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A Note on the Efficiency of Black Markets in Foreign Currencies

SANJEEV GUPTA*

THERE EXISTS CONSIDERABLE LITERATURE on the efficiency of foreign exchange markets, with most of the empirical work supporting the hypothesis that the foreign exchange markets are weak form efficient.[1] In some countries, however, trading in foreign currencies takes place in black markets which are the result of restrictions placed on the foreign sector.[2] The importance of these markets in sustaining the illegal import and export of goods and assets, as well as illegal capital flows, has been growing in the past few years.[3] In this paper, market efficiency tests are performed on the black market exchange rates in India, Taiwan, and South Korea.

It is quite conceivable that black markets may not be efficient because the information about prices and market participants is generally imperfect: the markets tend to be thin and often segmented, and the transaction costs, as measured by the buy-sell differential, tend to be high. All these factors could hinder efficient adjustment of exchange rates to new information.[4] A test of market efficiency is a test simultaneously of efficiency and of the assumptions of market equilibrium. The theory underlying financial efficiency tests has been omitted here since it is well-known and accepted. Weak-form tests of market efficiency are based on the autocorrelation functions of rates of return on currency positions, on nonparametric tests like the runs analysis, and on mechanical trading rules applied to historical currency prices in the black market. Finally, the cross-correlations between the changes in the black market rate and changes in the official exchange rate are examined to see if the black market exchange rate "predicts" the movements in the official rate.

I. Data

The empirical tests have been carried out on both the monthly and the weekly black market exchange rates in India, Taiwan, and South Korea. The black market exchange rate (Eb_t) is defined as the price of a U.S. dollar in domestic

Kiel Institute of World Economics.

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[1] See, for instance, Giddy and Dufey [7]; Burt, Kaen, and Booth [3]; Cornell and Dietrich [4]; and Logue, Sweeney, and Willet [11].

[2] For a discussion of the factors leading to the emergence of black markets in foreign currencies and its determinants, see Culbertson [5]; Blejer [2]; and Gupta [8].

[3] For some empirical estimates of over- and under-invoicing of exports, imports, and smuggling in India, see the Kaul Committee Report [9], and Nayak [12].

[4] Free availability of information, the large number of transactors, and zero transaction costs are not necessary conditions for the efficient adjustment of prices. For a detailed explanation, see Fama [6].

currency in the black market, usually for unlicensed transfers. The monthly observations refer to the end-of-the-month price of a U.S. dollar, and are the midpoints of the buying and the selling rates for transactions taking place physically within the country and at the major trading centers of the world.[5] The monthly period ranges from January 1958 to March 1976. The data have been obtained from several editions of *Pick's Currency Yearbook*. Data for the monthly official exchange rate series (Eo_t) have been collected from the *International Financial Statistics*.

The weekly black market exchange rate refers to the selling price of the U.S. dollar prevailing on Tuesdays in Hong Kong.[6] Data for these exchange rate series and the official rate have been obtained from the *Far Eastern Economic Review*. The period covered is from 7 September 1976 to 18 September 1979, a total of 159 weeks.[7]

The market efficiency tests are not performed on actual exchange rates but on the first differences of their natural logarithms. Because of the opportunity cost of holding foreign exchange, the first differences should have been adjusted for relative interest rates,[8] but, given the difficulty of finding interest-bearing instruments of comparable risk in these currencies, such adjustments were not carried out.

II. Empirical Results

A. The Autocorrelation Functions

For both the monthly and weekly exchange rate series, autocorrelation functions were calculated for lags of up to 24.[9] In only three instances for the weekly series were the coefficients significant at the .05 level. These were for two week and nine week lags in the Indian rupee and for the five week lag in the Taiwanese dollar. In the monthly series for the Indian rupee and Taiwanese dollar, no coefficient was found to be statistically significant. However, for the South Korean won, coefficients significantly different from zero at the .05 level were found for the first, fourteenth, and twenty-first lags.

These indications of dependency should be treated with caution, since they could be due to sampling errors. More importantly, the observed price distributions were strongly leptokurtic. The implication of the latter is that the probability of relatively large or small changes from one week to the next is greater than would be expected under a normal distribution.[10] Therefore, the significance tests

[5] This is based on the information supplied by the foreign correspondents of *Pick's World Currency Report*, and currency dealers in the various trading centers.

