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Cointegration: Black-Market & Official Exchange Rates In Nine Pacific Basin Countries

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This paper investigates the long-term relationship between the black-market and official exchange rates of nine Pacific basin economies over the period of their financial liberalization from January, 1974, through June, 1989 (186 monthly observations). Using the cointegration modeling technique, all of the pairs of black-official market exchange rates were found to be cointegrated, signifying a long-term equilibrium between each pair. Error-correction models were also estimated for each exchange rate pair, all nine systems were representable in an error-correction stochastic structure. However, in general the stochastic structure of each official rate in relation to the corresponding black-market rate was relatively less sophisticated than the **inverse**. Some of specific results are: a) a few official exchange rates indicated some type of smoothing mechanism used by the central money authority to stabilize its currency value, b) some official exchange rates were representable as either flat or completely unpredictable movement, c) feedback from the black market played a significant role in influencing the official rates' dynamics, and d) most of the black-market rates displayed greater complexity in relation to the corresponding official exchange rates. The overall results seem to suggest that a liberalized official exchange rate may not necessarily align itself with an efficient black-market rate, since the difference between the official and black-market rate characteristics could also be attributable to the factors determining each rate.

I. Introduction

Over the past decade, the Pacific region has emerged in prominence as a center for trade and finance, a fact which promises to persist for

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the next few decades due to its expected high growth rate. This area is also empirically interesting, thanks to an assemblage of economies at varying stages of development: fully industrialized(Japan), newly-industrialized (Hong Kong, Singapore, South Korea, and Taiwan), and soon-to-be-industrialized (Indonesia, Malaysia, the Philippines, and Thailand). Although these nine Asian countries have been liberalizing their financial sectors and have achieved at various stages, currency black markets continue to flourish, even in Japan (with its most liberalized financial markets). Furthermore, like the world's other leading trading countries, these Asian countries adopted a managed-float system in which their currencies were floated, but with frequent intervention to maintain orderly markets and to keep the exchange rate at or near desirable level. However some of them are possibly imposing a certain degree of exchange controls and other non-monetary barriers on free currency trading. These controls and barriers inevitably engender black markets in foreign currencies.

Recently, the behavior of the exchange rates in currency black markets has begun to catch researchers' attention. Culbertson (1975), Dornbusch et al. (1983), and Olgun (1984) suggest that black-market rates are determined by the spread between the official rate and the equilibrium rate. Booth and Mustafa (1991) examined the Turkish markets for U.S. dollars and West German marks and reported finding cointegration between the official and black-market rates, with the latter more volatile and continuously overshooting the centrally-determined official rate. Until now, no study has been conducted on the relationship between black-market rates and official rates of Asian countries, thus this paper attempts to fill this void.

The purpose of this paper is to examine the official and black-market exchange rates in nine Pacific-Basin economies, ascertain their interrelatedness, and attempt to formulate the stochastic structure of each black-market rate in relation to the corresponding official rate, over the period of financial liberalization from January, 1974, through June, 1989. The behavior of the nine currencies (18 time series) with differing degrees of central control is carefully studied. Cointegration tests are performed to establish error-correction models. A form of relationship between black-market and official rates may be found, if possible, for each Asian country and/or for a group of countries and/or for all nine-Asian countries. The results may shed some light on the degree to which each country's official exchange rate aligns itself with its efficient black-market rate.

The paper is organized as follows. Section II describes the data used in this study (time series of nine Asians' black-market and official exchange rates) as well as the modus operandi of the estimating techniques - stochastic structure of the black-market and official exchange rates, cointegration and error-correction processes. In section III, the 18 exchange rate time trends and their volatilities are analyzed, and the empirical results of the stationarity test, cointegrating regressions, and error-correction modeling are reported. Finally, the summary and conclusions are provided is Sector IV.

II. Data and Methodology

The data for this study consist of the average monthly exchange rates for one U.S. dollar in Japanese yen; Korean won; Singapore, Hong Kong, and Taiwanese dollars; Indonesian rupiah; Malaysian ringgit; Philippine peso; and Thai baht. For each currency, the official rate was obtained from the International Monetary Fund's *International Financial Statistics*, While the black-market rate was collected from various issues of *Pick's Currency Yearbook* and *World Currency Yearbook* for the period from January, 1974, through June, 1989, resulting in eighteen time series, each with 186 observations.

Stochastic Structure of Official and Black-Market Rates

According to the Purchasing Power Parity theory, the dynamics of an equilibrium exchange rate may be approximated by:

$$EE_t = P_t - P_t^* \quad (1)$$

where EE_t is the percentage change of the equilibrium value of one U.S. dollar in terms of local currency; P_t and P_t^* are the percentage change in domestic and U.S. price levels. If the two economies are not perfectly integrated, the changes in their price levels will be independent of each other, and the change in the equilibrium exchange rate should fluctuate randomly. In a newly industrialized country, the official exchange rate is usually defined by a basket of the convertible currencies of its major trading partners, one of which is usually the U.S. Thus, a large change in the equilibrium rate may be only partially reflected in the official rate. Even when a significant change in the official rate is required, the local government policy of caution and gradualism may again cause the change to be partially implemented. Finally, other government policies regarding exports, conservation of foreign currency reserves, or purely political reasons may carry a greater weight in the periodic setting of the official exchange rate, which can now be expressed as:

$$OE_t = G_t + \Sigma_i W_i EE_{t-i} \qquad (2)$$

where OE_t is the change in the official exchange rate; G_t a function of other government policies; and W_i the weight allocated to each of the most recent changes in the equilibrium exchange rate. That is to say, the change in the official exchange rate is dictated partly by government policies and partly by the smoothed-over impact from recent changes in the equilibrium rate. Hence, it is reasonable to assume that the official exchange rate in a newly-industrialized country is usually at some distance from its equilibrium value.

On the other hand, the black-market rate's adjustment to the changing circumstances is more rapid, since it is set by presumably well-informed traders with flexibility and the ability to change their quotes at a moment's notice. The currency dealers are assumed to focus on the equilibrium and official rates as their points of reference:

$$BE_t = \pi OE_t + (1-\pi) EE_t \qquad (3)$$

where BE_t is the percentage change in the black-market rate, $0 \leq \pi \leq 1$. In other words, the black-market helps to bridge the gap between a currency's volatile equilibrium rate and its slow-adjusting official rate. For example, if an unexpected inflationary shock caused the equilibrium exchange rate to increase, the black-market rate would almost instantaneously follow in the same direction while the government officials were trying to decide whether or not to take action. Later, either the situation reverses itself and both the equilibrium and black-market rates move back toward the official rate, or the government determines that the new equilibrium is a permanent one and moves the official rate toward the other two rates. Thus, we hypothesize that a long-term affinity between the official and black-market rates exists, and that the black-market rate is more volatile than, and continuously overshoots, the official rate.

Cointegration and Error-Correction Processes

In an analysis of economic time series, differencing is usually performed until stationarity is achieved; an autoregressive-moving-average model is then fitted, and parameters are estimated (Box and Jenkins, 1976). Some information is lost, however, through differencing. Engle and Granger (1987) and Granger (1988) outline an approach on modeling a system of cointegrated time series by combining the properties of unit root test with those necessary for an error-correction presentation. In essence, a system of nonrationally time series may move under the same set of forces so that their interrelationship is quite stable. But the observed system may not always be in equilibrium. Small perturbations can jolt the system out of this stable relationship, but the prevailing forces will push the system back toward the long-run equilibrium. Following Engle and Granger, we took the following steps in estimating the parameters of an error-correction model for a system of cointegrated time series (X_t, Y_t):

1. Stationarity Test Each of the eighteen time series of exchange rates was tested for stationarity by means of two regressions:

$$\triangle X = \alpha_1 + \beta_1 X_{-1} \quad (4)$$

and $$\triangle^2 X = \alpha_2 + \beta_2(\triangle X)_{-1} \qquad (5)$$

where X is a log-transformed exchange rate,

$\triangle$ is lag operator such that $\triangle X = X_t - X_{t-1}$

$X_{-k} = X_{t-k}$ and $(\triangle X)_k = X_{t-k} - X_{t-k-1}$

The series X_t has a unit root -- and, therefore, not stationary -- if β_1 is negative and not statistically different from zero. To ensure that X_t has only one unit root, the second differences of X_t were regressed on its first differences as in (5). The first difference of X_t is stationary if β_2 is significantly different from zero. To test the null hypothesis of $\beta_1 = \beta_2 = 0$, we used the critical value of the test statistic from Table II in Engle and Granger (1987), which was 3.37 at the 5% significance level for 100 observations.

