IS THE MALAYSIAN INTER-BANK FOREIGN EXCHANGE MARKET EFFICIENT? : SOME RECENT EVIDENCE USING THE COINTEGRATION TECHNIQUE

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ABSTRACT

This paper investigates the implication of cointegration for foreign exchange market efficiency using both quarterly and monthly data. By using the Engle-Granger representation theorem, it can be shown that if two spot rates are cointegrated, then at least one may be used to predict the other. In other words, the spot rate does not embody all available information and hence is inconsistent with the weak form efficient market hypothesis. The results of our findings are consistent with the proposition that the Malaysian spot exchange rate market is weakly efficient at least in the long-run for the major currencies considered in the analysis .

INTRODUCTION

Malaysia's market for foreign exchange has developed rapidly since the implementation of the floating exchange rate in 1973. Prior to this period the exchange rate was pegged to the Pound Sterling. The rapid development in the market was due to factors such as liberalisation of exchange controls, inflow of foreign investments, improvement in communication facilities and exchange market operations, and the licensing of more foreign exchange brokers. Bank Negara Malaysia in their report in 1993 showed that the monthly average currency transactions increased from RM450 million in 1973 to more than RM37 billion in 1993. A forward exchange market covering transactions of various maturities also emerged for banks and customers to hedge against the exchange rate risk as volatility in the currency market increased in the early 1980's. Although most of the dealings in Malaysian foreign exchange are still spot transactions, the growth of the forward market has been quite spectacular in recent years.

There are two types of foreign exchange markets, namely the inter-bank market and customer-based market. Inter-bank market deals in transactions of the commercial banks either directly

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among themselves or through brokerage firms. The inter-bank market has developed from the purchasing and selling of currencies for ringgit to more sophisticated cross-rate arbitrage transactions, where the U.S. dollar could be purchased and sold for other currencies in addition to the ringgit. The customer-based market, however, involves dealings between commercial banks and their customers for transactions involving payments and receipts from trade, investment and services.

The currency transactions can be either in spot or forward, with the forward market still at its infancy stage as it was started in the late 1980s. The market is regulated by Bank Negara Malaysia under the Exchange Control Act of 1953. Under the Act only commercial banks (including Bank Islam) are allowed in exchange dealings. Apart from these banks, some 40 finance companies and about 459 licensed money-changers are allowed to operate in market (Bank Negara Malaysia, 1994). The major function of the central bank is to ensure that the market is not over exposed to risk, by monitoring the activities of the money and foreign exchange markets.

A summary of foreign exchange earnings from 1988 to 1992 by major commercial banks in Malaysia is given in Table 1. As shown in Table 1, domestic banks earned about 20% of "other income" or more than 2% of interest income in the form of foreign exchange earnings in 1992. In general the earnings have increased over the period. For example, the contribution of foreign exchange earning to Ban Hin Lee Bank increased from 6.74% in 1988 to 21.39% in 1992 (See Table 1). It is also obvious from Table 1 that foreign banks earned a higher percentage of foreign exchange earnings against other income as well as interest income compared to the local banks. Two reasons may be provided for this phenomena. First, foreign banks are not allowed to establish branches in the country, and as such their business operations are rather limited. The foreign exchange operations provide a profitable off-balance-sheet activity for these banks. Second, foreign banks are better equipped with sophisticated telecommunication technology, and their association with their respective parent companies enable them to be more informed about current development in the international capital markets.

The primary purpose of this paper is to test the efficienct market hypothesis (EMH) in the foreign exchange market. In particular, we intend to investigate if commercial banks in Malaysia can use some simple "trading rules" to make abnormal profits in the spot market in the long-run. In other words, we intend to show if it is possible to profit by trading across currencies, exploiting the movements in one exchange rate to predict the movements of the other exchange rates. We employed the tests of cointegration to examine the EMH. Specifically, the two-step procedure suggested by Engle and Granger (1987) is used in our analysis. The approach has several interesting features. First, it exploits the non-stationarity properties of economic variables: in the case of EMH, they are the spot rates. Second, the approach is most useful when examining long-run relationships implied by economic theory. Recently, similar approach has been used by MacDonald and Taylor (1989), Coleman (1990), Copeland (1991) and Tronzano (1992) to test for efficiency in currency markets.

This empirical work is important for at least two reasons. First, most of the literature on integration of financial markets and on the behaviour of foreign exchanges has focused on the experiences of developed economies. Very few studies on the efficiency of the developing markets have been undertaken[2]. It is unclear if the results obtained for the developed countries could be generalised for the markets of developing countries where the volume of transactions is relatively small compared to transactions in the major markets, and intervention by the central bank is not uncommon. Second, the results obtained from this study can be useful to policy-makers. In particular when asset and commodity markets are efficient (that is, their prices reflect the relevant information), economic agents who make decisions on the basis of observed prices will ensure an efficient allocation of resources. Thus price in this case is a sufficient statistic for decision making (see Levich 1989).

