividing through by the (for now) fixed non-traded goods price:

$$e^{b}B/m = \theta(\hat{E}^{b}) \qquad (14)$$

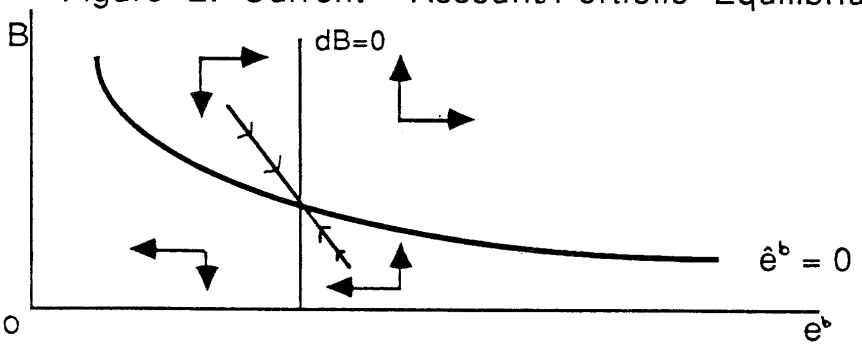
The actual rather than expected rate of depreciation is used here to reflect the assumption of perfect foresight on the part of the private sector. Because agents are indifferent between many dollars at a low exchange rate and few dollars at a high rate, portfolio demands for dollars (when the black market rate is stable) trace out a downward sloping curve in (e^{b},B) space:

Figure 1: Portfolio Equilibrium Curve



The determination of the black market rate at any instant of time is made through the portfolio balance equation described above, given that B is considered fixed in any instant, while e^B is considered to be fully flexible. In the long run, the black market rate and the private sector stock of dollar holdings are determined by the requirements of both portfolio and current account equilibrium. The steady state is depicted below, as are the directions of movement of the two state variables out of equilibrium and the stable saddle path. As noted on page 5, movements in the stock of dollars B, represented by the vertical arrows, are constrained to equal the private sector's current account balance; hence, no instantaneous jumps in the value of B are allowed. Note that for any given official rate, a single value of the black market rate clears the current account, so the dB = 0 curve is shown to be vertical.

Figure 2: Current Account/Portfolio Equilibrium

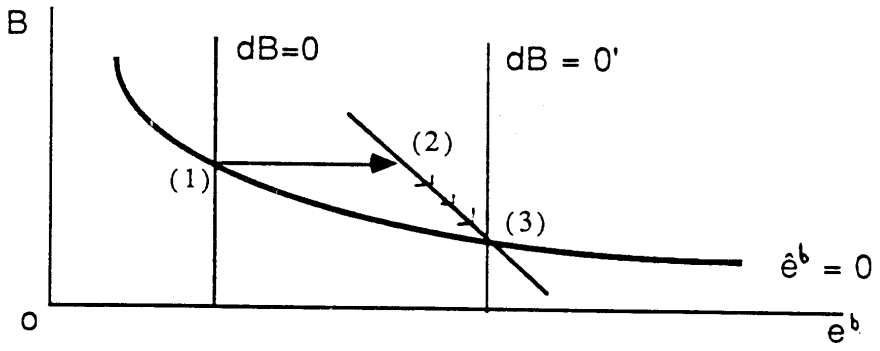


II.4 The impact of unanticipated and anticipated devaluations

The case of an unexpected devaluation is addressed first. We assume, as above, that the devaluation causes a decline in the flow supply of dollars to the private sector at the old black market rate; for current account balance to be maintained, a depreciation of the black market rate

is required, so that the dB = 0 curve shifts to the right (below). At the moment of devaluation, the black market rate jumps just enough so as to hit the stable saddle path; after this, current account losses of dollars drive the black market rate up still further until it reaches the new long run equilibrium at the same moment dollar holdings reach their new steady state level:

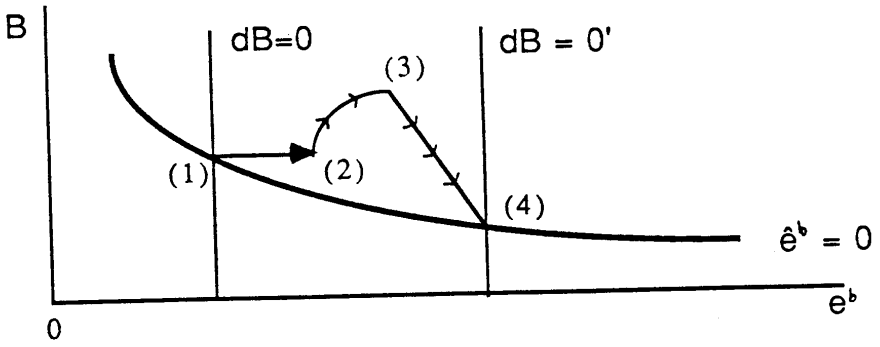
Figure 3: Response to Unanticipated Devaluation



In practice most devaluations are probably at least imperfectly anticipated. Figure 4 below indicates the path of the black market rate in response to advance news of a future devaluation. This news raises the anticipated rate of black market depreciation, so that dollar demands and the black market rate rise. Obviously, e^b cannot jump to its new steady state level, or the private sector would accumulate dollars and acquire an excessive stock of them by the time the official devaluation actually occurred. For the same reason, the rate cannot immediately rise to the stable saddle path associated with the anticipated new equilibrium, for by the time the devaluation occurred, given the prevailing directions of motion, the private sector would be far above the new stable path. As shown below, the black market rate will jump initially, then continue to

depreciate while the private sector accumulates dollars (since at the old official exchange rate, the current account will be in surplus) so that the economy hits the new stable saddle path at the instant the devaluation is actually enacted. At this point, the economy travels down the saddle path as above, with the black market continuing to depreciate while dollar holdings now decline, because following the devaluation the current account goes into deficit.

