STOCK PRICES AND EXCHANGE RATE DYNAMICS

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Abstract

We study the long-run and short-run dynamics between stock prices and exchange rates and the channels through which exogenous shocks impact on these markets through the use of cointegration methodology and multivariate Granger causality tests. We apply the analysis to a group of Pacific Basin countries over the period 1980 to 1998. The evidence suggests that stock and foreign exchange markets are positively related and that the US stock market acts as a conduit for these links. Furthermore, these links are not found to be determined by foreign exchange restrictions. Finally, through the application of recursive estimation the evidence shows that the financial crisis had a temporary effect on the long-run comovement of these markets.

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1. INTRODUCTION

The recent emergence of new capital markets, the relaxation of foreign capital controls and the adoption of more flexible exchange rate regimes have increased the interest of academics and practitioners in studying the interactions between the stock and foreign exchange markets. The gradual abolition of foreign exchange controls in emerging economies has opened the possibility of international investment and portfolio diversification. At the same time, the adoption of more flexible exchange rate regimes by these countries in the late 1980's and early 1990's has increased the volatility of foreign exchange markets and the risk associated with such investments. The choice of currency denomination has added an important dimension to the overall portfolio decision.

Classical economic theory suggests a relationship between the stock market performance and the exchange rate behaviour. For example, "flow oriented" models of exchange rate determination, (see e.g. Dornbusch and Fisher (1980)), affirm that currency movements affect international competitiveness and the balance of trade position, and consequently the real output of the country, which in turn affects current and future cash flows of companies and their stock prices. Movements in the stock market may also affect exchange rates. Equities, being part of wealth, may affect the behaviour of exchange rates through the demand for money according to the monetarist models of exchange rate determination (see Gavin, (1989)). Similar links can be traced through the portfolio-balance models as well (see Branson (1983) and Frankel (1983)).

Previous studies, which have examined the relationship between stock and foreign exchange markets mainly for US (see e.g. Aggarwal (1981), Soenen and Hennigar (1988), Ma and Kao, (1990), Roll (1992) and Chow et al. (1997)), found different results concerning the links between the two markets. For example, Aggarwal (1981) finds that revaluation of the US dollar is positively related to stock market returns. In contrast, when Soenen and Hennigar (1988) considered a different period, 1980-1986, found a significantly negative relationship. Roll (1992), who used daily data over the period 1988-1991 found also a positive relationship between the two markets. On the other hand, Chow et al (1997) using monthly data for the period 1977-1989 found no relationship for monthly excess stock returns and real exchange rate returns. When repeating the exercise, however, with longer than six months horizons they found a positive relationship between a strong dollar and stock returns.

At the micro level other works have focused on evaluating the exposure of domestic firms to foreign currency risk. Apart from the economic exposure, which arises from variations in firm's discounted cash flows when exchange rates fluctuate, firms also face transaction exposure due to gains or losses arising from settlement of investment transactions stated in foreign currency terms. Empirical work using an unconditional pricing multi-factor asset pricing model generally reports that the exchange risk is not priced either in the US or in the Japanese markets (see e.g. Jorion, (1991), Hamao (1988) and Brown and Otsuki (1990)). More recent studies, however, using a conditional international asset pricing model with exchange risk find that the conditional model outperforms the unconditional model used by prior work, and report that the exchange risk is priced for the four largest countries, US, UK, Japan and Germany (see e.g. Dumas and Solink, (1995) and Choi et al. (1998)).

Our study concentrates on the macro level issues and contributes to the literature in the following ways. First, the paper clarifies the theoretical issues of the relationship between stock and foreign exchange markets. It discusses the channels through which exogenous shocks impact on these markets and link them together. Secondly, it considers simultaneously both the short-run and the long-run dynamics of the financial markets. Earlier empirical work focused their analysis on the linkage between the returns in the two markets and did not consider the relationship between the *levels* of the series. One of the reasons for concentrating on returns is the fact that financial time series do not satisfy the basic assumption of stationarity required to avoid spurious inferences based on regression analysis. By differencing the variables, however, some information regarding a possible linear combination between the levels of the variables may be lost. It should be noted that economic theory does not preclude a relationship of exchange rates and stock prices in terms of *levels.* The use of cointegration technique, developed initially by Granger (1981) to explore the long-run relationship between two series, overcomes the problem of nonstationarity and allows an investigation into both, the levels and differences, of exchange rates and stock prices.

Thirdly, it is shown that the lack of causal relationship between the stock and foreign exchange markets in a country might be due to the omission of an important variable from the system, which acts as a conduit through which the real exchange rate affects the stock market, invalidating the results of some of the previous studies. Caporale and Pittis (1997) have shown that inferences about the long-run relationship

of variables and the causality structure are invalid in an incomplete system. The important variable omitted from the system is the US stock market, which can be thought of as representing the influence of world markets. As foreign capital restrictions are lifted in the Pacific Basin Stock markets there will be an increase in the degree of correlation between the local market and other financial markets around the world, as well as an increase in the link between the foreign exchange and stock markets.[1]

Finally, previous studies have concentrated almost exclusively on US. Our study examines the relationship between stock and foreign exchange markets for a group of Pacific Basin countries providing another insight into the issue.

The paper tries to answer the following questions. What is the long-run relationship between the stock markets and foreign exchange markets? Has the relationship changed in recent years following the opening of stock markets to foreign investors? What has been the effect of the financial crisis of July 1997 on this relationship? What is the direction of causality between these markets and what are the implications for the transmission mechanism of shocks? Can domestic stock markets be isolated from world markets? Answers to these questions have policy implications for the implementation of exchange rate and foreign exchange control policies. Understanding the dynamic links between stock and foreign exchange markets should also assist multinational corporations in managing their foreign exchange exposure.

The paper is structured as follows. Section II explains methodological issues. It discusses the theoretical links between the stock and foreign exchange markets within the cointegration methodology. It examines the application of multivariate Granger causality tests suggested by Dolado and Lutkerpohl (1996). Testing for the direction of causality is associated with some interesting hypotheses regarding the type of channel that links the stock and foreign exchange markets. It finally explains

[1] Many studies have found supportive evidence on the internationalisation of stock markets following the abolition of foreign exchange controls, see e.g. Taylor and Tonks (1989) for the case of UK based on a bivariate cointegration analysis, and Kasa (1992) for a multivariate framework on US, Japan, England, Germany and Canada. With regard to emerging capital markets, see e.g. Bekaert and Harvey (1995), who have used a regime switching framework to model changes in market integration based on one factor asset pricing model; Bekaert and Harvey (2000) who conditioned mean and variance on both local and world information to capture changes in the degree of market integration; and Phylaktis and Ravazzolo (2000) who measured financial integration by analysing the covariance of excess returns of national stock markets.

the recursive-based method to test for constancy of the long-run relationship developed by Hansen and Johansen (1998). Section III discusses the data and presents the empirical results. Section IV summarises the main findings and the policy implications.