LITERATURE REVIEW

The behaviour of exchange rates has long been researched by economists. Focus has been on the issue of whether past exchange rate movements can be used to make meaningful predictions of the future spot rates. Examples of some of the more recent investigations include those by Alexander and Johnson (1992), Baillie and Bollerslev (1989), Tronzano (1992), Lajaunie and Naka (1992), Copeland (1991), Coleman (1990) and Karfakis and Parikh (1994), among others. While all these studies were based on cointegration theory, the results obtained were mixed.

Alexander and Johnson (1992) found that currencies like the Pound Sterling, the French Franc,

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[2] *Examples of studies that have been undertaken to examine the exchange markets of developing countries include de Macedo (1979) and Blejer and Khan (1980).*

the Deutsche Mark, Swiss Franc and the Japanese Yen are inefficient, that is, the movement in one of these currencies may be used to predict the other. By using Johansen (1988) maximum likelihood procedure on daily data, Baillie and Bollerslev (1989) concluded that spot rates shared a common stochastic trend and were, therefore, linked together by an underlying long-run relationship.

Levich (1989) in his article points out that efficiency depends on the availability of information. If larger banks (or other financial institutions) have access to more recent information then they can consistently earn larger profits. He also argued that intervention by the Central Bank will only result in market inefficiency. Speculators may use some trading rules in regulated markets to earn abnormal profits. However, we will explain later that under certain conditions this may not necessarily be true.

By contrast, Tronzano (1992) found that the market for these currencies is efficient, implying that market information is efficiently disseminated and there exist no opportunities for speculators to systematically make abnormal profits in the spot market by using rules or price relationship. Lajaunie and Naka (1992) using both the bivariate and multivariate models showed that the Tokyo spot market is consistent with the EMH. The four currencies are the Japanese Yen, Duetsche Mark, the British Pound and the Canadian Dollar, all in terms of the US Dollar[3].

Copeland (1991) tested five daily spot exchange rates for consistency with EMH. In the paper he provides two important reasons for preferring to use spot over forward rates to test for EMH. First, new information is readily incorporated in the spot market. Second, the spot rate is not obscured by the existence of time varying risk premium. The test results which are based on Johansen's (1988) method support the absence of cointegration between all pairs of spot rate and hence is consistent with the hypothesis that spot rates are determined in a weakly efficient market. Karfakis and Parikh (1994) also applied the multivariate VAR framework to the Australian foreign exchange market. Their results rejected the non-cointegration between the Australian dollar and the other leading currencies.

[3] The test procedures developed by Phillips and Ouliaris (1990), Johansen and Juselius (1990) and Johansen (1991) were used in this study.

COINTEGRATION AND MARKET EFFICIENCY

The fundamental theoretical aspects of efficient capital markets have been discussed in the well known work by Fama (1970). The essence of the efficiency hypothesis is that in an efficient market, the price of an asset should reflect all available information so that no simple trading rule may be used to earn abnormal profits. Subsequent studies have explored the efficiency hypothesis for different auction markets (spot and forward foreign exchange market; treasury bill market etc.). The test for foreign exchange efficiency which we proposed is based on an application of cointegration theory which is useful for examining long-run relationship between economic variables.

One important implication of cointegration is that two non-stationary time series data are said to be cointegrated when a linear combination of the two is stationary (see Granger, 1986; Engle and Granger, 1987). A cointegrated series will move together in the long-run, and any shock will allow the series to return to their mean. In other words, a cointegrated series will not drift apart without being bound by each other (that is, self-correcting) in the long-run.

According to Granger (1986), if X_t and Y_t are a pair of prices from a jointly efficient speculative market (e.g. spot market), they cannot be cointegrated. This is simply because if the two processes are cointegrated, one can be used to forecast the other. Hence this would violate the efficient market hypothesis. Thus, an important implication of cointegration theory is that there can be no cointegration of asset prices in a weakly efficient market. In the present context this means that two spot rates cannot be cointegrated, otherwise one spot rate can be used to forecast the other.