2. Cointegrating Regression The official rate was next regressed on the corresponding black-market rate. The reverse regression was also applied to ascertain the direction of causality. Regression residuals were saved and labeled to identify the two series involved as well as the direction of dependency. Hence, for a pair of time series (X_t and Y_t), two regressions were run:

$$Y_t = \alpha_{yx} + \beta_{yx} X_t + \varepsilon yx_t \text{ (official rate on black-market rate)} \qquad (6)$$

and $$X_t = \alpha_{xy} + \beta_{xy} Y_t + \varepsilon xy_t \text{ (black-market rate on official rate)} \qquad (7)$$

The standard error of regression and the Durbin-Waston statistic of the residuals were examined. The null hypothesis is no cointegration, i.e., $\beta = 0$ and D-W $= 0$.

The Dickey-Fuller and augmented Dickey-Fuller regressions (Fuller, 1976; Dickey and Fuller, 1981) were next performed on each residual series in order to detect a unit root and hence the series' non-stationarity. The two regression equations are:

$$\text{DF}: \ \triangle\varepsilon_t = -\phi\varepsilon_{t-1} \tag{8}$$

and

$$\text{ADF}: \ \triangle\varepsilon_t = -\phi\varepsilon_{t-1} + \theta_1\triangle\varepsilon_{t-1} + \theta_1\triangle\varepsilon_{t-2} + \cdots + \theta_q\triangle\varepsilon_q \tag{9}$$

If ϕ is statistically significant, the residuals are stationary; that is, the two original non-stationary time series are cointegrated, and the errors are simply deviations from equilibrium. Stationary deviations imply that the original time series can be represented as an error-correction process, with the deviations acting as control on future movements. In addition, if any of the θs are statistically significant, an order higher than unity is indicated for the autoregressive process in the residuals.

3. Error-Correction Modeling A cointegrated system of two time series (X_t, Y_t) may be represented by an error-correction process:

$$\triangle X_t = \beta_1 \varepsilon xy_{t-1} + exy_t \tag{10}$$

$$\triangle Y_t = \beta_2 \varepsilon yx_{t-1} + \gamma\triangle X_t + eyx_t. \tag{11}$$

where the system is written in a triangular form, with X_t being exogenous and its movement regulated by the most recent perturbations, and with Y_t depending on the most recent change in X_t as well as on the error term. Each of the above equations is called "restricted vector autoregressions" (RVAR) because the parameters β_1, β_2, and γ are estimated by constraining the change in X_t and Y_t to be dependent on the cointegrating residuals ε_{t-1}. Terms involving lags ($\triangle X_{t-k}$ and $\triangle Y_{t-k}$, $k>1$) may be added to the above system of simultaneous equations, when warranted, to form an augmented restricted vector autoregression (ARVAR).

A test may also be performed to ascertain whether the system can be written in the levels alone, i.e.,

$$\triangle X_t = \alpha_1 + \beta_1 X_{t-1} + \beta_2 Y_{t-1} + exy_t \quad (12)$$

$$\triangle Y_t = \alpha_2 + \beta_3 X_{t-1} + \beta_4 Y_{t-1} + \gamma \triangle X_t + eyx_t \quad (13)$$

where each change in X_t and Y_t is not constrained to be a function of the recent deviations from equilibrium ("unrestricted vector autoregression" or UVAR). If none of the βs are significant, the system can adequately be represented in changes alone, otherwise the system's dynamics are also dependent on the levels of the variables. Terms involving lags in changes ($\triangle X_{t-k}$ and $\triangle Y_{t-k}$, where $k > 1$) may be included if a higher-order system is called for. The information gained on UVAR can be incorporated into the error-correction equation to arrive at the final, comprehensive model.

III. Empirical Results

Figures 1 through 3 present plots of the nine official / black-market pairs of exchange rates, grouped according to their level of economic development. Overall, the graphs appear to show a major pattern change of these official and black-market exchange rates in 1985. Basically, the change reflected the U.S. dollar's depreciation *vis-à-vis* other major currencies, a drastic appreciation of the Japanese yen in 1985, and a subsequent step-up of Japanese investment in Asian countries (Ying, 1990). Japan's investment in Asia also reflects a relocation overseas of its industries owing to the high cost of domestic labor. Meanwhile, South Korea, Taiwan, Hong Kong, and Singapore also faced rising labor costs and were relocating some of their industries to other Asian countries, principally Thailand and Malaysia, in order to stay competitive in the international markets.

The mean, standard deviation, and coefficient of variation for each rate, computed annually as well as for the entire fifteen and half-year period, are presented in Table 1. The average rates confirm our visual observation of 1985 as a pivotal point for the U.S. dollar, resulting in its steep drop against the Japanese yen, a moderate depreciation against Singapore and Taiwanese dollars, a slight appreciation against the Malaysian ringgit, Philippine peso, and Thai Baht, and a sharp appreciation against the South Korean won, Indonesian rupiah, and Hong Kong dollar. A major change around 1985 in the variability of some exchange rates is also noticeable: while the standard deviation of both official and black-market Korean won and Indonesian rupiah, the official Philippine peso, and Taiwanese dollar increased dramatically, that of the two yen rates dropped slightly. For the Thai Baht, Malaysian ringgit, and Hong Kong dollar, however, the pre-1985/post-1984 change in the standard deviation of the official rate is in the opposite direction of that of the black-market rate. All these result in an interesting change in the coefficients of variation: most currencies recorded an increase, some of which (e.g. the Taiwanese official rate) was quite substantial, while the CV of the official Hong Kong dollar decreased considerably.

There appeared to be a structural change in the Singapore dollar's value relative to the U.S. dollar at the beginning of 1978 when the U.S. dollar went down from about S$2.45 to S$2.17. The black-market rate stays close to the official rate for most of the six-year period, 1978-1984. A separation is quite visible during 1976 and from 1985 on. A similar pattern of behavior can be seen in the plots for the Malaysian ringgit black-market and official rates. The only difference between these two closely-related currencies is that the ringgit depreciated against U.S. dollar from 1980 on, while the Singapore dollar either stabilized or appreciated.

Two distinct characteristics can be detected in the Hong Kong dollar. Up to 1985, the black-market rate closely tracked the official rate, then fluctuated considerably about the official rate (the standard deviation of the black-market rate increased from .0221 in 1984 to .2922 in 1985, and to .3084 in 1986). Meanwhile, the official rate began to depreciate against the U.S. dollar in 1980 and continued doing so until 1985, when it suddenly became flat at about HK$7.80.

Five currencies (South Korean won, Taiwanese dollar, Indonesian rupiah, Thai baht, and Philippine peso) appear to be under a great extent of central control. This is quite evident, in light of the contrasting behavior between the official rate, which remained fixed for long durations, and the black-market rate, which displayed a very high degree of volatility. The South Korean won, for instance, was pegged at 484 to the U.S. dollar during 1975-1979, while the black-market rate indicated the won's overvaluation by generally remaining at 500 or above during the same period. The won was eventually devalued to 580 in the first two months of 1980 before being floated against the U.S. dollar, at which time it promptly deteriorated further and bottomed out at 892.5 in November 1985 before reversing course. The black-market rate, meanwhile, fluctuated around a value of 850 during the six-year period of 1983-88 before joining the official rate at around 670 in 1989.