2. METHODOLOGICAL ISSUES

2.1 Bivariate and Trivariate cointegration

The relationship between domestic and foreign stock markets can be represented by

$$(1) \quad P_t^{PBC} = \alpha_0 + \alpha_1 S_t^{PBC} + v_t ,$$

where P_t^{PBC} is the domestic stock price, S_t^{PBC} is the real exchange rate defined as domestic prices relative to foreign prices multiplied by the nominal exchange rate and v_t is a disturbance term.[2] All data are transformed by natural logarithms. Following Chow et al (1997) we use the real exchange rate instead of the nominal because it reflects better the competitive position of an economy with the rest of the world.[3]

On the basis of economic theory the coefficient α_1 can either take a positive or a negative value. One of the explanations of the comovement between foreign exchange and stock markets relates to the relationship of these markets and economic activity. The behaviour of the real exchange rate is one of the major determinants of economic activity. A fall in the real exchange affects the competitiveness of domestic goods versus foreign goods and the balance of trade of a country. This increases the level of domestic aggregate demand and the level of output. The long-run relationship between exchange rates and economic activity has been well documented in several studies (see e.g. Cornell (1983) and Wolff (1988)).

On the other hand, economic activity also affects the level of stock prices. The stock price of a firm reflects the expected future cash-flows, which are influenced by the future internal and external aggregate demand. Consequently, stock prices will incorporate present and expected economic activity as measured by industrial production, real economic growth, employment rate or corporate profits (see Fama (1981), Geske and Roll (1983)). Empirical studies have confirmed the long-run

[2] The nominal exchange rate is expressed in domestic currency per unit of foreign currency.

[3] Furthermore, the nominal exchange rate of these countries has not varied substantially during this period.

positive relationship between stock prices and economic activity (see e.g. Schwert (1990), Roll (1992) and Canova and DeNicole (1995)).[4] Thus, a fall in real exchange rate may increase stock prices through its effect on economic activity implying that $\alpha_1 < 0$. This scenario is based on the "flow" approach to exchange rate determination and will be referred to as the "flow" approach scenario.

There is, however, another scenario concerning the link between the stock and the foreign exchange markets, which is based on the portfolio-balance approach to exchange rate determination and will give rise to $\alpha_1 > 0$. According to this model, agents allocate their wealth amongst alternative assets including domestic money, and domestic and foreign securities. The role of the exchange rate is to balance the asset demands and supplies. Thus, any change in the demand for and supply of assets will change the equilibrium exchange rate. For example, an increase in domestic stock prices will increase wealth and the demand for money and consequently interest rates will go up. High interest rates in turn, will attract foreign capital, resulting in an appreciation of the domestic currency and a rise in the real exchange rate. This scenario will be referred to as the "stock" approach.[5]

Previous studies have estimated equation (1) in difference form and some of them found evidence to support the "flow" approach, some the "stock" approach and others neither. The models described above, however, could be incomplete systems because of the omission of an "important variable". If that is the case inferences about the long-run relationship of variables and the causality structure are invalid. Lutkepohl (1982) and more recently Caporale and Pittis (1997) have shown that the omitted variable in the extended system is the only determining factor for the sensitivity of causality inference between the variables of the incomplete system. Caporale and Pittis (1997) take a first order bivariate VAR and derive the condition for which both eigenvalues are equal to one, which is equivalent to no cointegration

[4] There is the possibility of a J-effect. The deterioration in the terms of trade will increase the costs of imports, domestic inflation and may reduce domestic demand and stock prices. This effect is, however, short-term.

[5] For an individual firm, however, the economic currency exposure will depend on the currency structure of its exports, imports and financing. Thus, devaluation can either raise or lower a firm's stock prices depending whether the firm is an exporting firm or it is a user of imported inputs. If it is involved in both activities, stock prices could move in either direction.

and no causality between the two variables of the system.[6] They go on to show how these inferences are affected if the bivariate VAR is part of a trivariate system and the omitted variable causes a) none, b) one, and c) both variables in the bivariate system.

Thus, non-cointegrability in our system might arise because of the omission of an important "causing" variable. In the present context, the US stock market, representing the world capital markets, could be a conduit through which the foreign exchange and the local stock markets are linked. In the "flow" approach, an increase in the US stock market conveys information about the performance of the US economy since there is a long-run relationship between the stock market and the real activity in a country. That implies an increase in US imports and an increase in Pacific Basin countries' exports since there are substantial trade links between these countries and US. That leads on the one hand, to an appreciation of their currency and a rise in the real exchange rate, and on the other hand, to an increase in the domestic economic activity, which causes the local stock market to rise.[7,8]

Within the "stock" approach, an increase in the US stock market will cause the local stock market to rise as a result of the greater integration between Pacific Basin countries markets and world markets. The resulting increase in wealth will trigger a series of events as explained earlier, which will lead to a rise in the real exchange rate.

The complete system can thus be represented by equation (2)

$$(2) \quad P_t^{PBC} = \alpha_0 + \alpha_1 S_t^{PBC} + \alpha_2 P_t^{US} + v_t ,$$

where P_t^{US} is the US stock price. The coefficients α_1 and α_2 are expected to be positive under both scenarios, "stock" and "flow". We will be distinguishing between the two scenarios and their implied channels of transmission of shocks, also called "stock" and "flow" channels respectively, through the application of multivariate Granger causality tests for cointegrating systems.

In implementing the tests for cointegration we use the likelihood ratio test due to Johansen (1988) and Johansen and Juselius (1990). In the bivariate case $Y_t \equiv (P_{PBC},$

[6] They reaffirm in another way Engle and Granger's (1987) result that at least one-way Granger causality is necessary for cointegration.

[7] See Mundell (1963) and Fleming (1962) for an explanation of how an exogenous increase in exports leads to an increase in real output and an appreciation of the nominal exchange rate.

[8] In a recent paper, Canova and DeNicolo (1995) have shown theoretically and empirically that the relationship between stock returns and domestic output is enhanced when foreign influences are considered.

S_{PBC},) where P_{PBC} is the stock price index in the Pacific Basin country and S_{PBC} the real exchange rate for each Pacific Basin country versus the US; *n* the number of variables in the system, two in this case. If Y_t is cointegrated, it can be generated by a vector error correction model (VECM):

$$(3) \quad \Delta Y_t = \mu + \sum_{i=1}^{k-1} G_i \Delta Y_{t-i} + G_k Y_{t-1} + \varepsilon_t,$$

where μ is a 2 x 1 vector of drift, *G*'s are 2 x 2 matrices of parameters, and ε_t is a 2 x 1 white noise vector. The Johansen trace test statistic of the null hypothesis that there are at most r cointegrating vectors $0 \le r \le n$, and thus *(n-r)* common stochastic trends is

$$(4) \quad trace = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i),$$

where $\hat{\lambda}_i$'s are the *n-r* smallest squared canonical correlations of Y_{t-1} with respect to ΔY_t corrected for lagged differences and *T* is the sample size actually used for estimation.

In the case of the trivariate system $Y_t \equiv (P_{PBC}, S_{PBC}, P_{US})$ and in equation (3) μ is a 3 x 1 vector of drift, *G*'s are 3 x 3 matrices of parameters, and ε_t is a 3 x 1 white noise vector.