Figure 4: Response to Anticipated Devaluation



We now indicate the paths of various key indicators in response to the anticipation of a devaluation. The time paths of the black market rate and the official rate are indicated in Figure 5 below. T_0 refers to the time at which the news of the future devaluation arrives, T_1 to the time of devaluation, and T_2 to the time at which the black market rate and black market dollar holdings reach their new steady states.

Figure 5: Exchange rate path for anticipated devaluation

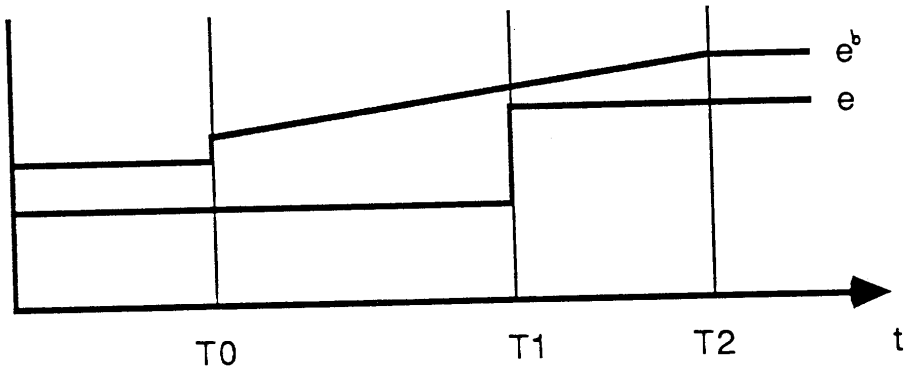
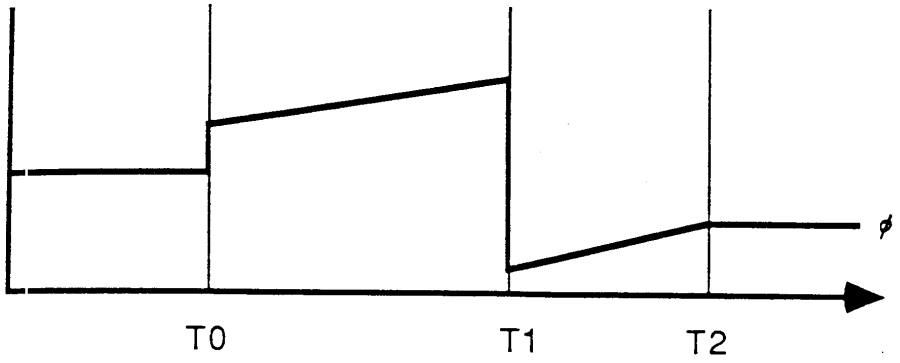


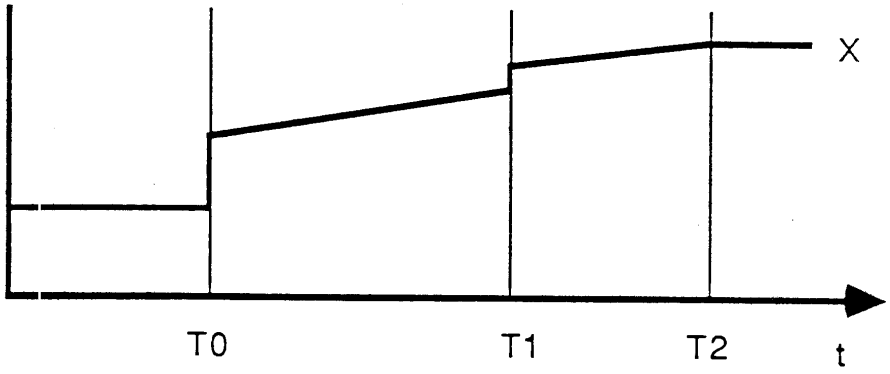
Figure 6 depicts the path of the under-invoicing share ϕ, which varies directly with the premium implicitly charted above. At the news of future devaluation, ϕ jumps upwards and grows as the black market rate depreciates. With the devaluation itself, the premium and the under-invoicing share fall initially but then recover partially as the black market continues to depreciate until reaching its new steady state level.

Figure 6: Under-invoicing with anticipated devaluation



Total exports rise when either the black market rate, the official exchange rate, or both depreciate:

Figure 7: Total exports with anticipated devaluation



Official exports $X(1-\phi)$, imports $\beta(1-\phi)X + OS'$, and the current account $X(1-\phi)(1-\beta) - OS'$ vary linearly with each other. Initially, the

depreciation of the black market rate causes declines in official exports and reserve accumulation. At the moment of devaluation, official exports, imports, and the current account increase markedly before then deteriorating as the black market rate continues its rise to its new equilibrium level. We know, however, that in long run private current account balance, official exports and reserve accumulation will stabilize at a higher level than prior to the devaluation. In Figures 8 and 9, the official current account is assumed to be in balance prior to the anticipation of devaluation; following devaluation, both official exports and imports rise while the central bank enjoys a current account surplus.