[6] However, there are a few exceptions: six observations refer to the exchange rate on Mondays and two observations refer to the previous week's rate.

[7] The period of study for both the weekly and the monthly series has been determined by the availability of data.

[8] For instance, see Giddy and Dufey [7], pp. 11–14.

[9] The complete results of the various tests are not reported in this paper because of space. Complete results of any or all of the tests are available from the author upon request.

[10] The same has been observed in the studies dealing with stock markets (Fama [6]) and freely floating exchange rates (Giddy and Dufey [7]; Burt, Kaen, and Booth [3]; and Cornell and Dietrich [4]).

Table I

The Q Test

Currency	Q Statistic	
	Weekly	Monthly
Indian rupee	35.676	26.596
South Korean won	18.707	45.845[a]
Taiwanese dollar	21.58	22.192

[a] Significant at .05 level.

which assume normal distributions could be misleading. These tests may indicate dependency when none is actually present. Since very few coefficients were found to be significant, and these did not display any systematic pattern in terms of signs and lags, the results based on autocorrelation functions were considered to be supportive of independence.

The Box-Pierce statistic (or the Q statistic) can be used to test for a flat autocorrelation structure. Under the null hypothesis that all autocorrelations are zero,

$$Q = N \sum_{j=1}^{24} \hat{\rho}_j^2,$$

where

N = the number of observations and

$\hat{\rho}_j$ = the estimated autocorrelation at lag j.

It will be approximately chi-square distributed with j degrees of freedom. The estimated values of Q for the three currencies are reported in Table I. These were compared with the tabulated value of chi-square for twenty-four degrees of freedom at the .05 level of significance. The estimated values of the Q statistic for the weekly series of all three currencies, and the monthly series of the Indian rupee and the Taiwanese dollar, were below the critical value of chi-square. Hence, the null hypothesis of a flat autocorrelation for these particular series cannot be rejected, thereby implying that the rates of return on these currencies are uncorrelated over the time period studied.

To examine whether bias is present in the South Korean monthly series, this was broken into three segments of six, four, and eight years respectively. This was done because of visual evidence of possible structural changes in the process determining the exchange rate series. For the first and third subperiods, no autocorrelation coefficient is significantly different from zero. In the second subperiod, however, two coefficients (at first and second lags) are found to be significant at the .05 level. An examination of the second subperiod reveals that the official exchange rate of the won was frequently devalued in 1964 and 1965,[11] resulting in many discrete shifts in the mean of the process generating the rates

[11] For instance, the won was devalued on 3 May 1964, and a system of fluctuating rate was introduced. It was further devalued in March and June of 1965. When these two years are dropped from the second subperiod, the autocorrelation functions for the remaining two years turn out to be white noise.

of return on currency positions. These shifts biased the autocorrelation coefficients for the monthly series of the South Korean won. It would be reasonable to conclude, then, that the null hypothesis of market efficiency for the South Korean won cannot be rejected despite some apparent signs of dependence in the pooled series. Thus, the results based on the autocorrelation functions are not only consistent with the hypothesis that the black foreign exchange markets for these currencies are efficient, but they are also consistent with the assumptions underlying the market equilibrium model.

B. Runs Analysis

A run is defined as a sequence of price changes of the same sign. Runs of +, −, and 0 price changes for monthly and weekly exchange rate series of the three currencies were computed.

The results indicate that for the weekly series of the South Korean won and Taiwanese dollar, the total number of observed runs are greater than expected. However, the reverse is true for the Indian rupee. For none of the currencies is this difference significant at the .05 level.

For the monthly series of the Taiwanese dollar, the actual number of runs are very close to the expected number. However, the actual number of runs for the monthly Indian rupee and South Korean won series are less than the expected. Only for the South Korean won is this difference significant at the .05 percent level, indicating positive serial correlation. When account is taken of the fact that this series is mean nonstationary, this result is not surprising. Therefore, the results of the runs analysis also tend to support the hypothesis of independence.

C. Filter Rules

In order to detect dependencies which are not a strict function of time (e.g., are of nonlinear form), certain trading strategies called filter rules have been devised. These filter rules were first employed by Alexander [1] to identify potentially profitable swings in stock prices.