2.2 Multivariate Granger causality tests

Apart from the examination of the long-run co-movements of foreign exchange and stock markets, we explore the short-run dynamics by performing Granger causality tests for cointegrating systems. Such an exercise will provide an understanding of the interactions amongst the variables in the system and will shed light on the type of channel, "stock" and/or "flow", that has linked the various markets.

In exploring the causality issue between stock markets and the real exchange rate we apply the methodology for multivariate Granger causality tests for cointegrating systems suggested by Dolado and Lutkepohl (1996).[9] Dolado and Lutkepohl (1996) propose a method which leads to Wald tests with standard asymptotic χ^2 - distributions and which avoids possible pretest biases associated with the usual procedure of estimating a first order differenced VAR if variables are known

to be I(1) with no cointegration, and an error correction model if they are known to be cointegrated.

Their method is performed directly on the least squares estimators of the coefficients of the VAR process specified in levels of the variables.[10] The procedure is based on the argument that the non-standard asymptotic properties of the Wald test on the coefficients of cointegrated VAR systems are due to the singularity of the asymptotic distribution of the least square estimators. Their suggested method gets rid of the singularity by fitting a VAR process whose order exceeds the true order. They show that this device leads to a non-singular distribution of the relevant coefficients.

The method involves the following steps. First, one finds the lag structure of the VAR by testing a VAR(k) against a VAR(k+1), k ≥ 1 using the standard Wald test. Secondly, if the true data generating process is a VAR(k), a VAR(k+1) is fitted and standard Wald tests are applied on the first k VAR coefficient matrix.

In the context of our paper, the above method implies estimating the undifferenced VAR of VECM of equation (3),

$$(5) \quad Y_t = \mu + A_1 Y_{t-1} + ... + A_p Y_{t-k} + \varepsilon_t ,$$

where A_i are 3 x 3 coefficient matrices in our case. The expanded version of the VAR for each Pacific Basin country is

$$(6) \quad \begin{bmatrix} P_{PBC} \\ S_{PBC} \\ P_{US} \end{bmatrix} = \begin{bmatrix} A_{10} \\ A_{20} \\ A_{30} \end{bmatrix} + \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{bmatrix} \begin{bmatrix} P_{PBC,t-1} \\ S_{PBC,t-1} \\ P_{US,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{PBC} \\ \varepsilon_{SPBC} \\ \varepsilon_{US} \end{bmatrix},$$

where A_{i0} are the parameters representing intercept terms and A_{ij} the polynomials in the lag operator L. We select the lag structure using the Wald test, and then re-estimate the VAR adding one extra lag. Since each equation has the same lag length, we estimate the three equations using OLS as the estimates are consistent and asymptotically efficient.[11] We test various hypotheses concerning the two channels of links between stock and foreign exchange markets.

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[9] The discussion below is presented in terms of the trivariate system.

[10] It should be noted that although the variables are allowed to be potentially cointegrated, it is not assumed that the cointegration structure of the system under investigation is known. Therefore, preliminary unit root tests are not necessary and, the testing procedure is robust to the integration and cointegration properties of the process.

[11] See e.g. Enders (1995).

(i) "Flow" channel: $A_{13}(L) \neq 0$, $A_{23}(L) \neq 0$, $A_{12}(L) \neq 0$.

(ii) "Stock" channel: $A_{13}(L) \neq 0$, $A_{21}(L) \neq 0$.

(iii) "Flow" and "Stock" channels: $A_{13}(L) \neq 0$, $A_{23}(L) \neq 0$, $A_{12}(L) \neq 0$, $A_{21}(L) \neq 0$.

2.3 Tests for parameter constancy in cointegrated VAR-models

An important issue relating to a cointegrating VAR model is that of parameter constancy. Stepthon and Larsen (1991) have shown that Johansen's test may be characterised by sample dependency. This is specifically relevant to our study because the Asian financial crisis in mid 1997 might have affected the links between the stock and the foreign exchange markets. The currency collapse might have made domestic assets less attractive, forcing a stock market collapse and thus, a possible increase in the links between the two markets. Previous work on the 1987 stock market crash and the Mexican crisis has shown that correlations between stock markets increase during a crisis (see e.g. Roll, (1989), Arshanapalli and Doukas, (1993) and Calvo and Reinhart, (1996)).

We apply the recursive estimation suggested by Hansen and Johansen (1998) for the evaluation of parameter constancy in cointegrated VAR models, using estimates from the Johansen FIML technique under two VAR representations. In the "Z-representation" all the parameters of VECM are reestimated during the recursions, while under the "R-representation" the short-run parameters are kept fixed to their full sample values and only the long-run parameters are reestimated.

We perform two tests. The first examines the null hypothesis of constancy of the cointegration space for a given cointegrating rank. Hansen and Johansen (1998) propose a likelihood ratio test, which is constructed by comparing the likelihood function from each recursive sub-sample with the likelihood function under the restriction that the cointegrating vector estimated from the full sample falls within the space spanned by the estimated vectors of each individual sample. The test statistic is distributed as a chi-square with $(n-r)r$ degrees of freedom, where n is the dimension of the cointegrating space.

The second test concerns the non-zero eigenvalues, which have a unique relationship to the cointegrating vectors. Thus, when the cointegrating vectors have

undergone a structural change, this will be reflected in the estimated eigenvalues. Hansen and Johansen (1998) have derived the asymptotic distribution of the estimated eigenvalues.

3 EMPIRICAL RESULTS

3.1 Data

Six Pacific Basin countries were selected for the empirical analysis: Hong Kong, Indonesia, Malaysia, Singapore, Thailand and Philippines. The sample period varies for each country depending on the availability of data. For Malaysia and Thailand the sample period is 1980.01 to 1998.12; for Hong Kong 1981.01 to 1998.12; for Indonesia 1983.05 to 1998.12; for Philippines 1986.05 to 1998.12; and for Singapore 1990.01 to 1998.12. The data consist of monthly stock market index prices (1990=100) expressed in local currency, local bilateral spot exchange rates expressed as domestic currency per U.S. dollar, and consumer price index (1990=100). All the observations were obtained from the *International Financial Statistics* data base in *Datastream*[12] and are end-of-the month observations. All the series are expressed in logarithmic form. The stock market index prices used are as follows: the Hang Seng Price Index for Hong Kong; the Jakarta SE Composite Price Index for Indonesia; the Kuala Lumpur Composite Price Index for Malaysia; the Philippines SE Composite Price Index for the Philippines; the Singapore Straits Times Price Index for Singapore; the Bangkok S.E.T. Price Index for Thailand; and the Standard & Poors' Composition Index for the US.

The real exchange rate is defined as

$$ln\, S_t^{PBC} = ln\, CPI_t^{PBC} - ln\, e_t^{PBC} - ln\, CPI_t^{US},$$

where CPI_t^{PBC} is the consumer price index for the Pacific Basin country, e_t^{PBC} is the nominal exchange rate and CPI_t^{US} is the consumer price index for US.