Figure 8: Official Exports, Imports with anticipated devaluation

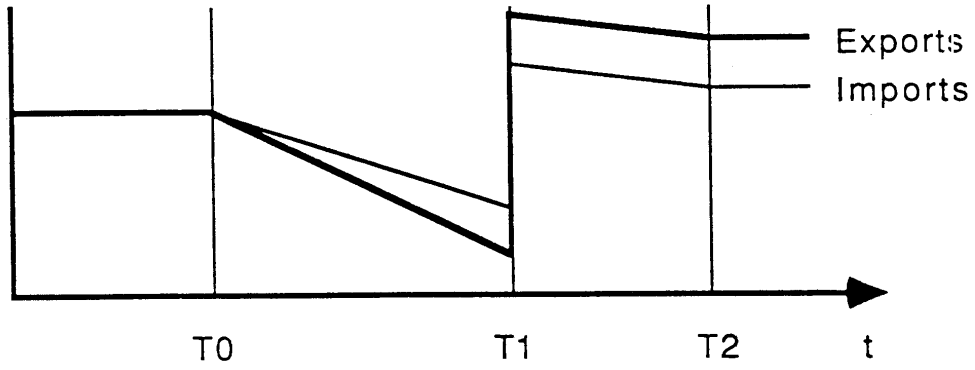
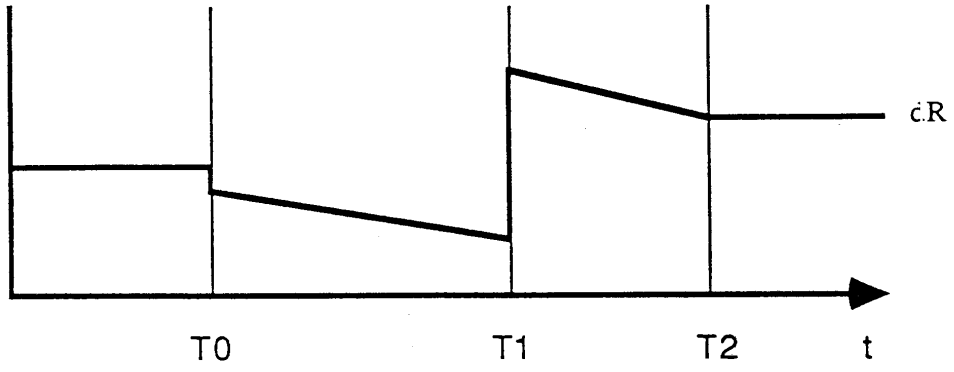


Figure 9: Official Current Account with Anticipated Devaluation



In sum, the predicted trends in official exports, imports, reserves, and the current account, in anticipation of and following devaluation, correspond closely to the patterns described by Kamin (1988).

III. Inflation, Black Markets, and the Devaluation Cycle

Even if initially successful, a single devaluation rarely achieves permanent success and is often followed by subsequent devaluation attempts. Moreover, devaluations are not exogenous shocks whose timing is independent of economic trends within the country; they typically respond to deteriorations in external balance and macroeconomic performance. In this section, we consider the effects of a persistent trend, constant non-traded goods price inflation $\hat{P}_N$, that operates to continuously over-value the real official exchange rate, forcing the government to devalue periodically to maintain some minimum level of foreign reserves.

III.1 The devaluation cycle under static expectations

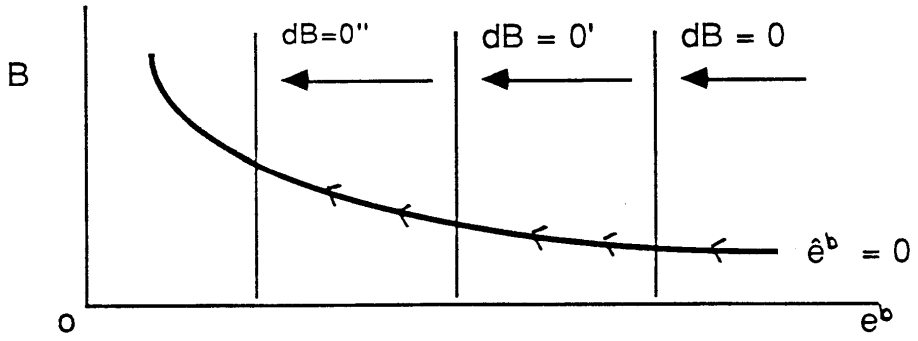
Note that for constant price growth $\hat{P}_N$, the real official rate e appreciates at the rate $-\hat{P}_N$. Therefore, the real black market rate that clears the private current account appreciates as well:

$$\hat{e}^b = \eta_{e^b,e}(-\hat{P}_N) \quad < 0 \qquad \text{for } \eta_{e^b,e} > 0 \text{ [8]} \tag{15}$$

Figure 10 shows the path of the real black market rate and dollar holdings when exchange rate expectations are static, that is, when no changes in the rate of black market depreciation is anticipated.

8/ $\eta_{e^b,e}$ is the elasticity of the black market rate with respect to the official rate, and is derived by log-differentiating the private current account balance condition. As with de^b/de, it can be shown that $\eta_{e^b,e}$ is less than one, although its sign will be ambiguous.

Figure 10: Impact of Inflation on Black Market



With both real exchange rates e^b and e appreciating, total exports fall while under-invoicing rises in response to the widening premium. The official current account balance must therefore deteriorate. Obviously, this process cannot continue indefinitely, for the central bank must eventually run out of reserves (or foreign borrowing opportunities). As in Rodriguez (1978), we assume that when central bank reserves dwindle to some critical level R', the government devalues the official rate by at least enough to ensure a temporary official current account surplus and the restoration of its reserve holdings. [9] The rate of reserve accumulation is highest immediately following the devaluation. Thereafter, the steady growth of prices resumes its attack on the official current account. Eventually, reserve accumulation becomes negative and reserves again decline to R', the government again devalues, and a new cycle commences.