The filters are buy-sell rules based on past and current behavior of the exchange rate. The rule employed in this study is "Buy when the price is X percent above its previous low, and sell when the price is Y percent below its previous high." Obviously, an infinite number of such rules can be designed by varying X and Y and changing the basic form of the rule. The profits from following these trading rules should not be compared to the profits from buying and holding the home currency, but to buying the foreign currency in the beginning of the period and selling it at the end of the period to get back into the domestic currency.[12]

In order to reduce the number of trading strategies, buy-sell filters (X percent and Y percent above) were assumed to be equal in all cases. These buy-sell limits vary between .25 percent and 4 percent for the weekly series, and between .25 percent and 8 percent for the monthly series.

The results show that in the case of weekly series the filters above 1 percent

[12] For details, see Logue and Sweeney [10].

invariably yield negative rates of return for all three currencies, but for filters between .25 percent and .75 percent, positive annual rates of return were realized, some in excess of 10 percent. For the monthly series, filters below 1 percent generally outperformed the buy-hold strategy. However, two points should be kept in mind when interpreting some of the seemingly high rates of return: (1) these rates of return have not been adjusted for transaction costs. These costs could be particularly high in this type of market where the information on participants and prices is imperfect, and the market is relatively thin; and (2) for our purposes, the relevant criteria ought to be the average profit per transaction. Positive profits can be realized only when the transaction costs are less than the average profit per transaction.

Though it was not possible to get a reliable estimate of the transaction costs, some indication of these costs can be obtained by looking at the buy-sell differential for a typical day. The buy-sell differential as a percentage of selling price varies between 3 percent to 8.33 percent. Even if 3 percent is taken to be the average representative figure of transaction costs of a buy-sell in these markets, all profits from the application of the filter rules disappear.

As pointed out earlier, the profits reported are those resulting from following a trading strategy alone, and do not include income from interest earnings. If an interest differential exists in favor of the home country, then the filter profits (unadjusted for the interest rate differential) would tend to be biased upward. The converse would hold if interest rates abroad are higher than at home.

In a developing country, besides the restrictions on the foreign sector, controls also exist on the financial sector of the economy in the form of interest rate ceilings on deposits. Thus, there emerges a black market in loanable funds in addition to a black market in foreign currencies. The interest rates in these markets are generally higher than those in the controlled market. If these high interest rates are used to adjust the profits from the various trading strategies, the corrected profits would be even lower. Thus, any claim that correlates high (unadjusted) profits with market inefficiency must be viewed with skepticism.

D. Cross-correlations

Finally, cross-correlations between ΔEb_t and ΔEo_t were estimated for each country for both the weekly and the monthly exchange rate series.[13] Cross-correlations $R(\Delta Eb_t, \Delta Eo_{t+k})$ for lags 0 to 16 for the weekly and the monthly series were computed. The statistical significance of nonnegative lags was examined to see if the movements in the official rate are "predicted" (or anticipated) by the black market rates.

In only three instances for the weekly series were the coefficients significant at the .05 level. These were for the zero week and one week lags for South Korea and for the nine week lag for Taiwan. However, the latter was barely significant. These results indicate that in South Korea, changes in the weekly official exchange rate are anticipated one week ahead, and in Taiwan, possibly nine weeks ahead, by the black market. In India, it seems that changes in the weekly

[13] Because Taiwan had a system of multiple (official) exchange rates up to June 1960, the monthly period for this country ranges from July 1960 to March 1976.

black market exchange rates are poor short-term "predictors" of changes in the official exchange rate.

In the monthly series, seven coefficients were found to be statistically significant. These were for lags zero and three for South Korea, lag zero for India, and lags zero, four, thirteen, and fourteen for Taiwan. The highly significant coefficients at lag zero for all three countries suggest that the black market rate responds immediately to changes in the official rate. The significance at lags other than zero for South Korea and Taiwan suggests that changes in the official rate are, in large part, anticipated in these countries. In South Korea, for instance, the black market anticipates changes in the official rate three months before. In Taiwan, on the other hand, it seems that changes in the official rate are anticipated as much as thirteen months ahead. Thus, the black market exchange rates in Taiwan and South Korea anticipate changes in the official exchange rate but not in the case of India.

III. Conclusions

The importance of this paper arises from the fact that it provides more evidence on the efficiency of financial markets generally, and specifically for a market which does not appear to possess all the characteristics usually assumed to be necessary for efficiency. The results of the paper may also be useful for policy-makers interested in using black market exchange rates as indicators of market trends and as guides for setting the official exchange rates.

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