In the cointegration analysis, the series involved must be of similar statistical characteristic, that is, they must be of the same order of integration. Following Granger (1986), a variable X_t is said to be integrated of order d, if X_t achieves stationarity after differencing d times, denoted $X_t \sim I(d)$. Consequently, if X_t is stationary after differencing once, then we may denote $X_t \sim I(1)$ and its changes $\Delta X_t \sim I(0)$. A stationary series is obviously integrated of order zero, $I(0)$. Many of the economic variables (including exchange rates) are known to be $I(1)$ and as a result the conventional method of regressing one $I(1)$ variable on another as in the case of the conventional method

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[4] *In general a set of series, all of the same order* ***d****, are said to be cointegrated if and only if some linear combination of the series - with non-zero weights only-is integrated of order less than* ***d****.*

of testing market efficiency tend to be biased towards rejecting the null hypothesis of no relationship even when the relationship does not exist (see for example Granger and Newbold (1974) and Phillips (1986)).

A set of series must be integrated of the same order in order to be cointegrated. Granger (1986) shows that if two variables X_t and Y_t, both are $\sim I(1)$, it is generally true that any linear combination of these series is also $\sim I(1)$. However, if there exists a constant A, such that $Z_t = X_t - AY_t$, is $I(0)$, then X_t and Y_t are said to be cointegrated with A called the cointegrating parameter[4]. In this special case, X_t and Y_t are said to be cointegrated of order $(1,1)$ and by the Engle and Granger representation theorem[5] (see Engle and Granger, 1987) there exists an error correction representation of the form

$$(X_t - X_{t-1}) = -\rho_1 Z_{t-1} + lagged\,(\,\Delta Xs\,,\,\Delta Ys\,) + \varepsilon_{1t} \qquad (1)$$

and

$$(Y_t - Y_{t-1}) = -\rho_2 Z_{t-1} + lagged\,(\,\Delta Xs\,,\,\Delta Ys\,) + \varepsilon_{2t} \qquad (2)$$

where $Z_{t-1} = (X_{t-1} - AY_{t-1})$, $\rho_1 \neq 0$ and $\rho_2 \neq 0$. The first term on the right sides of equations (1) and (2) are the error correction terms. ECM may be viewed as a description of how the economy eliminates equilibrium error. It is obvious from the error correction model (ECM) that there are two possible series of causation of X_t by Y_t, either through the Z_{t-1} term, that is, if $\rho_1 \neq 0$, and through lagged ΔY_t terms if they are present in the equation.

In the currency market, the implication is that no exchange rate should be cointegrated with any linear combination of other currencies against which it floats freely. Otherwise, given the low cost of transaction in currency markets, arbitrage opportunities would exist. Thus, the cointegration analysis suggested by Engle and Granger (1987) is sufficient to test the weak form market efficiency hypothesis.

TESTS OF UNIT ROOTS AND COINTEGRATION

The first step in the cointegration analysis is to determine the order of integration in the data series. If the data series do not follow the same order of integration, then there can be no mean

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[5] *The constant term **A** measures the long-run relationship between the two variables and **Z** indicates the extent of any divergence from the relationship. If the relationship between the two variables is positive, **Z** being **I(O)** implies that they cannot drift apart.*

ingful relationship between them. The order of integration may be determined by using the Dickey and Fuller (1981) test for unit root, for both level and first-difference form of the series.

The Dickey-Fuller unit root test is conducted on the following regression equation, say for US Dollar (US):

$$\Delta US_t = \alpha_0 + \rho US_{t-1} + \sum_{i=1}^{n} a_i \Delta US_{t-i} + \mu_t \qquad (3)$$

and used to test the null hypothesis $H_0 : US_t$ is $I(1)$, which is rejected (in favour of $I(0)$) if ρ is found to be negative and significantly different from zero. The t-ratio of ρ, calculated is compared to the approximate critical value given in MacKinnon (1991)[6] . The number of lag lengths of the lagged dependent variable (n) that appears on the right side of equation (3) is chosen to ensure that the disturbance term, μ_t follows a white noise. The order of lag, n is set as the highest significant lag order from either the autocorrelation function (ACF) or partial autocorrelation function (PACF) of the first difference. Note that if each α_i is equal to zero then the test reduces to the Dickey-Fuller test (DF), otherwise we have the Augmented Dickey-Fuller (ADF) test. The ADF test provides a generalisation of the DF test to allow for the possibility of higher-order autoregressions. The above tests were also carried out for first-difference of the variables and to do this we estimate

$$\Delta^2 US_t = \beta_0 + \rho \Delta US_{t-1} + \sum_{i=1}^{n} \beta_i \Delta^2 US_{t-i} + \eta_t \qquad (4)$$

where the null hypothesis is $H_0 : US_t$ is I(2), which is rejected (in favor of I(1)) if ρ is found to be negative and statistically significant from zero. If this is the case the US_t is said to be non-stationary in levels, but stationary in first differences.

The second step of cointegration involves testing whether linear combination of the variables are integrated of the same order as the individual variables. If they are, then the variables are not cointegrated. The residuals from the cointegrating regression are subjected to both the Dickey and Fuller (1979 and 1981) and Sargan and Bhargava (1983) cointegration regression Durbin-Watson (CRDW) test statistic. The power of these tests in small sample is limited and in view of this a 10 percent or 5 percent level of significance is commonly used in the analysis[7] .