Essentially the same story can be gleaned from the Indonesian rupiah and Thai baht. The official rate of both currencies was pegged at a certain level for a long duration while the black-market rate fluctuated considerably about the official rate, even as the latter was devalued in stages. After 1985, the baht appeared to strengthen while the rupiah continued its descent, with the black-market recording ever higher premium. Finally, the Taiwanese dollar and Philippine peso display similar characteristics as the rupiah: when the official rate was pegged to U.S. dollar during 1974-85, each black-market rate as a rule registered a substantial premium over the official rate.

Correlation coefficients were next computed each year for each official/black-market pair of exchange rates and reported in Table 2. The correlation for the entire fifteen-and-one-half year period is positive and highly significant for every pair, with a minimum of .9171 for the Taiwanese dollar. Annual correlation coefficients, however, tell a different story. The Japanese yen exhibits the closest and most consistent relationship, followed by the Singapore dollar, the Malaysian ringgit, and the Hong Kong dollar. As mentioned previously, these four markets happened to be the more liberalized among our nine sample countries. The relationship for the other five markets appears intermittent, with some periods when the official rate was fixed and the correlation coefficient could not be calculated (Indonesian rupiah and Korean won), other periods when the correlation was negative-- sometimes highly significantly so (the Philippine peso in 1980, Indonesian rupiah in 1989, and the Korean won in 1984 and 1986), and still other periods when the more typical positive relationship was found. The table generally confirms the story derived from the plots, with the Korean won and Taiwanese dollar appearing to be more freely floating from 1982 through 1989.

2. Test for Nonstationarity

The results of the unit-root test are reported in Table 3. In all eighteen series, β_1 was not statistically different from zero; in fifteen out of eighteen series, the parameter β_1 was negative. The exceptions were the official Taiwanese dollar, Indonesian rupiah, and Philippine peso. When the second differences were regressed on the first differences as in equation (5), the parameter β_2 of every series was significant, indicating stationarity in the first differences. Hence, each of the eighteen time series had exactly one unit root and was therefore non-stationary.

3. Cointegrating Regressions

Table 4 reports, for each pair of exchange rates, the results from the cointegrating regressions (CR), the Dickey-Fuller regression (DF), and the augmented Dickey-Fuller regression (ADF) of their residuals. The standard error of regression and the Durbin-Watson statistic are also listed. Finally, the reverse regression was also performed.

All cointegration regressions in Panel A yielded very significant parameters — with the smallest t-statistic of 32.88 for the Taiwanese dollar — concurring with their high correlation that was calculated earlier. Every Durbin-Watson statistic was large and significantly different from zero.

The results for stationarity test for the residuals, together with the number of lags of other significant explanatory variables, are reported in Panel B of Table 4. Each ϕ had the correct sign and was statistically significant, implying that the cointegrating residuals had no unit roots. From these pieces of overwhelming evidence, it can thus be concluded that each pair of the official/black-market exchange rates was cointegrated, indicating a long-term equilibrium relationship between each pair of them.

4. Error-Correction Modeling

The unrestricted and restricted vector autoregressions were next applied to the first differences of all eighteen series. Table 5 reports the parameter estimates, their t-statistic, standard error of the regression, and the Durbin-Watson statistic of the residuals for each exchange rate. In six currencies, the error-correction parameter was statistically significant (and with the correct sign) in all of the black-market rates but in none of the official rates, making each official rate exogenous to the corresponding black- market rate. For the Indonesian rupiah and Philippine peso, however, the direction of influence was from the black-market to the official rate; and for the Malaysian ringgit, the dynamics of both official and black-market rate were significantly influenced by the error-correction term. To accentuate both the similarities and individual characteristics of the nine systems of exchange rates, the final model of their stochastic structure is restated here in a vector-autoregressive form, using L as the backshift operator: $L(X_t) = X_{t-1}$.

Japanese yen

$$(1+.14784L^6)\ \triangle OJY_t = .145331\ \triangle BJY_{t-1} + eoj_t$$

$$\triangle BJY_t = -1.029896\ \varepsilon jbo_{t-1} + ebj_t$$

This was a closed-loop, flexible system in which the previous month's change in black-market yen, together with a sixth-lagged change in the official rate, exerted a significant influence on the official yen's dynamics. The black-market rate, in turn, was governed solely by its long-term relationship with the official rate via the error-correction term.

South Korean won

$$\triangle OKW_t = .105404 - .015694 \triangle BKW_{t-1} + eok_t$$

$$(1 - .166363L) \triangle BKW_t = -.161743\ \varepsilon kbo_{t-1} + ebk_t$$

The official Korean won displayed a positive trend and also received significant influence from the previous month's change in the black-market rate. The black-market exhibited a first-order autoregressivity while being controlled by its long-term affinity with the official rate via the error-correction term.

Singapore dollar

$$(1 + .22753L^7)\ \triangle OSD_t = eos_t$$

$$(+.161695L^8)\ \triangle BSD_t = -.964742\ \varepsilon sbo_{t-1} - .214266 \triangle OSD_{t-6} + ebs_t$$

Both time series followed an autoregressive process: seventh order for the official rate, and eight order for the black-market one. In addition to the short-term influence from the error- correction term, the black-market rate also had as significant explanatory variable the change in official rate six months prior.

Taiwanese dollar

$$(1 - .265734L^3)\ \triangle OCD_t = -.079863 + .021502 BCD_{t-1} + eoc_t$$

$$(1 + .190613L) \triangle BCD_t = -.203145\ \varepsilon cbo_{t-1} + ebc_t$$

Of the eighteen currencies examined, only the official Taiwanese dollar displayed a negative trend, signifying a definite appreciation of that currency against the U.S. dollar. It was also the only series having a level variable (BCD_{t-1}) as its significant predictor. Combined with a third-order autoregressivity, the model indicates that the central monetary authority might have applied some type of smoothing formula based on quarterly rate of change, while accommodating to developments in the black-market over the previous month. In comparison, the black- market rate appeared more efficient, with only a first-order autoregressivity in evidence. Interestingly, no trend was visible in the dynamics of the black-market rate, probably because it was already incorporated in the error-correction term.

Thai Baht

$$\triangle OTB_t = eot_t$$
$$\triangle BTB_t = .42383\, etbo_{t-1} - (.489987L^4 - .336822L^5 + .594763L^8)\triangle OTB_t + ebt_t$$

The official rate was a simple random walk. Its black-market counterpart was more complicated and less efficient, however, showing significant impact from the change in the official rate four, five, and eight months prior, in addition to the error-correction term.

Malaysian ringgit

$$\triangle OMR_t = -.146063 + .150305\, \triangle BMR_{t-6} + eom_t$$
$$(1 + .210558^8)\triangle BMR_t = -.515346\, embo_{t-1} + ebm_t$$

This is the only system in which the error-correction term was significant in the dynamics of both official and black-market rates. The official ringgit was also influenced by feedback from the black market with six months' lag. The black-market rate reached even farther back with an eight-lagged autoregressive term as the other significant explanatory variable besides the cointegrating residuals.

Hong Kong dollar

$$(1 + .155015L^2)\triangle OHD_t = .002809 + eoh_t$$
$$(1 - .199299L^4 - .145891L^7)\triangle BHD_t = -.494933\, ehbo_{t-1} + ebh_t$$

The official rate exhibited a second-order autoregressivity, with a positive trend, while the dynamics of its black-market rate suggested fourth and seventh lag autoregressive impact, in addition to the error-correction mechanism.

Indonesian rupiah

$$\triangle OIR_t = .008165 - .14561\ \varepsilon iob_{t-1} + eoi_t$$
$$\triangle BIR_t = .009521 + ebi_t$$

The significant error-correction term in the official rupiah rate indicated exogeneity of the black-market rate. Combined with a positive trend in both rates, our model suggested a depreciating currency, with the monetary authority moving cautiously to provide for smooth and gradual movement of the exchange rate in order not to aggravate the problem.