The path of the real black market rate and private sector dollar holdings over the course of the devaluation cycle (assuming static

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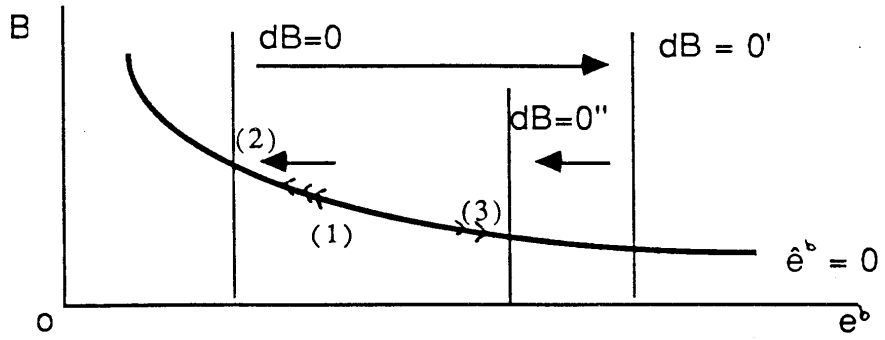
9/ There is no clear consensus on the actual motivations underlying the decision to devalue. Rodriguez (1978) models the central bank as devaluing when its foreign reserves hit some minimum level. Collins (1984) criticizes this approach, noting that many countries have maintained over-valued exchange rates for considerable periods of time with (net) negative reserves.

expectations concerning the depreciation of the black market rate) are shown below in Figure 11. At (1), the real black market rate appreciates and dollars are accumulated in response to price inflation as discussed above. This process continues until (2), when continued official deficits force reserves to critical levels. At this time, a maxi-devaluation shifts the dB=0 line to the right, so the private sector current account goes into deficit; subsequently, e^b depreciates and dollar holdings are drawn down while the dB=0 curve moves leftward again. At (3), the private sector goes into current account surplus again. The real black market rate reverses and resumes its appreciation while dollar holdings are built up and official reserves drawn down, thus initiating the new cycle.

Figure 11: Devaluation Cycle with Static Expectations



III.2 The devaluation cycle with rational expectations

Note that the nominal black market rate E^b depreciates continuously over the devaluation cycle:

$$\hat{E}^b = \hat{e}^b + \hat{P}_N = \eta_{e^b,e}(-\hat{P}_N) + \hat{P}_N = \hat{P}_N(1-\eta_{e^b,e}) > 0 \qquad (16)$$

Rational, forward-looking portfolio holders will anticipate this depreciation and demand higher average ratio's of dollars to local

currency than would be the case if they held static expectations concerning the black market rate. We therefore define a new portfolio relationship $\theta'(\ )$ based on the expected depreciation of the real black market rate, given the level of inflation $\hat{P}_N$:

$$\theta'(\hat{e}^b) = \theta(\hat{E}^b) = \theta(\hat{e}^b + \hat{P}_N) \tag{17}$$

so that

$$\theta'(0) = \theta(\hat{P}_N) > \theta(0). \tag{18}$$

We define in turn a new steady state portfolio equilibrium curve which lies above the original relationship in (e^b, B) space.

$$e^b{}_{B/m} = \theta'(\hat{e}^b) \tag{19}$$

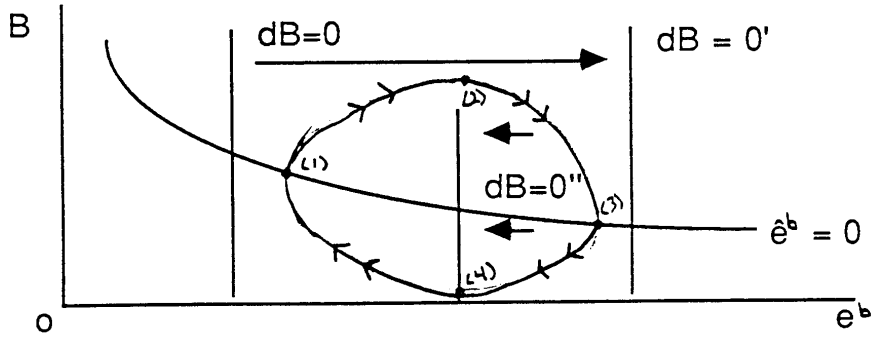
In addition to expectations of positive average black market rate depreciation, private sector agents with perfect foresight will hold recurrent expectations of accelerations and decelerations in E^b's depreciation, depending upon the current phase of the devaluation cycle. These expectations will cause real black market rates to rise in advance of flow dollar shortages and fall in advance of flow dollar surpluses. In the static expectations case, for example, the real black market rate appreciates until the moment of official devaluation. If agents held rational expectations, they would anticipate the devaluation and resultant depreciation of the black market rate, increase their demand for dollars, and bid up the price of dollars in advance of the devaluation itself. We would therefore expect the appreciation of the real black market rate to

reverse itself and become a depreciation even before the official devaluation occurs.

Similarly, in the static expectations case the real black market rate depreciates following official devaluation until it equals the (appreciating) value which would clear the private sector current account; at that point, it reverses direction and appreciates while the private sector runs a current account surplus. In a rational expectations framework, by contrast, agents anticipating the heightened dollar inflows associated with the appreciating real official exchange rate will reduce their demand for dollars in advance of the turnaround in dollar flows. Hence, the depreciation of the real black market rate will slow and turn to appreciation even prior to the private sector current account's switch from deficit to surplus. This appreciation will continue until anticipations of a subsequent devaluation mark the beginning of a new cycle.

Based on these considerations, the devaluation cycle under rational expectations and perfect foresight is shown in Figure 12 below. The cyclic paths of dollar holdings and the real black market rate closely resemble those depicted in Dornbusch et.al.(1983) to describe the path of the seasonal premium in the Brazilian black market rate. Both cases derive from periodic fluctuations in the supply of foreign exchange to the private sector.