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[6] *The MacKinnon (1991) critical values is now preferred to the original Dickey-Fuller tables because it is based on more replications.*

DATA

Data used in our analysis are both monthly and quarterly spot exchange rates, spanning the period January 1973 to August 1992. The exchange rates series used in the analysis are, Ringgit Malaysia (RM), Pound Sterling (BP), Duetsche Mark (DM), Japanese Yen (JY), Singapore Dollar (SD) and Swiss Franc (SF). The monthly (quarterly) rates are quoted at last dealing day for the month (quarter). All exchange rates are expressed in terms of foreign currencies per unit of US dollar. The primary source of data is the Quarterly Bulletin published by Bank Negara Malaysia. The efficienct market hypothesis was tested on the logarithm of prices rather than on the level of prices. The advantage of using logs in the analysis is that it makes the analysis independent of whether exchange rates are expressed as units of currency i per unit of currency j or unit of j per unit of currency i. The sample size for each series in the monthly and quarterly observations is 237 and 79 respectively.

EMPIRICAL RESULTS

Results of the unit root tests using both quarterly and monthly data for all the currencies are presented in Tables 2 and 3. Table 2 reports the ADF statistics for all the variables in level and first-difference forms. The results strongly suggest that the variables are non-stationary in their level form. In all cases, the null hypothesis of *I(1)* could not be rejected. However, when the first-difference of the variables was tested, the null hypothesis that the currencies are *I(2)* was rejected. In most cases lagged dependent variables are needed in the auxiliary regression given by equation (3) to induce white noise. For example, the number of lags entering the auxiliary regression for Ringgit Malaysia (RM) and Pound Sterling (BP) are 8 and 10 respectively (See Table 2)

Similar results were reported for the quarterly frequency data in Table 3. The Table shows that higher order differencing is not required for the logarithm of all the spot rates except for Pound Sterling (BP). For the Pound Sterling, the null hypothesis that the series is *~I(1)* could not be rejected only at the 10 percent significant level. Nevertheless, we continue to report the results for comparison purposes. Therefore, the evidence in Tables 2 and 3 suggest that all the variables in the logarithm of the nominal foreign currencies series contain a unit root, that is, they are *~I(1)*

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[7] *The methodology employed is based on Engle and Granger (1987), and the interested reader is referred there for details. The procedure was chosen to reduce the computational burden. However, the procedure suffers from several shortcomings, when n>2. An alternative procedure is discussed in Johansen (1988) and Johansen and Juselius (1990).*

processes. Our findings are consistent with those reported, among others, by Baillie and McMahon (1989) and MacDonald and Taylor (1989).

Since all variables are of uniform order of integration, that is, they are *~I(1),* we proceed by examining whether their linear combination resulted in the stationarity of their residuals, that is, whether they are cointegrated. As cointegration theory does not imply anything about causality, we therefore report the results of the cointegration bidirectionally. In Table 4, the CRDW statistics show that the null hypothesis of no cointegration is rejected in most cases (17 out of 30 cases) at the five percent significant level. However, Engle and Yoo (1987) have cautioned the use of CRDW in the analysis. Accordingly, they recommended the use of ADF statistic in the cointegration analysis. The empirical results of the ADF test are not supportive of cointegration between any of the spot rates.

Table 5 summarises the results of the cointegration tests using quarterly frequency. For ADF test, in all cases, the computed test statistic is larger than the tabulated critical value at the five percent level. The results of the cointegration test indicates that there is no evidence of cointegration for the given pairs of exchange rates. Results of the cointegration using quarterly frequency do not change our results significantly and we conclude that the spot market is efficient.

Recent articles by Dwyer and Wallace (1992) and Karfakis and Parikh (1994) argue that cointegration of two spot rates in terms of a common currency is not a sufficient condition for market efficiency. Accordingly, they argued that foreign exchange markets involve the simultaneous determination of several exchange rates through international arbitrage, and therefore a bivariate framework as reported above may be inappropriate to test EMH. In this study we also employed the multiple variable case to examine the absence of cointegrating relationship. We follow the approach provided by Coleman (1990) and Lajaunie Naka (1992) to test for market efficiency for the higher-order system and the results are given in Tables 6 and 7. Results from monthly frequency data (Table 6) show no evidence of long-run equilibrium relationship among the six spot rates. Similarly, in Table 7 we report that with the exception of the JER equation, the results using quarterly frequency data are consistent with the EMH based on the ADF statistics at the 10% level of significance. We conclude that based on the empirical evidence the currency market is efficient at least in the long-run. Our results are consistent with those reported by Copeland (1991), Coleman

(1990), Tronzano (1992) and Lajaunie and Naka (1992) where they found no evidence of cointegration among major currencies.