One of the objectives of the study is to examine the impact of stock markets liberalisation on foreign exchange and stock markets. For this purpose we divided the sample period into pre and post liberalisation sub-periods. In doing so we were faced with two problems. First, liberalisation can take many forms, such as relaxing currency restrictions, reducing foreign ownership restrictions, allowing capital and

[12] The only exception is for Hong Kong, where the CPI series was obtained from the Monthly Statistical Bulletin published by the Hong Kong Monetary Authority.

dividends to be repatriated e.t.c. In addition, these reforms might not take place at the same time. This made the choice of the liberalisation date difficult. Second, in some countries foreigners had been allowed to participate in local markets through indirect means, such as Country Funds and American Depository Receipts (ADRs), prior to the lifting of various restrictions on foreign investors. Theoretical and empirical studies support the view that such means increase the integration of local markets with global markets (see e.g. Errunza, Senbet and Hogan (1998), Tandon (1997) and Urias (1994)).

In Table 1.A, we summarize three different signals of liberalisation for each country: the official liberalisation date (OLD), which is based on information obtained from a variety of sources reported in the table, the First Country Fund (FCF) and the First ADR. In our analysis we have used both the OLD liberalisation date and the date for the introduction of FCF to divide the sample period into pre and post liberalisation sub-periods. The introduction of first ADR has in all cases followed the introduction of FCF. Furthermore, in order to show the extent of liberalisation in these countries we present in Table I.B various indicators of direct and indirect barriers for institutional investors at the end of 1989.[13] As it can be seen our six countries differ in the degree of foreign exchange restrictions. We have on the hand, Hong Kong and Singapore, which have virtually no foreign exchange controls and foreign ownership regulations throughout the period i.e. they have open markets, and on the other hand, Indonesia, Philippines and Thailand, which maintained restrictions even after they have opened their markets to foreign investors. We can refer to these markets as semi-open. Malaysia was a closed market until 1989 and completely open until September 1998.

Thus, our investigation will explore the effects of foreign exchange retsrictions on the links between stock and foreign exchange markets through the division of the sample into pre and post liberalisation sub-periods and through any differences in the results between open and semi-open markets.[14]

[13] We chose that date because many liberalisations clustered in the late 1980's.

3.2 Bivariate and Trivariate cointegration results

Before testing for cointegration we tested for unit roots in all the stock market indices and the real exchange rates for the two sub-periods, whenever that was possible. The results are not presented but can be made available by the authors. We used the Augmented Dickey Fuller test with and without trend as recommended by Engle and Granger (1987) and the Phillips and Perron (1988) test again with and without trend. We found that the null hypothesis of a unit root for the first difference can be rejected for all series. On the other hand, the null hypothesis of a unit root in levels was accepted in all cases.[15] Thus, like most financial series, the stock market and exchange rates are I(1), which means that first differencing is required to achieve stationarity.

We proceeded to test for cointegration for each Pacific Basin country. The results for the bivariate case are shown in Table 2. We use the Johansen trace statistic which has been corrected for small sample bias (see Reimers (1992)).[16] Thus, we use $(T - nk)$ in equation (4) instead of T. The lag length is chosen by applying the Schwarz information criterion (SIC) on the undifferenced VAR developed by Schwarz (1978). Reimers (1992) finds that the SIC does well in selecting the lag length.

Using a 5 percent significance level, we cannot reject the null hypothesis that there are zero cointegrating vectors, either for the first or the second sub-period, for all the countries except Hong Kong in the second sub-period. In the latter case the long-run cointegrating parameter α_1 in equation (1) is 5.488 providing support for the link between the markets based on the portfolio-balance approach to exchange rate determination. The test for excluding S_t^{PBC} from the cointegrating relationship indicates that the restriction is rejected and the coefficient is statistically significant $\left[\chi^2(1) = 5.34\right]$.

In order to identify the direction of causality we have performed a Wald test on the G matrix in equation (3). The hypothesis that the real exchange rate causes the

[14] In the case of Hong Kong the sample period has been divided into the 1980's and 1990's in order to compare possible changes in the links between the markets, which could be due to other factors, such as company information and liquidity.

[15] Lags were added in order to induce whiteness of the residuals.

[16] The trace test appears to be more robust to nonnormality of errors compared to the maximal eigenvalue (see Cheung and Lai (1993) for Monte Carlo results on this issue).

Hong Kong stock market is rejected $\left[\chi^2(1) = 2.41\right]$, whereas the hypothesis for reverse causality is strongly accepted $\left[\chi^2(1) = 59.88\right]$. This finding is to be expected because of the fixed parity between the Hong Kong dollar and the US dollar. Under this regime, the real exchange rate can only change due to variations in the price levels, which can be triggered, by a change in the stock market.[17] For example, considering an increase in the Hong Kong stock market and using the monetary framework that will increase wealth and the demand for real money balances, creating an excess demand for money and a fall in prices (in a full-employment economy) as agents refrain from spending to build up their balances. There is a fall in the real exchange rate, which will reverse itself in the long-run as demand for exports rises and puts pressures on domestic prices.

As explained in section 3.1 non-cointegrability in the previous system can arise because of the omission of an important "causing" variable, which, in the present context, is the US stock market. The results for the trivariate case for all the countries apart from Hong Kong in the second sub-period are shown in Table 3. Using a 5 percent significance level, we cannot reject the null hypothesis that there are zero cointegrating vectors in the first sub-period for any of the countries, both open and semi-open ones. On the other hand, the results for the second sub-period show that the hypothesis that there is one cointegrating vector in the full three-dimensional system cannot be rejected in every case. Furthermore, the null hypothesis that there is one cointegrating vector cannot be rejected for the post liberalisation period when that starts from the introduction of FCF. This confirms the results of other studies that country funds render local markets at least partially integrated. In order to save space in the rest of the analysis, we present the results for the post liberalisation sub-period when FCF is used.

In Table 4, we present the long-run cointegrating vectors for the second sub-period. In every case the results show that the real exchange rate is positively related to the domestic stock market. The US stock market is also positively related to the stock market of each Pacific Basin country providing supporting evidence for the integration of these markets with the US market. In Table 5, we perform the test of

[17] Under fixed exchange rates the price level differential between the domestic and foreign country should be zero if Purchasing Power Parity holds all the time. Since price convergence takes time, however, there can still be variations in the real exchange rate.

excluding S_t^{PBC} and P_t^{US} from the cointegrating relationship. In each case the restriction is rejected, which implies that all estimated coefficients of the accepted cointegrating vectors are statistically significant.

The results from the above analysis have highlighted an interesting point. The lack of foreign exchange restrictions might be neither a necessary nor a sufficient condition for a link between foreign exchange markets and stock markets. It is not a sufficient condition because no such links were found in the first sub-period for both the bivariate and trivariate systems and for both types of markets, open and semi-open. As Bekaert and Harvey (2000) point out liberalisation may not be enough to induce foreign investors to actually invest in the country. Home bias or other concerns such as lack of information on company stocks may impede international investment (see Bekaert (1995) and Levine and Zervos (1996)). For example, Levine and Zervos (1996) have found that countries where information about firms, such as price-earnings ratios, is comprehensive and published internationally, have larger, more liquid, and more internationally integrated stock markets than countries that do not publish firm information as comprehensively and widely.