Figure 12: Devaluation Cycle with Perfect Foresight



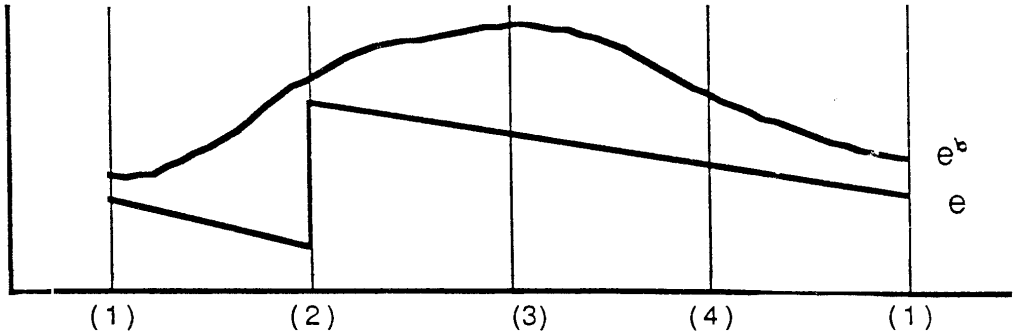
At (1), the dB=0 line moves left on account of continuous inflation as discussed above. The private sector expects the imminent devaluation that will take place when reserves decline to the critical level R'; accordingly, dollar demands rise and the depreciation process starts in advance of the actual devaluation, with the stock of dollar holdings rising as well. Private dollar holdings reach their highest point at (2) the point of devaluation, after which the current account goes into deficit and dollar holdings are drained off.

Following the devaluation, continued private current account deficits reduce dollar holdings and depreciate e^b. However, the dB=0 line moves leftward due to continuous inflation, and private sector agents anticipate future increases in under-invoicing and flow dollar supplies. The depreciation of the black market rate therefore slows and reverses at (3), prior to the point where the dB=0 line reaches the current black market rate and turns current account deficit into surplus. This latter event occurs at (4), after which dollar holdings rise again and the decline in e^b slows in anticipation of a new devaluation cycle.

The actions of forward looking investors play an important role in accelerating the government's decision to devalue in the pre-devaluation phase of the cycle. The anticipatory depreciation of the real black market rate causes the official current account balance to deteriorate more quickly than it would have under static expectations, and hence the critical reserves threshold R' is reached more quickly as well. In this sense, the role of agents in the black market resembles that played by private speculators anticipating devaluation in models of fixed exchange rate, convertible currency regimes. (See Krugman, 1979, Flood and Garber, 1984)

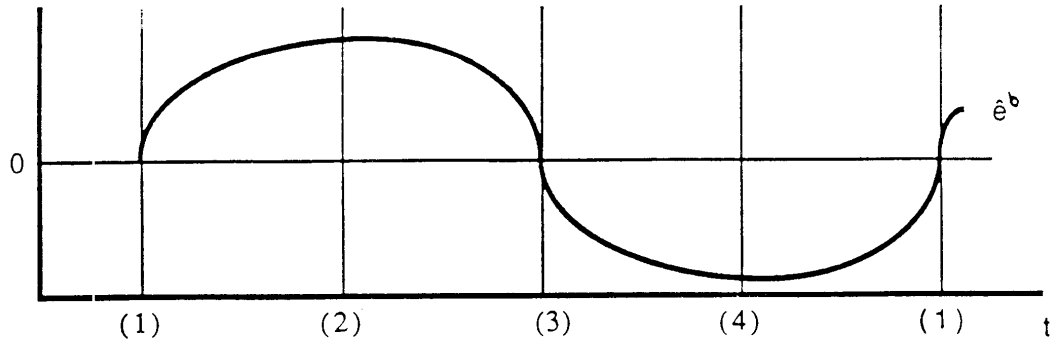
We now examine the paths of key performance indicators over the course of the devaluation cycle. The paths of the real black market and official rates are shown below. The labels along the X-axis refer to the points in the cycle denoted in Figure 12 above.

Figure 13 Devaluation Cycle paths of real exchange rates



Depicted in Figure 14 is the rate of change in the real black market rate. Note that the absolute value of its rate of change varies with vertical distance between the current (e^b,B) combination and the steady state portfolio equilibrium curve. The point of fastest depreciation occurs not at the point of official devaluation (2), where the graph of the devaluation cycle is flat while the equilibrium curve slopes downwards, but at some later point where the slope of both paths are equalized. Similar reasoning establishes that the point of fastest appreciation of the real black market rate (slowest depreciation of the nominal rate) occurs somewhat after the private current account becomes positive at (4).

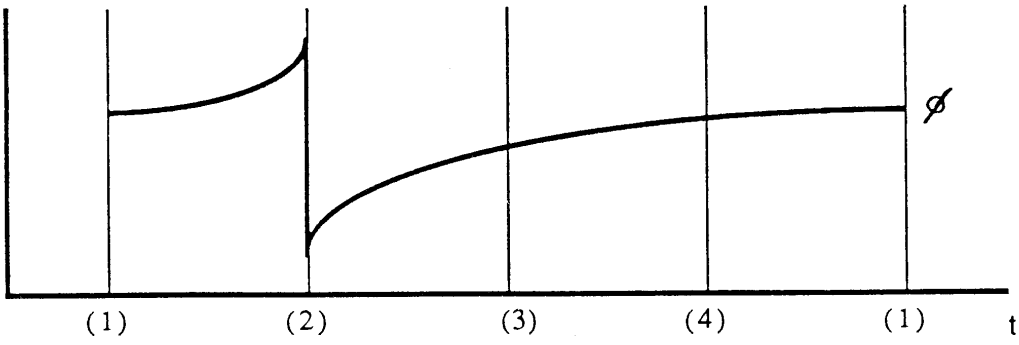
Figure 14:Rate of Black Market Depreciation over Cycle