CONCLUSION AND POLICY IMPLICATIONS

While much has been researched on integration of financial markets among the developed economies, relatively few have examined the markets of the developing economies. The characteristics of the developing markets differ from that of the developing countries. For example, the foreign exchange market in Malaysia is characterised by high levels of government intervention as well as incomplete forward trading. The market is also relatively small compared to those of the major currency markets of the U.S., U.K., Germany and Japan.

In this paper, the efficient market hypothesis was tested on the Malaysian foreign exchange market. The spot rates of six key currencies were selected for our study. There are the Malaysian Ringgit, Pound Sterling, the Deutsche Mark, the Singapore Dollar, the Swiss France and Japanese Yen, all against the U.S. Dollar. These currencies are subjected to efficient market test using the cointegration technique. The advantage of this method is that it accounts for nonstationarity problem often encounterd in economic time series analysis. The empirical results of the unit root test suggest that all the exchange rate series appear to be non-stationary in level. The evidence also suggests that the major currencies are not cointegrated, implying that the foreign exchange market is efficient at least in the long-run. Both the univariate and multivariable tests confirm this result. We also show that our conclusion is insensitive to the sampling frequency used in the analysis.

Despite the level of intervention by the central bank and the undeveloped forward foreign exchange market, the results tend to support the implication that the speculative market is efficient. This is possible if the intervention by central bank results in less volatile exchange rate movements. This is simply because if exchange rates become more volatile, more uncertainty will be introduced to the market. This in turn could result in loss of information and contribute to market inefficiency. It is also generally true that the authorities are reluctant to undertake large adjustments in the market, and the nature of intervention is systematic and predictable. Further, the major participants in the currency market are large traders (commercial banks) and they have massive databanks as well as experts to analyse the information. The rewards of being right are enormous and the penalties for being wrong are great. The spot market cannot be systematic and predictably wrong in the long-run.

The behaviour of the foreign currency market is important to investors and multinational firms, whether they are interested in making speculative profits or in protecting their investments from changes in the value of currencies. This is especially true for an open economy like Malaysia's. This study provides empirical support for the EMH and thus leads to the conclusion that investors (or speculators) cannot earn large return from the foreign exchange market using some simple trading rule. For the corporate managers, an efficient market means that the need to actively select currencies and the timing of transactions are of lesser importance. This is because in an efficient market, managers must formulate hedging policies to cushion the effect of exchange rate risk on trade. Several studies have shown the negative effect of exchange risk on trade (see Maskus) (1986) and Anderson (1988). However, managers could minimise decisions regarding currency composition of their balance sheet and pursue other objective of the firm if the financial market is efficient. The proposition that exchange rate volatility produces negative impact on trade has both theoretical and empirical support (see Maskus (1986) and Anderson (1988), among others). They could minimise decisions regarding the currency composition of their balance sheet and pursue other objectives of the firm if the market is efficient.

At the macro level, a well functioning foreign exchange market is important to facilitate trade and capital flows as well as inflows of foreign investments. When asset and commodity markets are efficient then price serves as aggregators of information. Price becomes a sufficient statistic for decision making since the observed price will ensure an efficient allocation of resources.

Finally, the findings of lack of cointegrating relationship among the major currencies exclude the possibility of long-run abnormal profits. However, one cannot rule out the possibility that the forex market may be inefficient if the short-run dynamics are considered in the analysis. If this is the case then it is possible for speculators to gain in excess of normal profit in the short-run. Clearly, more work on the short-run version of EMH is need. The band-spectral regression technique may be more appropriate here since it is able to separate the short-run and long-run aspects of the hypothesis.

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Table 1 : Commercial Bank's Foreign Exchange Earning*