Philippine peso

$$(1 - .329724L^4 + .16027L^7)\ \triangle OPP_t = .005187 - .112499\ \varepsilon pob_{t-1} - (.150193L^7 - .169499L^8)\triangle BPP_t + eop_t$$
$$(1 - .211087L^8)\triangle BPP_t = -.443172\triangle OPP_{t-1} + 253107\triangle OPP_{t-2} + ebp_t$$

The peso is another currency that had significant error-correction term as a predictor of the official rate instead of the black-market rate. Lagged influence from both the black- market and official rates as far back as seven and eight months prior were detected. The black-market rate was the simpler of the two, with only detectible impact from an eight-lagged autoregressive term and from the change in official rate of the previous two months. The official rate, on the other hand, not only displayed a seventh-order autoregressivity, but also received an impact from the black-market, both in the short run via the error-correction mechanism and in the long-run from the seventh- and eight-lagged changes.

IV. Summary and Conclusion

This paper examined the relationship between the black- market and official foreign exchange rates of nine Pacific-Basin currencies: Japanese yen, South Korean won, Hong Kong, Singapore, and Taiwanese dollars, Indonesian rupiah, Malaysian ringgit, Philippine peso, and Thai baht. Using 186 monthly observations from January, 1974, through June, 1989, nine pairs of time series representing the price of one U.S. dollar in local currency were analyzed.

First, a test for stationarity was applied to individual time series. All eighteen time series were found to have a unit root, indicating non-stationarity. Following Engle and Granger, the cointegration test was applied to each of the nine official/black- market pairs of exchange rates. Each pair was found to be cointegrated, indicating a long-term relationship between the black-market and official rates for the U.S. dollars in every one of nine Pacific-Basin economies.

Error-correction models were then estimated for each exchange-rate pair. It was found that all nine systems were representable in an error-correction structure, through which mechanism six official rates led while two lagged their black- market counterparts, and one reprocating system.

The official exchange rates of five currencies (Japanese yen, Singapore, Taiwanese, and Hong Kong dollars, and Philippine peso) followed an autoregressive process. This may be interpreted as some type of smoothing mechanism applied by the central monetary authority to stabilize their currency value. Two other official rates (Indonesian rupiah and Thai baht) were representable as a random walk, suggesting that its movement was either flat or completely unpredictable. For the remaining two currencies Korean won and Malaysian ringgit, feedback from the black market played a significant role in influencing the official rate's dynamics.

The black-market rates displayed generally more complex characteristics, presumably because the black-market dealers utilized several sources of information to arrive at an optimal rate. In six currencies (Korean won, Singapore, Hong Kong, and Taiwanese dollars, Malaysian ringgit,. and the Philippine peso) and autoregressive process of vary order was detected. This could be related to the differing levels of efficiency in the black markets. The most deterministic system appeared to be the Indonesian rupiah, with positive trend and the error-correction structure. In terms of parsimony, the Japanese yen led the group, with single explanatory variable, followed by the Korean won and the Taiwanese dollar, where input from own rate one month prior and the error-correction term comprise the entire system. It is surprising to see Singapore and Hong Kong in the same group with such less efficient markets as the Philippines, Thailand, and Malaysia, where the black-market rate registered a significant impact from past changes in exchange rate — either official or black-market — after as long as six or seventh months' lag. Nevertheless, a liberalized official exchange rate may not necessarily align itself with an efficient black-market rate, since the difference between the official and black-market rate characteristics could also be attributable to the factors determining each rate. While government officials might set exchange rates to influence some macroeconomic variables or to carry out a certain policy, black-market dealers seem to follow their own strategy. On one hand, they attempt to max their profit while trying to see clues to future government actions. On the other, they try not to provoke penalties that might be imposed if their profit-making actions happened to jeopardize government policy.