Note that $\hat{E}^b = \hat{e}^b + \hat{P}_N$, so that movements in the growth rate of the nominal black market rate may also be read off this graph. While fluctuating, the growth rate of the nominal black market rate in the perfect foresight case will never be negative. To see this, note first that the real black market rate, when appreciating, must fall slower than that which clears the private current account. Otherwise, the current account would stay negative and dollar holdings would explode downwards; also, note that e^b reaches its maximum rate of decline after it has been passed by the dB=0 line, so it must have been appreciating more slowly both before and after that point. At the same time, we showed that in current account equilibrium the nominal black market rate depreciates continuously in response to real official rate appreciation. Hence, it follows that even at its highest rate of real appreciation, the nominal black market rate in perfect foresight must still show positive growth.

Figure 15 depicts the movement of the under-invoicing share over the course of the devaluation cycle. With the official exchange rate constant at all times except the moment of devaluation itself, while the black market rate depreciates continuously, we know the premium must rise continuously at all times except the point of devaluation, when it falls abruptly. The under-invoicing share moves monotonically with the premium, and accordingly follows a similar path:

Figure 15: Movement of Under-invoicing share over Cycle



Turning to officially measured trade statistics, we know that official exports, imports, and the current account must deteriorate at all times except the exact moment of devaluation. (Recall that these are linearly related through the central bank rationing function.) Between (3) and (1) in Figure 12, total exports fall in response to the real appreciation of both exchange rates while under-invoicing rises. Between (1) and (3), the under-invoicing share increases but total export movements are ambiguous. Section II.2, however, showed that for $\eta_{e^b,e} > 0$, real black market depreciation must lower official exports and the official current account balance. In the phase of the devaluation we are considering, not only does the real black market rate depreciate, but with the exception of the devaluation, the real official rate appreciates. Thus, in inverse movement to the under-invoicing share, the flows of official imports and exports shoot up at the point of devaluation and then fall continuously until the date of the next devaluation. Shown below are the movements of official exports, imports, and the current account.

Figure 16: Official Import/Export movements over Cycle

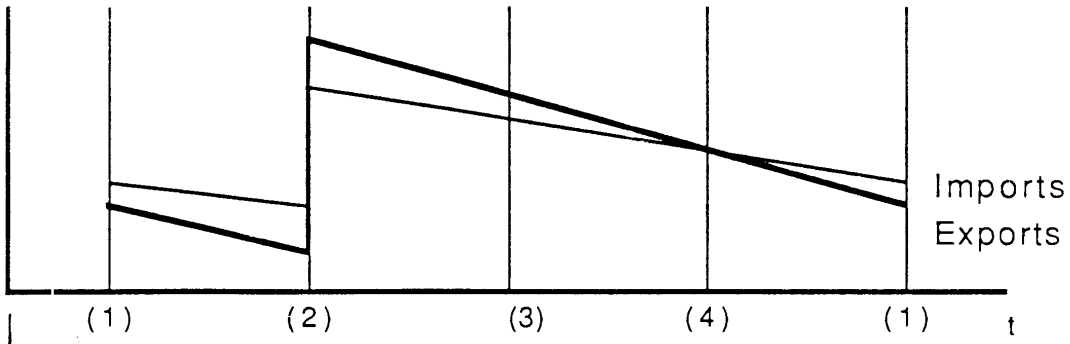
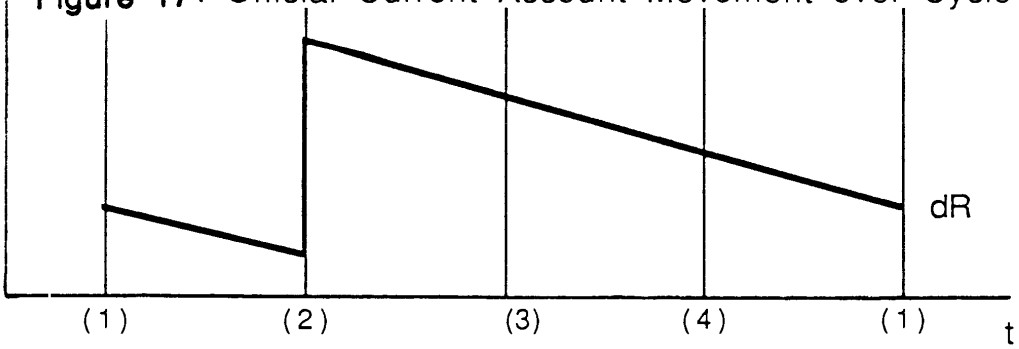


Figure 17: Official Current Account Movement over Cycle



V. **Empirical Evidence on Black Markets and Devaluation**

IV.1 The Paths of Black Market Variables

We first evaluate the predictions of our analysis for the behavior of the black market rate before, during, and after devaluation. Using data from Pick's Currency Yearbook, the average paths (over 13-quarter periods bracketing the devaluation) of the black market rate, the black market premium, and the real black market rate were calculated for more than 40 devaluation episodes in developing countries.[10]

The results of these calculations for the nominal black market rate are shown in Table 1 in the Appendix; all rates have been divided by the value prevailing in period T, the quarter in which the devaluation took place, so that numbers shown are actually index values. Table 1 indicates that nominal black market rates typically rise throughout the devaluation period. Given the continuous inflation prevailing in most of the countries in the sample, this is not surprising. Note, however, that as measured by the t-test for changes shown in the bottom row of the table, the depreciation of the black market rate is only statistically significant from the second quarter preceeding devaluation to the third quarter afterward; moreover, the depreciation is most marked in the quarter of devaluation itself. This evidence supports our predictions that, first, the black market rate will rise and not fall in response to

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10/ The full procedure for calculating such statistics is detailed in Kamin (1988). Briefly, for each devaluation, the value of the black market rate was calculated for the quarter in which the devaluation took place, the six quarters preceeding and the six quarters following the devaluation. The value of the black market rate in each quarter was then averaged (unweighted) with the value corresponding to the same quarter (relative to the devaluation period) for every other devaluation in the sample. The result was an average time profile of the black market rate across the typical devaluation episode.

official devaluation, second, the black market rate will depreciate in advance of the actual devaluation, and third, further depreciation in the black market will follow the devaluation.