In order to examine whether this explanation bears support in our particular case, we compared the institutional features of the emerging stock markets in the two periods as presented by the indicators constructed by the International Finance Corporation (IFC). These indicators are available on an annual basis from 1986-1993 for 23 developing countries. The information is given for four of our countries: Indonesia, Malaysia, Philippines and Thailand. Comparing the indicators for 1986 and 1990, one can observe a substantial improvement in accessing market information. For example, the Securities Exchange Bulletin was only available annually or monthly for all the countries in 1986, while since 1990, this information has been made available daily. A similar picture is obtained by looking at whether local brokers or international managers prepare market commentaries in English. In 1986, only in Malaysia, international managers prepared the commentaries. By 1990, this was the case for the other three countries as well. Finally, there was no regular publication of the price-earnings ratio in Indonesia in 1986. This has been, however, available since 1990.

In general, the above evidence lends support to the proposition that access to market information is important to international investors in addition to having access

to the capital market itself. The technological advances also facilitated the accessibility of information during the 1990's.[18]

The lack of differences in the results between open and semi-open markets in the second sub-period indicate that the relaxation of foreign exchange restrictions might not be a necessary condition for a link between foreign exchange and stock markets. This could be the case because substantial trade between the Pacific Basin countries and US provides a link between the economies, the cash flow of companies and thus, the stock markets. Chen and Zhang (1997) have studied the relationship between cross-country stock returns correlations and trades for Pacific Basin countries and found that countries with strong economic ties tend to have financial markets that move together.

3.3 Multivariate Granger causality tests

We examine the short-run dynamics of the system by performing multivariate Granger causality tests. Our objective in this exercise is to test hypotheses concerning the two channels of links between stock and foreign exchange markets. Applying the methodology suggested by Dolado and Lutkepohl (1996) and outlined in section 2.2, we examine the "flow" channel by testing the restrictions $A_{12}(L)=0$, $A_{13}(L)=0$ and $A_{23}(L)=0$, and the "stock" channel by testing the restrictions $A_{13}(L)=0$ and $A_{21}(L)=0$ using the Wald test. In addition, we test the restriction $A_{31}(L)=0$ to examine whether there is a feedback from the Pacific Basin stock market to the US stock market.

The results are shown in Table 6 and cover the second sub-period. It is interesting to note that the restriction $A_{13}(L)=0$ is strongly rejected in all the cases, while the restriction $A_{31}(L)=0$ is accepted in four of these countries. Thus, there is evidence that the US stock market is driving the Pacific Basin stock markets confirming on the one hand, the links between these economies and US, and on the other hand, the price leadership of the US market (see Lin et al, (1994)). The US market, with its dominance in the world market place, is the most influential producer of information.

[18] See e.g. Brady Commission (1988).

The results further show the channel through which the foreign exchange and the local stock markets are linked. In Indonesia and Singapore, the markets are connected through the "flow" channel since the restrictions $A_{12}(L)=0$, $A_{13}(L)=0$ and $A_{23}(L)=0$ are rejected, and in Thailand the markets are connected through the "stock" channel since the restrictions $A_{13}(L)=0$ and $A_{21}(L)=0$ are rejected. For Malaysia and Philippines the markets are connected through both channels since all of the above restrictions are rejected. These results imply that the type of channel is not connected to the degree of stock market openness. For example, in Indonesia, which has a semi-open stock market, the markets are connected through the "flow" channel, while in the other semi-open economy, Thailand the markets are connected through the "stock" channel. In Philippines, another semi-open economy, the markets are connected through stock and flow channels.

3.4 Tests for parameter constancy

In the last set of tests we subject our cointegrated VAR to parameter constancy tests to examine whether the financial crisis, which started with the flotation of the Thai Bhat in July 1997, had an effect on the relationship between the stock and foreign exchange markets. We applied the recursive estimation suggested by Hansen and Johansen (1998) and examined first the null hypothesis of constancy of the cointegrating space for a given rank. The base period varies for each country, depending on the introduction of FCF, but ends in 1994.12 and the extension is done by adding the succeeding observations one by one until the end of the sample, which is 1998.12. The likelihood ratio test, which compares the likelihood function from each recursive sub-sample with the likelihood function under the restriction that the cointegrating vector estimated from the full sample falls within the space spanned by the estimated vectors of each individual sample, has been scaled by the 95 percent quantile in the χ^2- distribution such that unity corresponds to a test with a 5 percent significance level.

Figures 1a to 6a show the path of the test statistics for each of the countries. For Hong Kong and Philippines the null hypothesis of parameter constancy cannot be

rejected.[19] There is some instability around the time of the crisis, but the statistic remains well below one. For the rest of the countries the increase in the statistic is such that passes unity substantially and that is more so in the case of Thailand and Indonesia.[20,21] For all the countries, apart from Indonesia, the statistic falls below one by February 1998, while in the case of Indonesia that takes place in February and then it rises again for the month of June before settling down. This brief increase is noticed in the other countries as well but the statistic remains below one. This increase could be due to the Russian crisis, which shook confidence again in emerging markets.

Figures 1b to 6b show the time path of the eigenvalues with 95 percent confidence bands. Apart from Hong Kong and Philippines there is a change during the period of the crisis. It is also observed that the point estimates increase resulting in bigger parameter estimates compared to the rest of the period.

The above results confirm that the hardest hit countries by the crisis were Indonesia and Thailand. The effect did not last for long and the long-run relationships between stock and foreign exchange markets was soon reestablished. That confirms the return of foreign funds to these countries. Net private capital flows to Asia were $102 billion in 1996, 38.5 in 1997, and an estimated 1.5 in 1998 and 58.8 in 1999.[22] Finally, the results show the increase in links between stock and foreign exchange currency returns during a crisis and confirm the results of studies, which examine intermarket relationships around the international market crash of October 1987.[23] These studies generally suggest that intermarket relationships intensified for a brief period around the crash, but then quickly resumed their normal pre-crash period relationships.

[19] It should be noted that a specific alternative is not formulated and that the recursive analysis should be seen as a misspecification test where the purpose is to detect possible instabilities in the parameters.

[20] The parameter constancy tests for Hong Kong refer to the bivariate case.

[21] In the case of Singapore the "Z" representation is marginally higher than unity in the first few months of 1995. Had the level of significance been 1 percent the null hypothesis of parameter constancy would have been accepted.

[22] See World Economic Outlook (May, 1998), IMF.

[23] See e.g. Dwyer and Hafer, (1988), Hardouvelis (1988) and Roll (1989).

4. SUMMARY AND CONCLUSIONS

In this paper, we have examined the long-run and short-run dynamics between stock prices and exchange rates in a group of Pacific Basin countries. Our main concerns were to examine whether these links were affected by the existence of foreign exchange controls, and by the Asian financial crisis of mid 1997.