	1988		1989		1990		1991		1992	
	A C	B D	A C	B D	A C	B D	A C	B D	A C	B D
1. Domestic Bank										
Ban Hin Lee Bank	472	6.74	1858	24.13	1905	22.07	3474	25.17	3383	21.39
	920	0.87	1044	2.65	1436	1.80	1723	2.54	2275	1.66
Bank Bumiputra	9458	5.10	9852	16.48	18935	29.50	16012	15.90	41152	26.45
	18977	0.90	20012	0.66	20906	1.01	22640	0.79	22706	1.92
Bank Buruh	246	3.93	-	-	242	8.71	434	11.02	188	4.98
	415	0.68	506	-	669	0.45	792	0.61	974	0.21
Bank Utama	492	8.15	(158)	-	1056	30.36	1365	21.16	3120	21.37
	817	0.90	767	-	677	1.63	1190	1.81	1687	2.58
Bank of Commerce	1267	15.10	1916	15.92	2378	14.88	14285	28.56	18001	30.61
	1526	1.96	2162	2.27	3467	2.10	7217	2.86	6823	2.67
Development and Commercial	5543	24.68	9235	32.70	9437	33.97	14433	31.56	14142	24.02
	3479	3.13	4070	3.44	4876	2.94	7626	3.08	9005	2.13
Eon Bank	431	11.03	496	13.54	822	21.94	536	25.16	494	20.64
	234	2.03	246	2.46	264	3.73	271	1.69	394	1.60
Hock Hua Bank	2122	34.03	2979	44.0	3281	39.86	3726	35.51	4924	33.78
	830	3.57	1024	4.37	1254	3.96	1548	2.93	2012	2.99
Hock Hua(Sabah) Bank	1122	29.46	1377	30.03	1567	29.81	1221	25.55	1010	43.63
	276	6.36	329	8.00	381	6.73	366	3.76	424	2.61
Kwong Yik Bank	1029	2.90	2007	4.74	2490	16.26	2508	12.88	4379	17.20
	1478	0.83	2010	1.42	2520	1.29	3303	1.03	3700	1.43
Malayan Banking	24348	13.59	31008	21.86	42890	23.32	37734	17.84	45182	17.24
	17352	1.95	20459	2.18	22801	2.42	29400	1.68	33249	1.71
Malaysian French Bank	3291	21.17	3715	19.69	3612	30.98	3447	24.32	4604	29.11
	1014	3.65	1343	2.88	1378	2.57	1844	2.02	2234	2.08
Mui Bank	2285	16.85	3215	32.84	3422	29.49	3332	27.76	3042	23.39
	1792	2.01	1948	2.48	2135	1.62	2274	1.52	2446	1.31
Oriental Bank	807	13.47	1242	21.55	1537	20.39	3047	20.04	3743	20.81
	1036	1.06	1188	1.49	1325	1.48	2553	1.55	2710	1.75
Perwira Habib Bank	1713	9.50	1716	8.82	1830	5.90	9649	17.61	12666	17.62
	1924	0.60	2271	0.52	2780	0.48	3765	2.33	4405	3.52
Public Bank	7353	12.63	11565	28.81	18353	28.50	17334	22.11	5606	6.91
	5771	2.39	6370	2.77	7184	4.00	9667	2.88	12989	0.57
Sabah Bank	1036	35.75	1040	32.47	942	28.36	1055	29.05	1218	0.57
	584	1.26	655	1.48	705	1.26	764	1.19	853	1.22
Southern Bank	833	3.02	500	1.82	1038	3.06	1156	2.67	2154	3.80
	1833	0.96	1801	0.46	2003	0.66	2217	0.60	2288	0.88
Pacific Bank	7353	12.63	11565	28.81	18353	28.50	17334	22.11	5606	0.69
	893	2.39	1098	2.77	1394	4.00	2024	2.88	2299	0.57
United Malayan Banking Corp.	17320	12.71	5499	3.90	18297	11.19	15696	9.54	15770	8.67
	6696	5.08	7054	1.38	8110	3.35	9764	2.57	9988	2.29
Wah Tat Bank	280	21.60	344	14.98	476	27.26	558	28.96	-	-
	166	2.10	169	2.45	188	2.86	223	2.70	-	-
United Asian Bank	5669	19.74	5373	22.59	7665	26.99	-	-	-	-
	2508	2.36	2623	1.97	3467	2.38	-	-	-	-

Table 1 (continued)