Figure 1 Japanese yen

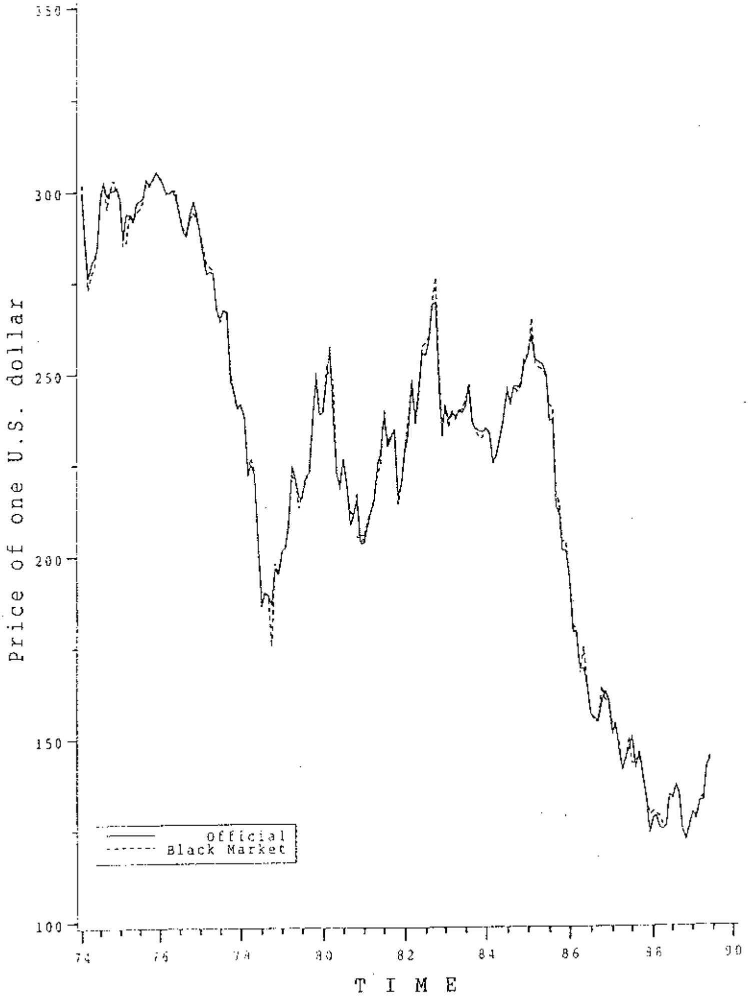

Figure 2 Newly Industrialized Countries

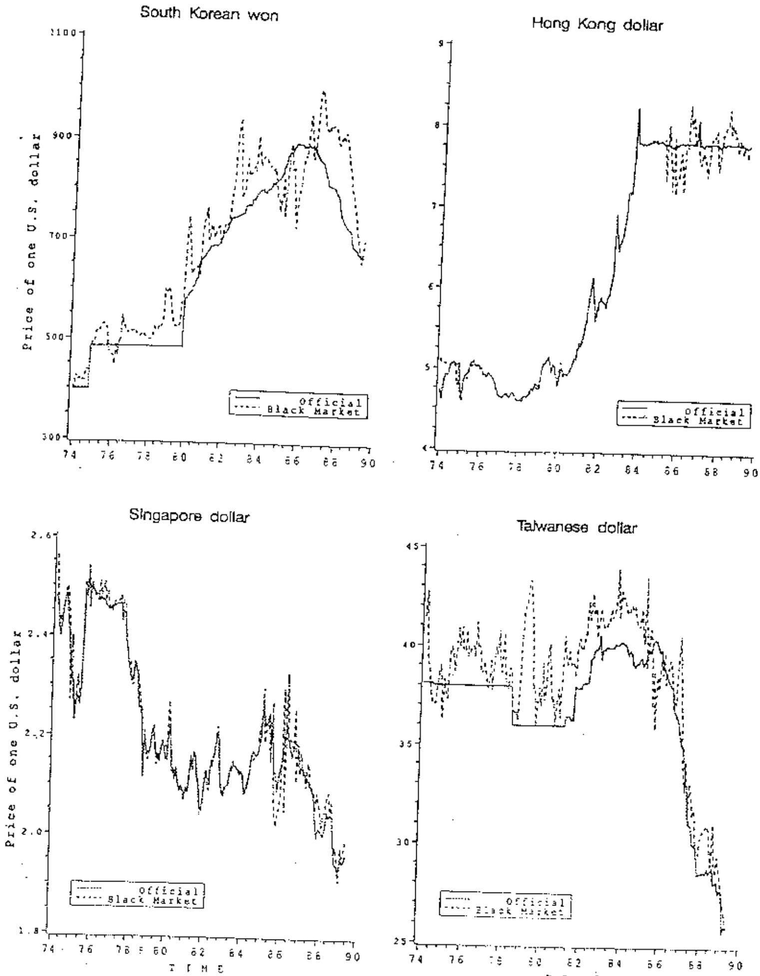

Figure 3 Emerging Economies

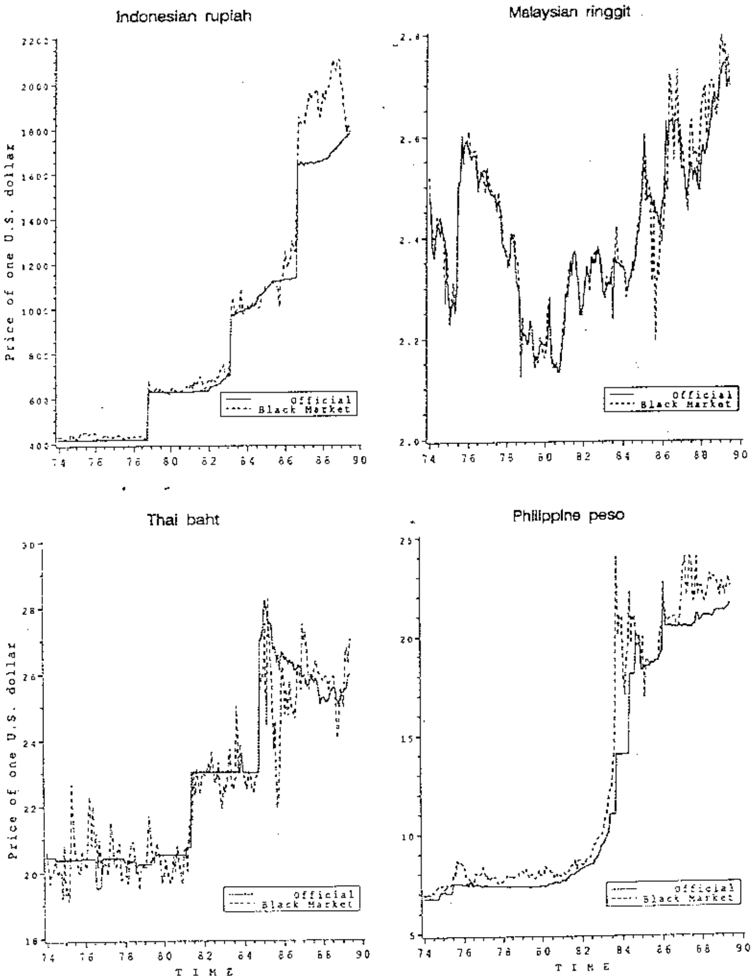

Table 1 Summary Statistics of Official and Black-Market Exchange Rates

A. Averages

Year		Japan Yen	Korea Won	Singapore $	Taiwan $	Thai Baht	Malaysia Ringgit	Hong Kong $	Indonesia Rupiah	Philippine Peso
74	Off	292.36	405.92	2.427	38.050	20.412	2.405	4.9355	415.00	6.820
	B-M	291.83	425.17	2.443	38.571	20.083	2.412	5.0092	426.42	7.138
75	Off	297.26	484.00	2.381	38.000	20.379	2.415	4.9420	415.00	7.275
	B-M	296.00	506.83	2.391	39.329	20.354	2.420	4.9104	438.83	7.895
76	Off	296.31	484.00	2.468	37.970	20.108	2.540	4.8848	415.00	7.457
	B-M	296.25	494.25	2.479	39.775	20.871	2.544	4.8762	427.42	7.905
77	Off	266.84	484.00	2.434	37.970	20.400	2.456	4.6622	415.00	7.400
	B-M	267.50	510.00	2.446	38.962	20.408	2.467	4.6496	426.42	7.801
78	Off	208.04	484.00	2.265	36.985	20.251	2.307	4.6900	450.00	7.365
	B-M	207.75	521.46	2.278	38.158	20.158	2.325	4.6667	464.17	7.857
79	Off	221.57	484.00	2.175	36.000	20.365	2.189	4.9955	625.00	7.362
	B-M	221.25	556.83	2.172	39.821	20.554	2.184	4.9783	630.67	7.966
80	Off	225.80	612.64	2.135	36.000	20.500	2.174	4.9722	625.00	7.488
	B-M	226.50	671.00	2.143	37.862	20.046	2.180	4.9758	636.58	8.035
81	Off	221.72	682.03	2.109	36.812	22.013	2.301	5.6087	628.50	7.899
	B-M	221.67	716.50	2.109	39.492	21.800	2.312	5.6017	662.92	8.298
82	Off	248.20	733.09	2.139	39.095	23.000	2.339	6.1058	661.90	8.565
	B-M	250.00	805.25	2.140	41.337	22.900	2.338	6.1008	698.00	9.079
83	Off	238.28	774.55	2.117	40.057	23.042	2.315	7.3013	933.23	11.224
	B-M	250.00	841.75	2.117	41.900	23.150	2.334	7.2850	959.17	14.285
84	Off	238.77	807.03	2.139	39.582	23.659	2.349	7.8171	1030.17	16.846
	B-M	238.89	828.39	2.138	41.746	23.292	2.353	7.8117	1026.17	19.779
85	Off	235.06	872.02	2.194	39.870	27.097	2.479	7.7880	1112.92	18.573
	B-M	236.58	807.51	2.167	39.333	25.067	2.428	7.5900	1105.50	18.802
86	Off	166.70	881.21	2.180	37.669	26.287	2.591	7.8190	1299.58	20.511
	B-M	167.32	900.93	2.180	38.762	25.367	2.585	7.8033	1452.50	20.951
87	Off	143.07	820.08	2.099	31.614	25.685	2.515	7.7967	1645.00	20.615
	B-M	143.44	926.08	2.117	32.287	26.337	2.551	7.6992	1910.42	22.833
88	Off	128.49	727.20	2.010	28.567	25.281	2.627	7.8073	1689.58	21.081
	B-M	129.28	849.58	2.041	30.142	25.462	2.678	7.9650	2024.58	22.483
89	Off	134.74	670.88	1.949	26.720	25.608	2.721	7.7905	1757.50	21.394
	B-M	135.00	687.17	1.958	27.308	26.133	2.753	7.7350	1848.33	22.550
Ave	Off	225.54	649.75	2.209	36.619	22.663	2.410	6.1949	854.17	12.076
	B-M	225.79	690.65	2.216	38.138	22.511	2.419	6.1800	917.03	13.057