We have examined these issues by applying cointegration methodology, which tests for a long-run relationship between the stock market in each Pacific Basin country, its real exchange rate, and the US stock market, and we have used recursive-based estimation to test for parameter constancy. We performed multivariate Granger causality tests to study further the interactions between the various markets.

The following conclusions have been derived from our analysis:

First, we found no long-run relationship between the real exchange rate and the local stock market in each Pacific Basin country for either the decade of the 1980's, or the decade of the 1990's, with the exception of Hong Kong. These cointegration and causality inferences are however invalid because the system is shown to be incomplete.

Secondly, the US stock market is found to be an important "causing" variable, which acts as a conduit through which the foreign exchange and the local markets are linked. The results of the trivariate system suggest that for all the countries the real exchange rate and the US stock prices are positively related to domestic stock prices for the period of the 1990's.

Thirdly, foreign exchange restrictions have not been found to be an important determinant of the link between the domestic stock and foreign exchange markets on the one hand, and between the domestic capital and world capital markets on the other hand. Free capital flow is not sufficient for international investment, access to market information is also important. Links between markets can also be fostered through other channels. This latter result supports the evidence presented in other studies (see e.g. Phylaktis (1997, 1999), which have found for the shorter end of financial instruments that there is substantial capital market integration between the Pacific-Basin Region and US during the 1990's even for countries with extensive foreign exchange controls. The open character of these economies in terms of exports and imports and the substantial trade with US provides a possible explanation for these results. A country's external trade to another country measures the degree of economic integration between them and the degree of how much the two economies'

cash flows are intertwined. Thus, financial integration can be closely related to economic integration. In addition, the analysis has provided evidence that Country Funds offer a way to foreign investors for accessing local markets and increasing their integration with global markets even in the presence of foreign exchange restrictions. Our results are at variance with Bekaert and Harvey (1998b), who have also made an attempt to date the integration of emerging markets with world markets by looking for a common break in the process generating the financial time series, which are likely to be related to the integration process. They included four of the countries in our sample, Malaysia, Indonesia, Philippines and Thailand. For Indonesia and Malaysia, the breaks found are much later than either the official liberalisation date or the introduction of the FCF. For Philippines, the dividend yield series presents the earliest break and is very close to the FCF date, while for Thailand US equity flows to market capitalisation has the earliest break and is close to the official liberalisation date. A possible explanation for the different results between our study and Bekaert and Harvey (1998b) might be the fact that our analysis is done within a better defined framework.

Fourthly, the results of the multivariate causality tests indicate that on the whole, the US stock market drives the system confirming the influence of the US on these economies. They also show the channel through which this influence brings together the foreign exchange and local stock markets. The channel has been found not to be connected to the degree of stock market openness.

Finally, the parameter constancy tests indicate that the increase in the parameters during the height of the Asian crisis was short lived and confirm that Indonesia and Thailand were badly affected. These results are in agreement with other studies which have studied the October 1987 crash and found that intermarket relationships intensified for a brief period around the crash, but then quickly resumed their normal pre-crash period relationship.

In conclusion, the analysis indicates that care should be taken in implementing exchange rate policies since stock and foreign exchange markets are closely linked. Furthermore, it indicates that the existence of foreign exchange restrictions does not isolate the domestic capital markets from world influences. The general increase in international trade and the resultant increase in economic integration have also increased financial integration and reduced the benefit of international diversification.

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Table 1.A: Comparison of different signals of liberalisation

Country	Official Liberalisation date	First Country Fund	First ADR
Hong Kong	01.73[a]	-	-
Indonesia	09.89[b]	02.89[b]	04.91[e]
Malaysia	12.88[b]	12.87[b]	08.92[b]
Philippines	06.91[c]	05.86[b]	03.91[b]
Singapore	06.78[a]	-	-
Thailand	09.87[d]	07.85[b]	01.91[b]

Source:

[a] Exchange Arrangements and Restrictions, IMF publications, (various issues).

[b] Bekaert and Harvey (1998a) and coincides with the International Finance Corporation (IFC) official liberalisation date, which is based on the Investable Index and represents the ratio of the market capitalisation of stocks that foreigners can legally hold to market capitalisation. A large jump in the Index is considered as evidence of an official liberalisation.

[c] Bekaert, and Harvey (2000). The date is in accord with the Foreign Investment Act, which removed, over a period of three years, all restrictions on foreign investments. Under the provisions, foreign investors are required only to register with the Securities and Exchange Commission and most sectors of the economy are opened to 100 percent foreign ownership. This date differs from the IFC official liberalisation date, which is October 1989, and is not associated with any particular regulatory changes.

[d] Bekaert and Harvey (2000). This date is in accord with the inauguration of the Stock Exchange of Thailand's Alien Board, which allows foreigners to trade stocks of those companies that have reached their foreign investment limits. Thais continue to trade stocks on the Main Board. Bailey and Jagtiani, (1994) report the same liberalisation date. This date differs, however, from the IFC liberalisation date, which is December 1988, and is not associated with any particular regulatory changes.

[e] Bekaert and Harvey (2000). In Bekaert and Harvey (1998a) 02.1992 is reported as the first ADR.

Table 1.B: Emerging stock markets - Direct and indirect barriers for institutional investors (end-1989)

	Foreign ownership Limit	Dividends Repatriation	Capital Repatriation	Withholding Taxes on Dividend	Taxes on Capital Gains
Hong Kong	100%	Free	Free	0.0%	0.0%
Indonesia	49%[a]	Free	Free	20.0%	20.0%
Malaysia	100%[b,]	Free	Free	35%(0%)	0.0%
Philippines[c]	40%[d]	Free	Free	15.0%	0.25%
Singapore	100%	Free	Free	0.0%	0.0%
Thailand	49% (25%)[e]	Free[f]	Free	20%(10)	25%(10)

Source: The table is based on the information provided in the IFC' s Factbook, Harrison (1994), the Euromoney Annual Report and the Exchange Arrangements and Restrictions, IMF. All the data are as of end-1989. Rates shown in brackets apply only to approved new money Country Funds, where these may be different from normal treatment.

[a] The limit is reduced to 25% of own capital for foreign exchange banks and non-bank financial institutions.

[b] Foreign acquisition of investments exceeding M$ 5 million in value or equivalent of 15% or more of voting power in a Malaysian company requires the prior approval of the Foreign Investment Committee. In September 1998, the financial markets were completely closed to foreigners.

[c] Transaction taxes on gross transaction value.
[d] Foreign nationals may purchase shares up to 40% of a company's shares via B shares. Foreign participation beyond 40% needs to have prior approval by the Board of Investment (BOI). Investment not exceeding 40% need simply to be reported to BOI and the Central Bank of the Philippines for purposes of repatriation of capital and remittance of profits.
[e] Foreign investors are allowed to hold up to 49% of companies listed on the SET with the exception of the commercial banks and finance companies, where foreign ownership is restricted to 25% of the capital.
[f] A report is required for the repatriation of dividends and capital gains.