Appendix Table 2 presents evidence on the movement of the black market premium during devaluation episodes. As predicted, the premium rises prior to devaluation; while the t-test for changes does not confirm this, note that in the two quarters preceeding devaluation the premium rises in twice as many cases as it falls. In the quarter of devaluation itself, the premium declines unambiguously. Finally, Table 2 shows weak evidence of a resumption in the widening of the premium following devaluation.

Appendix Table 3 shows the path of the nominal black market rate deflated by the CPI. The data indicate strongly that the real black market rate rises in direct, contemporaneous response to devaluation. There is also weaker evidence for a real depreciation of the black market rate in the quarters preceeding devaluation, and very mixed evidence concerning the movement of the real black market rate following devaluation.

In sum, the evidence strongly confirms the nominal exchange rate predictions of our analysis of the effects of an anticipated official devaluation. While the real black market rate also clearly depreciates in direct response to official devaluation, its movements before and after devaluation do not correspond as clearly to the movements predicted by the rational expectations analysis of the devaluation cycle. The data certainly do not allow us to reject the devaluation cycle model, however, and more research remains to be done in this area.

IV.2 Links between exports and exchange rates

We now address the contention that events in the black market cause corresponding movements in officially-measured trade indicators. Recall that official exports OX are total dollar exports multiplied by one minus the under-invoicing share: $OX = X(1-\phi)P_X$. Hence, the growth of official exports is represented:

$$\hat{OX} = \hat{X(1-\phi)P_X} = \eta_{X,e}\hat{e} + \eta_{X,e^b}\hat{be^b} + \eta_{(1-\phi),e}\hat{e} + \eta_{(1-\phi),e^b}\hat{be^b} + \hat{P_X} \qquad (20)$$

$$= \eta_{OX,e}\hat{e} + \eta_{OX,e^b}\hat{be^b} + \hat{P_X}$$

where:

$$\eta_{OX,e} = \eta_{X,e} + \eta_{(1-\phi),e} > 0 \qquad (21)$$

$$\eta_{OX,e^b} = \eta_{X,e^b} + \eta_{(1-\phi),e^b} \gtrless 0 \qquad (22)$$

To estimate the equation shown above, growth rates were calculated--for the seven years bracketing official devaluation, and for every devaluation in the sample--for the real official and black market exchange rates, dollar exports and dollar export prices. The OLS results for this equation, which was estimated on a pooled time-series/cross-devaluation sample, are presented in Appendix Table 4. (Estimation using IV techniques yielded approximately the same results.)

Equations 5 and 6 are shown for reference purposes; they omit all explanatory variables except lagged dependent variables and dummy variables for the different time periods, thus indicating the export growth variable's basic pattern of movement across the years of the devaluation episode. Period 1 is the third year prior to the devaluation,

and Period 7 is the fourth year following the devaluation. No dummy is included for Period 4, the year immediately following devaluation; this gives coefficients on other dummies interpretations as differences in intercept terms for that year relative to the devaluation year. They indicate that average export growth falls in Period 3, the year prior to devaluation, rises in Period 4, and rises still more strongly in Period 5, the second year following devaluation. These results exactly mirror those presented in Kamin (1988).

Equations 1 and 2 present the basic estimation results. As expected, the coefficients on the official real exchange rate are found to be positive while those on the real black market rate are estimated as negative. The coefficients on both rates are generally significantly different from zero, and F-tests confirm that they are of approximately equal absolute magnitude. This latter evidence suggests that total export responses must be accounting for very little of the official exports response to exchange rate changes. If total export responses were large, the response of official exports to official devaluation would be enhanced and to black market depreciation would be moderated. If $\eta_{X,e} = \eta_{X,e^b} = 0$, on the other hand, then $\eta_{OX,e} = \eta_{(1-\phi),e} \approx -\eta_{(1-\phi),e^b} = -\eta_{OX,e^b}$; this is exactly what we observe in the estimation results.

Equations 3 and 4 present the results of estimations based on the "fixed effects" model: slope coefficients are still kept constant across all observations, but intercept terms are allowed to vary (non-stochastically, or as 'fixed effects') both across devaluations and across time periods. The relaxation of the constraints on the intercepts does little to alter the magnitude or significance of the exchange rate coefficients, although the coefficients on the price growth term are

reduced somewhat and the lagged dependent variable changes sign and loses significance. However, the time pattern of export movements discerned in Equations 5 and 6 is largely unchanged in Equations 3 and 4; the drop in export growth prior to devaluation and rebound afterwards are not fully explained by inclusion of exchange rates changes and export price growth. Hence, while the estimated equations confirm that movements in the black market rate at least partially explain fluctuations in officially reported exports, it is clear that other factors besides under-invoicing movements must also be important during devaluation episodes.