B. Standard Deviations

Year		Japan Yen	Korea Won	Singapore $	Taiwan $	Thai Baht	Malaysia Ringgit	Hong Kong $	Indonesia Rupiah	Philippine Peso
74	Off	9.694	24.59	0.0539	0.052	0.039	0.0447	0.1487	0.00	0.119
	B-M	11.151	21.58	0.0702	1.880	0.418	0.0586	0.0981	7.63	0.193
75	Off	5.421	0.00	0.1160	0.000	0.010	0.1507	0.1433	0.00	0.242
	B-M	6.410	20.66	0.1181	1.158	0.945	0.1528	0.1522	11.31	0.582
76	Off	5.087	0.00	0.0125	0.000	0.432	0.0245	0.0905	0.00	0.080
	B-M	5.189	29.89	0.0188	0.734	0.765	0.0363	0.0901	7.49	0.303
77	Off	15.236	0.00	0.0416	0.000	0.000	0.0466	0.0250	0.00	0.017
	B-M	15.745	5.54	0.0412	0.903	0.536	0.0484	0.0227	5.98	0.233
78	Off	20.519	0.00	0.0732	1.029	0.116	0.0862	0.0735	81.74	0.005
	B-M	21.705	27.04	0.0677	1.450	0.469	0.0806	0.0695	92.11	0.148
79	Off	14.643	0.00	0.0193	0.000	0.137	0.0248	0.1117	0.00	0.026
	B-M	14.937	30.87	0.0229	2.713	0.526	0.0271	0.1290	8.35	0.159
80	Off	16.726	29.30	0.0411	0.000	0.000	0.0412	0.1019	0.00	0.075
	B-M	16.611	42.42	0.0565	1.273	0.353	0.0497	0.0959	8.93	0.176
81	Off	11.396	9.92	0.0403	0.846	1.222	0.0493	0.2926	2.15	0.189
	B-M	11.089	20.58	0.0414	0.667	1.052	0.0480	0.2744	17.77	0.298
82	Off	13.698	14.15	0.0400	0.913	0.000	0.0299	0.3759	18.13	0.281
	B-M	14.635	79.62	0.0463	0.874	0.452	0.0343	0.3695	23.86	0.538
83	Off	3.733	16.42	0.0225	0.139	0.144	0.0356	0.5406	110.17	1.774
	B-M	4.441	30.83	0.0253	0.883	0.763	0.0380	0.5269	112.29	4.747
84	Off	8.564	10.92	0.0343	0.400	1.577	0.0477	0.0167	30.40	2.604
	B-M	8.823	35.13	0.0383	0.489	1.228	0.0585	0.0221	32.43	1.426
85	Off	22.327	20.48	0.0619	0.407	0.659	0.0483	0.0198	13.08	0.208
	B-M	21.337	50.06	0.0951	1.991	1.969	0.1146	0.2922	43.99	0.814
86	Off	11.888	9.00	0.0542	1.227	0.155	0.0586	0.0560	252.00	0.606
	B-M	12.464	57.41	0.0881	0.958	0.601	0.1127	0.3084	287.14	0.588
87	Off	8.228	23.15	0.0435	2.231	0.254	0.0204	0.0181	5.54	0.242
	B-M	7.393	23.83	0.0342	2.012	0.617	0.0552	0.1743	48.12	0.931
88	Off	4.935	29.20	0.0351	0.278	0.175	0.0538	0.0062	25.40	0.147
	B-M	4.520	58.48	0.0342	0.920	0.634	0.0459	0.1321	62.54	0.454
89	Off	6.683	5.40	0.0128	0.991	0.242	0.0208	0.0115	12.28	0.139
	B-M	7.077	21.57	0.0293	1.125	0.823	0.0372	0.0814	75.14	0.316
Ave	Off	11.318	12.25	0.0430	0.517	0.325	0.0499	0.13070	35.15	0.431
	B-M	11.612	35.14	0.0527	1.256	0.757	0.0632	.1805	52.10	0.758

C. Coefficients of Variation

Year		Japan Yen	Korea Won	Singapore $	Taiwan $	Thai Baht	Malaysia Ringgit	Hong Kong $	Indonesia Rupiah	Philippine Peso
74	Off	0.03316	0.06058	0.02221	0.00137	0.00191	0.01859	0.03013	0.00000	0.01745
	B-M	0.03821	0.05076	0.02874	0.04874	0.02081	0.02430	0.01958	0.01789	0.02704
75	Off	0.01824	0.00000	0.04872	0.00000	0.00049	0.06240	0.02900	0.00000	0.03326
	B-M	0.02166	0.04076	0.04939	0.02944	0.04643	0.06314	0.03100	0.02577	0.07372
76	Off	0.01717	0.00000	0.00506	0.00000	0.02148	0.00965	0.01853	0.00000	0.01073
	B-M	0.01752	0.06048	0.00758	0.01845	0.03665	0.01427	0.01848	0.01752	0.03833
77	Off	0.05710	0.00000	0.01709	0.00000	0.00000	0.01897	0.00536	0.00000	0.00230
	B-M	0.05886	0.01086	0.01684	0.02318	0.02626	0.01962	0.00488	0.01402	0.02987
78	Off	0.09863	0.00000	0.03232	0.02782	0.00573	0.03736	0.01567	0.18164	0.00068
	B-M	0.10448	0.05185	0.02972	0.03800	0.02327	0.03467	0.01489	0.19844	0.01884
79	Off	0.06609	0.00000	0.00887	0.00000	0.00673	0.01133	0.02236	0.00000	0.00353
	B-M	0.06751	0.05544	0.01054	0.06813	0.02559	0.01241	0.02591	0.01324	0.01996
80	Off	0.07407	0.04783	0.01925	0.00000	0.00000	0.01895	0.02049	0.00000	0.01002
	B-M	0.07334	0.06322	0.02636	0.03362	0.01761	0.02280	0.01927	0.01403	0.02190
81	Off	0.05140	0.01454	0.01911	0.02298	0.05551	0.02143	0.05217	0.00342	0.02393
	B-M	0.05002	0.02872	0.01963	0.01689	0.04826	0.02076	0.04899	0.02681	0.03591
82	Off	0.05519	0.01930	0.01870	0.02335	0.00000	0.01281	0.06156	0.02739	0.03281
	B-M	0.05854	0.09888	0.02164	0.02114	0.01974	0.01467	0.06057	0.03418	0.05926
83	Off	0.01567	0.02120	0.01063	0.00347	0.00625	0.01538	0.07404	0.11805	0.15805
	B-M	0.01867	0.03663	0.01195	0.02107	0.03296	0.01628	0.07233	0.11707	0.33231
84	Off	0.03587	0.01353	0.01604	0.01011	0.06666	0.02031	0.00214	0.02951	0.15458
	B-M	0.03693	0.04241	0.01791	0.01171	0.05272	0.02486	0.00283	0.03160	0.07210
85	Off	0.09498	0.02349	0.02821	0.01021	0.02432	0.01948	0.00254	0.01175	0.01120
	B-M	0.09019	0.06199	0.04389	0.05062	0.07855	0.04720	0.03850	0.03979	0.04329
86	Off	0.07131	0.01021	0.01110	0.03257	0.00590	0.02262	0.00716	0.19391	0.02955
	B-M	0.07449	0.06372	0.04041	0.02471	0.02369	0.04360	0.03952	0.19769	0.02807
87	Off	0.05751	0.02823	0.02072	0.07057	0.00989	0.00811	0.00232	0.00337	0.01174
	B-M	0.05154	0.02573	0.01615	0.06232	0.02343	0.02164	0.02264	0.02519	0.04077
88	Off	0.03841	0.04015	0.01746	0.00973	0.00692	0.02048	0.00079	0.01503	0.00697
	B-M	0.03496	0.06883	0.01872	0.03052	0.02490	0.01714	0.01659	0.03089	0.02019
89	Off	0.04960	0.00805	0.00657	0.03709	0.00945	0.00764	0.00148	0.00699	0.00650
	B-M	0.05242	0.03139	0.01496	0.04120	0.03149	0.01351	0.01052	0.04065	0.01401
Ave	Off	0.05018	0.01885	0.01944	0.01413	0.01435	0.02068	0.02110	0.04115	0.03571
	B-M	0.05143	0.05088	0.02379	0.03293	0.03365	0.02612	0.02921	0.05681	0.05805

Table 2 Correlation Coefficients between Official and Black-Market Exchange Rates

Year	JY	KW	SD	CD	TB
74	.9857**	.8355**	.7662**	.5162	.0625
75	.9375**	.	.9875**	.	.0721
76	..9672**	.	.4127	.0000	.2253
77	.9962**	.	.9796**	.0000	.0000
78	.9856**	.	.9820**	.4921	.3788
79	.9944**	.	.9298**	.	-.3852
80	.9694**	-.0050	.9210**	.	.
81	.9887**	-.5751	.9814**	.1779	.8499**
82	.9867**	.7534**	.9808**	.4101	.
83	.9662**	.7571**	.9827**	.7080**	.1522
84	.9947**	-.9078**	.9468**	.5817*	.9819**
85	.9955**	-.0499**	.9641**	-.6926*	.7044*
86	.9835**	-.7666**	.5318	.0279	.2782
87	.9160**	.7527**	.7620**	.8600	.3586
88	.9844**	.8776**	.9286**	.6918*	.4322
89	.9967**	.7170	.9474**	.8980	.6655
74-89	.9990**	.9424	.9812**	.9065**	.9287**