Table 2: Bivariate Cointegration tests

	Johansen test statistics	
	H_0:r = 0	H_0:r ≤ 1
Hong Kong		
Jan1981-Dec1989(OLD)	1.71	0.22
Jan1990-Dec1998(OLD)	54.73**	6.13
Indonesia		
May1983-Jan1989(FCF)	9.18	1.91
May1983-Aug1989(OLD)	4.57	0.74
Feb1989-Dec1998(FCF)	6.06	0.20
Sep1989-Dec1998(OLD)	5.25	0.00
Malaysia		
Jan1980-Nov1987(FCF)	2.49	0.27
Jan1980-Nov1988(OLD)	4.57	0.87
Dec1987-Dec1998(FCF)	4.13	1.14
Dec1988-Dec1998(OLD)	3.39	0.49
Philippines		
May1986-Dec1998(FCF)	10.40	0.08
June1991-Dec1998(OLD)	4.70	0.19
Singapore		
Jan1990-Dec1998(OLD)	13.84	1.53
Thailand		
Jan1980-May1985(FCF)	7.64	3.01
Jan1980-Aug1987(OLD)	6.46	0.38
June1985-Dec1998(FCF)	3.37	0.18
Sep1987-Dec1998(OLD)	1.52	0.00

Notes: In the case of Hong Kong, a dummy variable was used, which took the value of one for the period 1997.01-1998.12 to capture the unification with China. If r denotes the number of significant vectors, then the Johansen trace statistics test the hypotheses of at most one and zero cointegrating vectors, respectively. The critical values introduced by Osterwalt-Lenum (1992) were used. The only exception is for Hong Kong, where the critical values have been re-evaluated by applying a Monte Carlo Simulation, repeated 10,000 times for a number of 400 observations, using the program DiSco, in order to consider the presence of the dummy. The statistics include a finite sample correction (see Reimers (1992)). * and ** denote significance at 10 % and 5% level respectively. OLD indicates the official liberalisation date; and FCF indicates the date for the introduction of the First Country Fund.

Table 3: Trivariate Cointegration tests

	Johansen test statistics		
	H_0:r = 0	H_0:r ≤ 1	H_0:r ≤ 2
Hong Kong			
Jan1981-Dec1989(OLD)	17.18	7.70	0.01
Indonesia			
May1983-Jan1989(FCF)	18.35	5.57	1.87
May1983-Aug1989(OLD)	12.68	4.37	0.67
Feb1989-Dec1998(FCF)	36.72**	15.64	5.47
Sep1989-Dec1998(OLD)	34.93**	13.82	4.14
Malaysia			
Jan1980-Nov1987(FCF)	15.64	4.57	0.55
Jan1980-Nov1988(OLD)	13.48	6.00	0.63
Dec1987-Dec1998(FCF)	41.28**	16.78	3.36
Dec1988-Dec1998(OLD)	25.61**	3.46	0.00
Philippines			
May1986-Dec1998(FCF)	43.07**	17.18	3.48
June1991-Dec1998(OLD)	35.09**	8.57	3.18
Singapore			
Jan1990-Dec1998(OLD)	41.05**	15.96	5.00
Thailand			
Jan1980-May1985(FCF)	20.66	11.03	3.42
Jan1980-Aug1987(OLD)	19.77	7.23	0.05
June1985-Dec1998(FCF)	34.91**	15.30	6.16
Sep1987-Dec1998(OLD)	41.41**	16.70	5.72

Notes: If r denotes the number of significant vectors, then the Johansen trace statistics test the hypotheses of at most two, one and zero cointegrating vectors, respectively. The critical values introduced by Osterwalt-Lenum (1992) were used. The statistics include a finite sample correction (see Reimers (1992)). * and ** denote significance at 10 % and 5% level respectively. OLD indicates the officla liberalisation date; and FCF indicates the date for the introduction of the First Country Fund.

Table 4: The long-run cointegrating vector of $P_t^{PBC} = \alpha_0 + \alpha_1 S_t^{PBC} + \alpha_2 P_t^{US} + v_t$ for the post-liberalisation period starting with the introduction of the First Country Fund.

	α_0	α_1	α_2
Indonesia Feb1989-Dec1998	10.561	1.635	1.361
Malaysia Dec1987-Dec1998	2.427	3.823	1.320
Philippines May1986-Dec1998	9.601	2.600	0.674
Singapore Jan1990-Dec1998	3.884	3.443	0.576
Thailand June1985-Dec1998	17.971	6.510	1.617

Table 5: Test of exclusion restrictions for S_t^{PBC} and P_t^{US}

	S_t^{PBC}	P_t^{US}
Indonesia Feb1989-Dec1998	6.40**	8.19**
Malaysia Dec1987-Dec1998	4.24**	8.10**
Philippines May1986-Dec1998	9.35**	6.84**
Singapore Jan1990-Dec1998	4.14**	6.20**
Thailand June1985-Dec1998	4.40**	6.91**

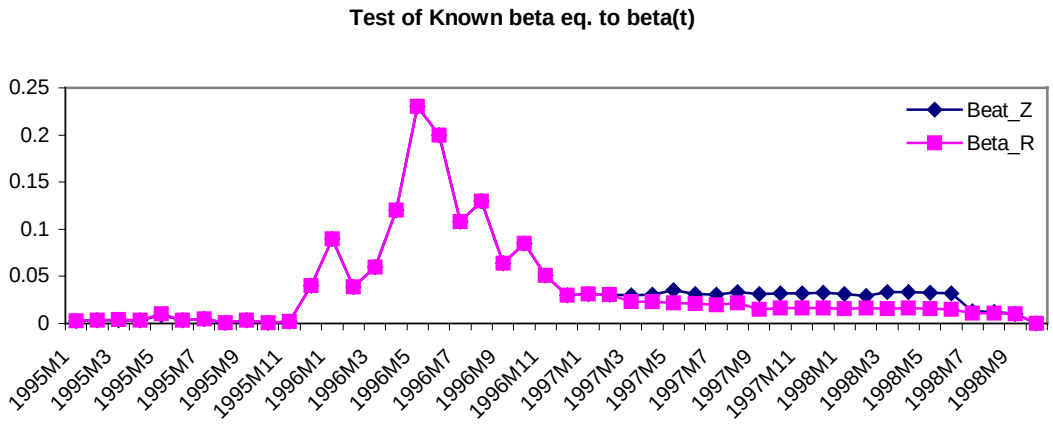
Notes**: F**igures are χ^2 statistics with one degree of freedom. ** denotes significance at 5%.

Table 6: Multivariate Granger Causality Tests for the post-liberalisation period starting with the introduction of the First Country Fund.