V. Conclusion

In this paper, we have shown how the presence of exchange controls, black markets for foreign exchange, and forward-looking expectations will condition the role of devaluation in stabilizing external balance problems in developing countries. A model of black markets for foreign exchange was developed to analyze the response of the external sector to both anticipated and unanticipated devaluation. This analysis was then extended to the case of a 'devaluation cycle' to examine the paths of key external balance indicators in the face of persistent inflation which over-values the real exchange rate and motivates periodic devaluation.

The predictions of these analyses correspond closely to actual trends in official current account statistics during devaluation episodes as described in earlier empirical research on the subject. In particular, the model explains why both exports and imports appear to decline prior to devaluation, why exports recover so rapidly immediately afterwards, and why imports also rebound so strongly, the real depreciation of the exchange rate notwithstanding. The empirical work presented in this paper

confirms the model's predictions concerning the behavior of the black market rate during devaluation episodes, and also verifies the negative relationship between the black market premium and official exports that was derived in the theoretical analysis. However, it is shown that movements in black market rates do not fully explain the observed pattern of export variation during devaluation episodes. Other factors are also clearly responsible for these export trends, and further research will be needed to identify them.

APPENDIX TABLES

Table 1 - Nominal Black Market Rate

Quarterly Values Index Normalized Around Devaluation Period: T = 1

	T-6	T-5	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4	T+5	T+6
Mean:	.72	.74	.75	.78	.85	.91	1	1.06	1.17	1.29	1.37	1.47	1.73
Std. Error:a	.04	.03	.03	.02	.03	.02	0	.02	.07	.11	.17	.22	.37
Median:	.74	.78	.79	.78	.82	.91	1	1.03	1.04	1.04	1.03	1.05	1.03
Change from previous period													
# Increasing:	-	37	33	37	39	37	45	37	34	30	27	31	28
# Decreasing:	-	17	21	17	15	17	9	17	20	24	27	23	26
H_o Prob.:[b]	-	0	.07	0	0	0	0	0	.04	.25	.55	.17	.45
T-test :	-	1.25	1.46	1.66	3.34	3.18	4.18	2.61	2.02	2.09	1.03	.93	1.45

Table 2 - Black Market Premium

Quarterly Values Index Normalized Around Devaluation Period: T = 1

	T-6	T-5	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4	T+5	T+6
Mean:	1.19	1.21	1.25	1.4	1.75	1.78	1	1.03	1.09	1.14	1.11	1.07	1.21
Std. Error:[a]	.11	.11	.12	.25	.52	.46	0	.02	.05	.09	.08	.11	.24
Median:	1.03	1.09	1.11	1.11	1.16	1.26	1	1.01	1.03	1.01	.99	1	.99
Change from previous period													
# Increasing:	-	29	25	29	32	31	6	29	26	22	20	25	24
# Decreasing:	-	18	22	18	15	16	41	18	21	25	27	22	23
H_oProb.:[b]	-	.07	.39	.07	.01	.02	0	.07	.28	.39	.19	.39	.5
T-test :	-	.76	1.48	1.12	1.2	.46	-1.69	1.74	1.34	.91	-1.2	-.34	1.07

[a]: Standard error of mean
[b]: Probability under H_o: No change from previous period.

Table 3 - Real Black Market Rate

Quarterly Values Index Normalized Around Devaluation Period: T = 1

	T-6	T-5	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4	T+5	T+6
Mean:	.87	.86	.87	.85	.89	.9	1	1	1.08	1.13	1.15	.95	.91
Std. Error:[a]	.04	.04	.04	.03	.03	.03	0	.03	.09	.14	.22	.09	.07
Median:	.88	.9	.94	.86	.9	.93	1	.99	.97	.94	.92	.87	.88
Change from previous period													
# Increasing:	-	21	22	15	22	22	30	13	16	11	11	12	13
# Decreasing:	-	18	17	24	17	17	9	26	23	28	28	27	26
H_o Prob.:[b]	-	.37	.26	.1	.26	.26	0	.03	.17	0	0	.01	.03
T-test:	-	-.13	.74	-1.55	2.04	.7	3.25	.15	1.04	.75	.16	-1.54	-.97

[a]: Standard error of mean
[b]: Probability under H_o: No change from previous period.

Table 4: Estimation Results for Export Growth Equation

Explanatory Variables	Basic		Fixed Effects Model		Reference	
	#1	#2	#3	#4	#5	#6
Intercept:	.08	.07	-.06	-.07	-.02	-.01
	(7.32)	(5.00)	(-2.62)	(-2.91)	(-.66)	(-.43)
$\hat{e}$	.05	.04	.06	.06		
	(2.24)	(1.98)	(3.36)	(3.24)		
$\hat{e}^b$:	-.06	-.05	-.06	-.06		
	(-5.00)	(-4.07)	(-5.26)	(-5.35)		
$\hat{P}_X$:	.72	.73	.54	.58		
	(13.79)	(13.24)	(11.67)	(11.98)		
$\hat{OX}_{-1}$:		.10		-.09		.08
		(1.65)		(-1.46)		(.89)
Period Dummies:						
Period 1:			.01		-.00	
			(.43)		(-.07)	
Period 2:			.01	.01	.01	.01
			(.34)	(.44)	(.28)	(.20)
Period 3:			-.04	-.04	-.05	-.06
			(-1.3)	(-1.07)	(-1.19)	(-1.24)
Period 5:			.07	.07	.09	.09
			(2.06)	(2.13)	(2.14	(1.93)
Period 6:			.03	.04	.04	.03
			(1.0)	(1.31)	(.88)	(.56)
Period 7:			.06	.06	.07	.08
			(1.8)	(1.96)	(1.60)	(1.34)
Corrected R^2:	.53	.56	.50	.54	.04	.04

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