Year	MR	HD	IR	PP
74	.5604	-.4483	.	.6077*
75	.9937**	.9820**	.	.9005**
76	.8421**	.9694**	.	-.0141
77	.9335**	.9402**	.	.7703**
78	.9653**	.9864**	.9931**	-.3779
79	.9374**	.9744**	.	.2290
80	.8828**	.8770**	.	-.5949*
81	.9632**	.9960**	.3719	.8872**
82	.9603**	.9982**	.5942*	.9260**
83	.5174	.9975**	.9437**	.9687**
84	.9953**	.5966*	.7024*	.4188
85	.6843*	.3768	1524	.3264
86	.8294**	.3809	.9721**	.8866**
87	.6890*	.3660	.2079	.0000
88	.4760	.4542	.7267**	:0086
89	.7128	.0100	-.8488**	.3300
74-89	.9641**	.9943**	.9916**	.9784**

Notes: * Significant beyond the .05 level
** Significant beyond the .01 level

JY = Japanese yen Kw = South Korean won SD = Singapore dollar
CD = Taiwanese dollar TB = Thai baht MR = Malaysian ringgit
HD = Hong Kong dollar IR = Indonesia rupiah PP = Philippine peso

Table 3 Test for Unit Roots of Each Time Series

The first differences of each exchange rate is regressed on its lagged level:

$$\triangle X = \alpha_1 + \beta_2 X_{-1}.$$

X has a unit root if β_1 is negative and not statistically different from zero. The second difference is then regressed on the lagged first difference:

$$\triangle^2 X = \alpha_2 + \beta_2 \triangle X_{-1}.$$

The first difference is stationary if β_2 is significantly different from zero. t-statistics (in parentheses) is used to test the null hypothesis of β_i = 0

		α_1	β_1	α_2	β_2
JY	off	.024828 (.481)	-.005339 (-.559)	-.003351 (-1.343)	-.899713 (-12.22)
	B-M	.030366 (.565)	-.006370 (-.64)	-.003480 (-1.345)	-.946432 (-12.85)
KW	off	.080422 (2.095)	-.012045 (-2.024)	.002644 (1.708)	-.941425 (-12.72)
	B-M	.154329 (2.029)	-.023265 (-1.992)	.002773 (.916)	-.904247 (-12.24)
SD	off	.017728 (1.397)	-.024004 (-1.501)	-.001304 (-1.199)	-1.044697 (-14.10)
	B-M	.055305 (2.65)	-.071402 (-2.726)	-.001743 (-1.031)	-1.399166 (-20.70)
CD	off	-.087037 (-3.183)	.023616 (3.108)	-.001813 (-2.223)	-.863945 (-11.77)
	B-M	.060187 (.708)	-.017246 (-.738)	-.003439 (-1.426)	-1.293530 (-18.28)
TB	off	.087542 (.811)	-.008431 (-.774)	.001309 (1.103)	-1.012471 (-13.66)
	B-M	.178479 (2.198)	-.056966 (-2.182)	.001995 (.758)	-1.314798 (-18.68)
MR	off	.023994 (1.388)	-.026820 (-1.364)	.000526 (.424)	-1.066144 (-14.42)
	B-M	.053012 (2.26)	-.059793 (-2.251)	.000652 (.375)	-1.249869 (-17.44)
HD	off	.008433 (.758)	-.003188 (-.519)	.002680 (1.972)	-.937271 (-12.75)
	B-M	.11800 (.749)	-.005360 (-.615)	.002731 (1.459)	-1.224206 (16.96)

IR	off	.007527	.000049		.008076	-1.023323
		(.168)	(.007)		(2.229)	(13.81)
	B-M	.020761	-.001966		.007938	-1.021372
		(.427)	(-.271)		(1.981)	(-13.78)
PP	off	.003739	.001064		.006740	-1.069837
		(.306)	(.211)		(2.850)	(-14.47)
	B-M	.018314	-.004879		.007775	-1.210211
		(.843)	(-.561)		(1.929)	(-16.69)

Table 4 Cointegrating Regression

A. Cointegrating Regression

For each pair of variables X and Y, two regressions were performed and residuals were analyzed to ascertain stationarity:

$$Y_t = \alpha_y + \beta_y X_t + \varepsilon yx_t, \quad \text{and} \quad X_t = \alpha_x + \beta_x Y_t + \varepsilon xy_t$$

	Official on Black Market			Black Market on Official		
	α_o	β_o	σ D-W	α_o	β_o	σ D-W
JY	-.023935 (-1.371)	1.004181 (310.24)	.0114 2.17387	.034071 (1.972)	.993936 (310.24)	.0114 2.175291
KW	.254753 (1.855)	.951500 (45.1)	.0732 .25719	.294178 (2.134)	.963790 (45.1)	.0736 .27608
SD	.032851 (2.875)	.955298 (66.55)	.0135 1.91172	-.001383 (-.115)	1.005039 (66.55)	.0138 1.99421
CD	.377121 (30851)	.885228 (32.88)	.0405 .54967	.164767 (1.56)	.965332 (32.88)	.0423 .63302
TB	.131509 (1.534)	.959755 (34.81)	.0394 .83256	.290761 (3.59)	.904595 (34.81)	.0382 .93684
MR	.077734 (4.795)	.908092 (49.49)	.0167 1.31243	-.018066 (-.992)	1.024266 (49.49)	.0177 1.37301
HD	.001372 (.107)	1.000457 (141.12)	.0211 .93639	.015095 (1.186)	.990393 (141.12)	.0210 .94331
IR	.361586 (8.357)	.938182 (145.0)	.0479 .39283	-.324246 (-6.707)	1.056645 (145.0)	.0509 .39414
PP	.007197 (.247)	.966685 (82.79)	.0744 .36596	.056936 (1.93)	1.007422 (82.79)	.0760 .37508

B. Test for Stationary of Residuals

Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) regressions are applied to the residuals of each cointegration regression:

$$\text{DF}: \quad \triangle\varepsilon = -\varphi\varepsilon_{-1}$$

$$\text{ADF}: \quad \triangle\varepsilon = -\varphi\varepsilon_{-1} + \theta_1\triangle\varepsilon_{-1} + \theta_2\triangle\varepsilon_{-2} + \theta_3\triangle\varepsilon_{-3} + \cdots + \theta_q\triangle\varepsilon_{-q}$$

A statistically significant φ means the residuals are stationary and the two original time series are cointegrated.

	Official on Black Market			Black Market on Official		
	$-\varphi_o$	σ D - W	No. of lags of other sig. explanatory term(s)	$-\varphi_b$	σ D - W	No. of lags of other sig. explanatory term(s)
JY	-1.089078 (-14.821)	.0114 1.98366	–	-1.089981 (-14.839)	.0113 1.98432	–
KW	-.128742 (-3.55)	.0360 1.81012	5	-.139448 (-3.738)	.0374 1.79364	5
SD	-.966693 (-13.139)	.0134 1.99877	1, 2	-1.010436 (-13.806)	.0137 1.98630	1, 2, 7
CD	-.276613 (-5.44)	.0279 2.24165	1	-.317833 (-5.865)	.0310 2.20883	1
TB	-.416344 (-6.914)	.0321 2.22364	1	-.468001 (-7.408)	.0325 2.17010	1
MR	-.657668 (-9.452)	.0157 2.17244	1, 3	-.687941 (-9.803)	.0169 2.14630	1, 3
HD	-.505884 (-8.276)	.0174 2.27528	1, 4	-.507569 (-8.277)	.0174 2.27219	1, 4, 7
IR	-.190109 (-4.254)	.0287 2.34482	1, 7	-.191528 (-4.289)	.0305 2.34302	1, 7
PP	-.182502 (-4.273)	.0431 2.14483	7, 8	-.188087 (-4.362)	.0444 2.14551	7, 8

Note: The number of lags in columns 3 and 6 should indicate whether DF or ADF was used.