	1988		1989		1990		1991		1992	
	A C	B D	A C	B D	A C	B D	A C	B D	A C	B D
1. Foreign Bank										
Algemene Bank Nederland	1895	64.30	2102	55.29	2382	53.73	2330	50.38	3412	53.48
	211	13.33	293	10.73	362	8.24	530	5.72	682	6.08
Bangkok Bank	1483	28.34	1732	27.44	1998	23.16	2007	36.50	2272	38.74
	339	6.79	382	7.27	404	6.25	385	5.11	408	5.44
Bank of America	3905	35.18	3562	16.45	4919	43.44	5290	39.26	7929	53.46
	574	13.76	624	7.92	852	9.33	1325	8.11	1060	10.56
Chung Khiaw Bank	2916	17.38	3249	22.99	4155	20.97	5515	21.71	5731	13.87
	1297	3.80	1517	3.34	2116	3.15	2633	2.45	3391	1.89
Citibank	11242	33.10	14528	36.44	9204	19.55	16835	23.39	-	-
	3317	5.41	3716	5.49	5124	2.86	4266	4.31	-	-
Deutsche Bank	1637	51.97	1811	51.37	4784	57.35	5359	49.61	6149	48.42
	333	10.34	473	8.48	743	13.34	1054	8.64	1231	6.64
Lee Wah Bank	1388	13.80	1591	20.74	2351	21.04	2834	19.97	3693	26.89
	750	2.86	968	2.57	1298	2.61	1645	2.11	2239	1.91
Oversea-Chinese Banking Corp.	3015	20.52	3746	22.92	3728	20.59	4250	16.79	4040	13.56
	2695	1.78	3136	1.86	3611	1.34	4552	1.22	5348	0.88
Overseas Union Bank	1976	35.57	1759	28.16	2214	27.68	2761	26.76	3567	34.09
	785	3.76	876	2.14	931	3.13	1061	3.09	1398	2.86
Security Pacific Bank	925	40.87	856	25.30	833	15.43	1449	19.64	2294	30.67
	183	7.27	214	5.31	305	4.48	327	5.68	362	8.03
Standard Chartered	19040	28.00	26604	33.90	26006	29.04	28439	27.53	35192	29.69
	4467	7.12	4932	8.47	5561	6.59	6452	6.27	7249	5.78
Bank of Nova Scotia	872	41.29	1661	53.96	864	23.92	1032	30.35	1718	34.62
	270	4.93	317	8.67	555	2.91	531	2.28	824	2.83
Bank of Tokyo	6259	50.92	6099	48.39	7551	49.70	6217	42.31	7253	42.08
	723	12.65	932	11.71	1113	11.06	1440	6.84	1645	5.92
Chase Manhattan Bank	2616	33.04	2904	29.93	3632	23.95	3276	18.29	-	-
	648	6.82	591	9.61	576	11.85	598	11.27	-	-
Hongkong Bank	12535	13.18	14793	15.31	16671	16.05	16213	14.69	30924	22.53
	5364	3.18	6025	3.45	6040	3.74	6816	3.03	7839	4.70
United Overseas Bank	326	38.13	207	36.13	179	30.13	161	23.85	149	20.87
	82	5.69	86	2.63	100	2.43	110	1.76	125	1.34

Source : Computed from various commercial bank's financial statements.

* A = Foreign exchange earning in RM thousands

B= % of other income

C= Bank total assets in RM millions

D= % of total interest income

Table 2 Test for Unit Root in Nominal Exchange Rate Series (Monthly)

Variables	Level ADF	Lags	First Difference ADF	Lags
RM	- 1.53	8	- 7.44	8
SD	- 1.01	0	- 7.60	3
JY	- 0.42	0	- 5.81	4
BP	- 1.99	1	- 4.03	10
DM	- 1.64	2	- 4.60	10
SF	-1.60	2	- 7.19	4

Notes: See the text for definition of variables.
Critical values for 237 observations are -3.46 (1%), -2.87(5%) and -2.57 (10%) [See MacKinnon (1991)]. ADF stands for Augmented Dickey-Fuller.

Table 3 Test for Unit Root in Nominal Exchange Rate Series (Quarterly)

Variables	Level ADF	Lags	First Difference ADF	Lags
RM	- 1.50	2	- 3.62	4
SD	0.86	2	- 3.32	5
JY	- 0.17	0	- 3.37	3
BP	- 1.96	0	- 2.88	5
DM	- 1.06	1	- 4.17	3
SF	- 1.46	0	- 3.46	3

Notes: See the text for the definition of variables. Critical values for 79 observations are -3.51 (1%), -2.90 (5%) and -2.59 (10%) [See MacKinnon (1991)]. ADF stands for Augmented Dickey-Fuller.

Table 4 Pairwise Cointegration Results (Monthly Frequency)

Cointegrating Regressions	CRDW	ADF	Lags
RM → SD	0.35	- 1.85	8
SD → RM	0.09	0.12	8
RM → JY	0.42	- 2.15	8
JY → RM	0.15	- 1.17	8
RM → BP	0.30	- 1.48	8
BP → RM	0.08	- 2.29	1
RM → DM	0.34	- 1.80	8
DM → RM	0.31	- 2.16	2
RM → SF	0.31	- 1.75	8
SF → RM	0.14	- 2.25	1
SD → JY	0.06	- 2.08	0
JY → SD	0.04	- 2.02	4
SD → BP	0.04	- 1.05	0
BP → SD	0.07	- 1.88	1
SD → DM	0.24	- 1.07	3
DM → SD	0.46	- 2.14	3
SD → SF	0.20	- 1.21	2
SF → SD	0.28	- 2.22	2
JY → BP	0.02	- 0.62	0
BP → JY	0.07	- 1.97	1
JY → DM	0.37	- 1.98	3
DM → JY	0.60	- 2.71	3
JY → SF	0.25	- 2.37	2
SF → JY	0.35	- 3.09	2
BP → DM	0.06	- 2.14	1
DM → BP	0.25	- 1.76	2
BP → SF	0.07	- 1.91	1
SF → BP	0.11	- 1.51	2
DM → SF	0.98	- 1.96	12
SF → DM	0.84	- 2.83	12