Table 5 Modeling Results

The left-hand side of each model represents the first difference in the log-transformed time series. The initial letter indicates the type of exchange rate (0 = official, B = black-market rate), followed by a two-letter currency designator (JY = Japanese yen, KW = South Korean won, SD = Singapore dollar, CD = Taiwanese dollar, TB = Thai baht, Mr = Malaysian ringgit, HD = Hong Kong dollar, IR = Indonesian rupiah, and PP = Philippine peso.). On the right-hand side, the error-correction variable has ε in the initial position, followed by a currency-designator letter (j = Japanese yen; k = South Korean won; s = Singapore dollar; c = Taiwanese dollar; t = Thai baht; m = Malaysian ringgit; h = Hong Kong dollar; r = Indonesian rupiah : and p = Philippine peso). The last two letters indicate the direction of cointegration regression (ob = official on black-market rate; bo = black-market on official rate). For the remaining explanatory variables, the initial letter indicates the source of influence (0 = official, B = black market), followed by the two-letter currency designator

$\Delta OJY =$	$-.004153$	$-.000245\,\varepsilon\,job_{-1}$	$-.14784\Delta OJY_{-6}$	$+.145331\Delta BJY_{-1}$	$\sigma=.0331$
	(−1.629)	(−.003)	(−1.962)	(2.012)	D-W=2.10935
$\Delta BJY =$	$-.003931$	$-1.029896\,\varepsilon\,job_{-1}$			$\sigma=.0329$
	(−1.585)	(−4.772)			D-W=1.8511
$\Delta OKW =$	$.105404$	$-.022355\,\varepsilon\,kob_{-1}$	$-.015694\Delta BKW_{-1}$		$\sigma=.0205$
	(2.426)	(−.299)	(−2.361)		D-W=1.89871
$\Delta BKW =$	$.002557$	$-.161743\,\varepsilon\,kob_{-1}$	$+.066363\Delta BKW_{-1}$		$\sigma=.0391$
	(.853)	(−3.967)	(2.251)		D-W=2.01575
$\Delta OSD =$	$-.001385$	$+.015015\,\varepsilon\,sob_{-1}$	$-1.161695\Delta OSD_{-7}$	$+.101920\Delta BSD_{-7}$	$\sigma=.0145$
	(−1.262)	(.055)	(−2.427)	(1.836)	D-W=2.11586
$\Delta BSD =$	$-.001924$	$-.964742\,\varepsilon\,sob_{-1}$	$-.161695\Delta BSD_{-8}$	$-.214266\Delta OSD_{-6}$	$\sigma=.0201$
	(−1.259)	(−8.638)	(−2.076)	(−2.076)	D-W=2.11414
$\Delta OCD =$	$-.079863$	$-119196\,\varepsilon\,cob_{-1}$	$+.265734\Delta OCD_{-7}$	$+.021502\Delta BCD_{-1}$	$\sigma=.0102$
	(−2.884)	(−1.697)	(3.197)	(2.83)	D-W=1.96515
$\Delta BCD =$	$-.002287$	$-.203145\,\varepsilon\,sob_{-1}$	$-.190613\Delta BCD_{-1}$		$\sigma=.0315$
	(−.957)	(−3.199)	(−2.45)		D-W=1.90144
$\Delta OTB =$	$.019639$	$-.022673\,\varepsilon\,tob_{-1}$			$\sigma=.03158$
	(.461)	(−.462)			D-W=1.99833
$\Delta BTB =$	$.002783$	$-.423825\,\varepsilon\,tob_{-1}$	$-.489987\Delta OTB_{-4}$	$+.336822\Delta OTB_{-5}$	$\sigma=.0317$
	(1.146)	(−6.69)	(−3.299)	(2.238)	D-W=2.13374
	$-.594763\Delta OTB_{-8}$				
	(−3.975)				

$\triangle OMR =$	$.000747$	$-.146063\,\varepsilon\, mob_{-1}$	$-.150305 \triangle BMR_{6}$		$\sigma -.0161$
	(.611)	(−2.007)	(−2.999)		D−W=2.04218
$\triangle BMR =$	$.000612$	$-.515346\,\varepsilon\, mob_{-1}$	$-.210558 \triangle BMR_{-8}$		$\sigma = .0221$
	(.366)	(−5.53)	(−3.073)		D−W=2.10701
$\triangle OHD =$	$.002809$	$-.100116\,\varepsilon\, hob_{-1}$	$-.155015 \triangle OHD_{-2}$		$\sigma = .0178$
	(.3.047)	(−1.344)	(−2.076)		D−W=1.82133
$\triangle BHD =$	$.000766$	$-.494933\,\varepsilon\, hob_{-1}$	$+.199299 \triangle BHD_{-4}$	$+.145891 \triangle BHD_{-7}$	$\sigma = .0238$
	(.418)	(−5.131)	(2.886)	(2.107)	D−W=2.02047
$\triangle OIR =$	$.008165$	$-.145610\,\varepsilon\, iob_{-1}$			$\sigma =..462$
	(2.293)	(−1.979)			D−W=2.01362
$\triangle BIR =$	$.009521$	$-.074386\,\varepsilon\, iob_{-1}$			$\sigma = .0534$
	(1.993)	(−.728)			D−W=2.00531
$\triangle OPP =$	$.005187$	$-.112499\,\varepsilon\, pob_{-1}$	$+.329724 \triangle OPP_{-4}$	$-.16027 \triangle OPP_{-7}$	$\sigma = .0269$
	(2.398)	(−3.813)	(4.271)	(−2.441)	D−W=2.25435
	$-.150193 \triangle BPP_{-4}$	$+.169499 \triangle BPP_{-8}$			
	(−3.147)	(4.483)			
$\triangle BPP =$	$.006190$	$-.073848\,\varepsilon\, pob_{-1}$	$+.211087 \triangle OPP_{-8}$	$-.443172 \triangle OPP_{-1}$	$\sigma = .0518$
	(1.496)	(− .957)	(2.964)	(−3.546)	D−W=2.02339
	$+.253107 \triangle OPP_{-2}$				
	(2.05)				

References

Booth, G.G., and C. Mustafa, "Long-run dynamics of black and official exchange rates," *Journal of International Money and Finance,* 1991, 10: 392-405.

Box, G.E.P., and G.M. Jenkins, *Time Series Analysis, Forecasting and Control, revised edition,* San Francisco: Holden-Day, 1976.

Culbertson, W.P., "Purchasing Power Parity and Black Market Exchange Rates," *Economic Inquiry,* 1975, 13, 287-296.

Dickey, David A., and Wayne A. Fuller, "Distribution of the Estimation for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association,* 1979, Vol 74, 427-431.

Dornbusch, R., D.V. Dantas, C. Pechman, R.R. Rocha, and D. Simoes, "The Black Market for Dollars in Brazil," *Quarterly Journal of Economics,* 1983, 98, 661-692.

Engle, Robert F., and C.W.J. Granger, "Co-Integration and Error Corrections: Presentation, Estimation, and Testing," *Econometrica,* 1987, 55, 251-276.

Fuller, W.A., *Introduction to Statistical Time Series,* New York: Wiley, 1976.

Granger, C.W.J., "Causality, Cointegration and Control," *Journal of Economic Dynamics and Control,* 12, 551-559.

International Currency Analysis, Inc., *Pick's Currency Yearbook,* various issues.

——, *World Currency Yearbook,* various issues.

International Monetary Fund, *International Financial Statistics,* various issues.

Olgun, H., "An Analysis of the Black Market Exchange in a Developing Economy," *Weltwirtschaftliches Archive,* 1984, 120, 329-347.

Ying, S.L. (ed.), *Foreign Direct Investment in ASEAN,* Kuala Lumpur: Malaysian Economic Association,1990.