Notes: See the text for definition of variables. * Critical values for 237 observations are -3.94 (1%), -3.36 (5%) and -3.06 (10%) [MacKinnon (1991)]. Critical values for CRDW for 200 observations are 0.29 (1%), 0.20 (5%) and 0.16 (10%) [see Engle and Yoo (1987)]. ADF and CRDW stand for Augmented Dickey-Fuller and Cointegrating Regression Durbin-Watson respectively.

Table 5 Pairwise Cointegration Results (Quaterly Frequency)

Cointegrating Regressions	CRDW	ADF	Lags
RM → SD	0.23	- 1.71	2
SD → RM	0.23	- 0.71	6
RM → JY	0.27	- 2.03	2
JY → RM	0.17	- 1.56	0
RM → BP	0.15	- 1.33	8
BP → RM	0.10	- 2.57	7
RM → DM	0.23	- 1.81	2
DM → RM	0.29	- 2.30	0
RM → SF	0.21	- 1.72	2
SF → RM	0.14	- 1.95	0
SD → JY	0.42	- 1.25	2
JY → SD	0.31	- 2.53	0
SD → BP	0.18	0.43	2
BP → SD	0.14	- 1.94	0
SD → DM	0.37	- 1.55	1
DM → SD	0.44	- 2.15	1
SD → SF	0.36	- 1.44	1
SF → SD	0.30	- 2.29	1
JY → BP	0.06	- 0.91	5
BP → JY	0.12	- 1.97	0
JY → DM	0.30	- 1.89	1
DM → JY	0.48	- 2.29	1
JY → SF	0.14	- 2.14	0
SF → JY	0.18	- 2.84	0
BP → DM	0.08	- 2.08	0
DM → BP	0.19	- 1.06	1
BP → SF	0.12	- 1.89	0
SF → BP	0.10	- 1.45	0
DM → SF	0.66	- 2.63	1
SF → DM	0.53	- 2.84	1

Note: See the text for definition of variables. Critical values for 79 observations are -4.04 (1%), -3.41(5%) and -3.10 (10%) [See MacKinnon (1991)]. Critical values for CRDW are 0.39 (100 obs) and 0.78 (50 obs). ADF and CRDW stand for Augmented Dickey-Fuller and Cointegrating Regression Durbin-Watson respectively.

Table 6 Multiple variable Cointegration Results (Monthly Frequency)

Cointegrating Regressions	CRDW	ADF	Lags
MAL → SIN, JAP, UK ,JER, SWIT	0.68	- 2.08	12
SIN → MAL, JAP, UK, JER, SWIT	0.08	- 1.14	1
JAP → SIN, MAL, UK, JER, SWIT	0.37	- 2.76	11
UK → JAP, SIN, MAL, JER, SWIT	0.56	- 2.60	12
JER → UK, JAP, SIN, MAL, SWIT	1.41	- 3.45	12
SWIT → JER, UK, JAP, SIN, MAL	1.07	- 3.67	12

Note:See the text for definition of variables. Critical values for 237 observations are -5.35 (1%), -4.78 (5%) and -4.48 (10%). [See MacKinnon (1991)]. Critical values for CRDW is 0.57 (200 obs). ADF and CRDW stand for Augmented Dickey-Fuller and Cointegrarting Regression Durbin-Watson respectively.

Table 7 Multiple variable Cointegration Results (Quarterly Frequency)

Cointegrating Regressions	CRDW	ADF	Lags
MAL → SIN, JAP, UK ,JER, SWIT	0.4238	- 2.9109	8
SIN → MAL, JAP, UK, JER, SWIT	0.4520	- 1.8263	1
JAP → SIN, MAL, UK, JER, SWIT	0.2929	- 2.8755	0
UK → JAP, SIN, MAL, JER, SWIT	0.7959	- 3.6917	1
JER → UK, JAP, SIN, MAL, SWIT	1.3480	- 4.5626	1
SWIT → JER, UK, JAP, SIN, MAL	1.8246	- 3.7292	1

Note:See the text for definition of variables. Critical values for 79 observations are -4.71 (5%) and -4.42 (10%). [See MacKinnon (1991)]. Critical values for CRDW are 1.28 (50 obs) and 0.76 (100 obs). ADF and CRDW stand for Augmented Dickey-Fuller and Cointegrarting Regression Durbin-Watson respectively.