		$A_{12}(L)=0$	$A_{13}(L)=0$	$A_{21}(L)=0$	$A_{23}(L)=0$	$A_{31}(L)=0$
Indonesia	$\chi^2(2)$	8.376**	12.006**	0.990	4.677*	4.161
Feb89-Dec98	P value	(0.01)	(0.00)	(0.38)	(0.09)	(0.13)
Malaysia	$\chi^2(2)$	14.336**	31.315**	15.787**	7.096**	2.800
Dec87-Dec98	P value	(0.00)	(0.00)	(0.00)	(0.03)	(0.25)
Philippines	$\chi^2(2)$	5.909*	19.001**	6.349**	6.545**	12.729**
Ma86-Dec98	P value	(0.052)	(0.00)	(0.042)	(0.04)	(0.00)
Singapore	$\chi^2(2)$	5.772*	49.036**	1.342	10.873**	3.578
Jan90-Dec98	P value	(0.055)	(0.000)	(0.511)	(0.004)	(0.17)
Thailand	$\chi^2(2)$	7.775**	35.875**	5.452*	3.351	3.460
Jun85-Dec98	P value	(0.02)	(0.00)	(0.06)	(0.187)	(0.18)

Notes: For an explanation of the restrictions see equation (6). Figures in parentheses are P-values. * and ** denote significance at 10% and 5% level respectively.

Figure 1a: Hong Kong



1 is the 5% significance level

Figure 1b: Hong Kong

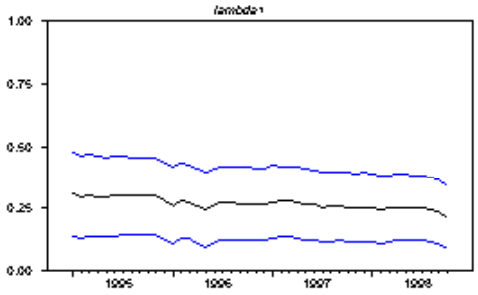
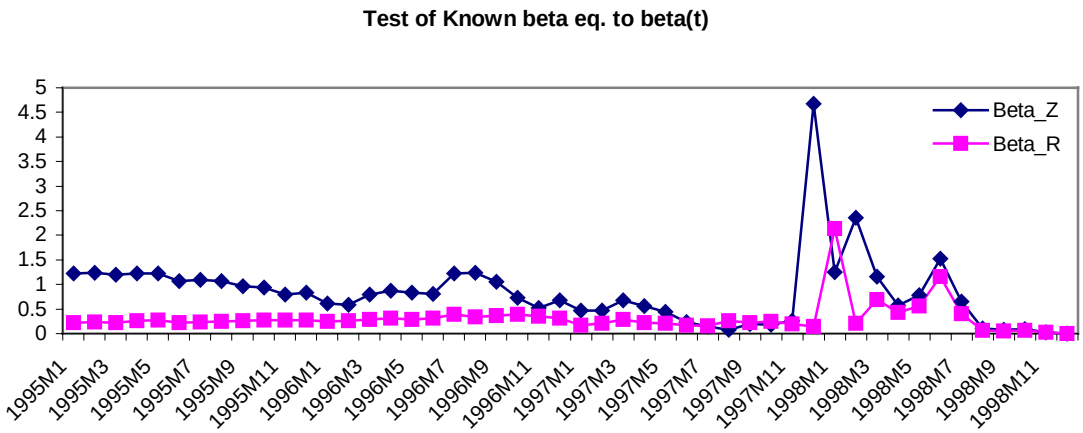


Figure 2a: Indonesia



1 is the 5% significance level

Figure 2b: Indonesia

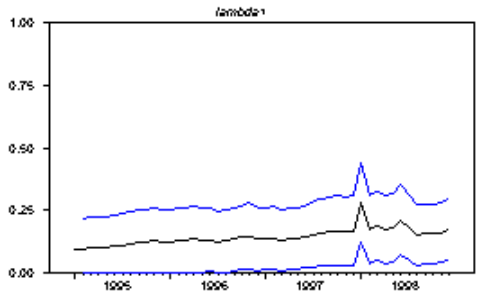
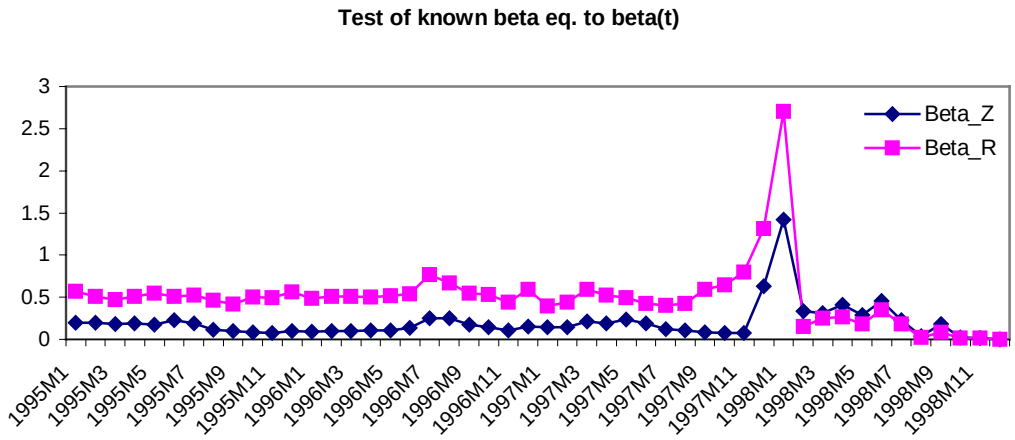


Figure 3a: Malaysia



1 is the 5% significance level

Figure 3b: Malaysia

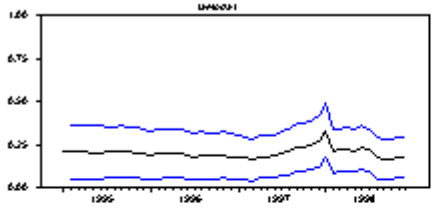
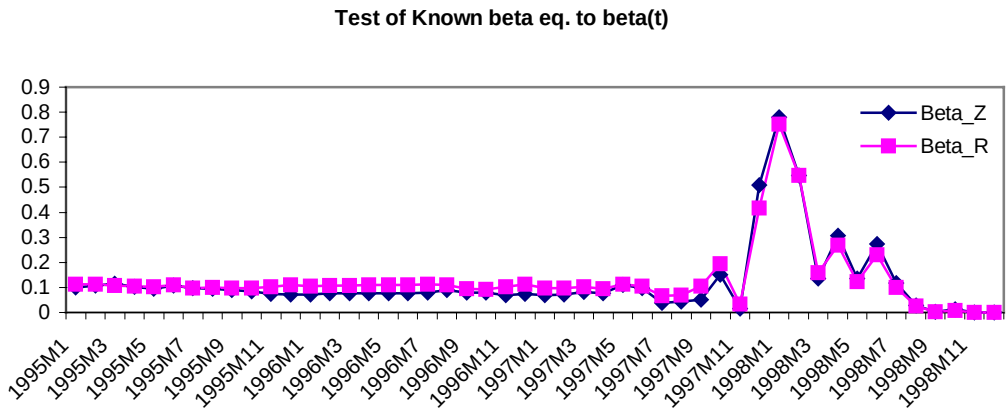


Figure 4a: Philippines



1 is the 5% significance level

Figure 4b: Philippines

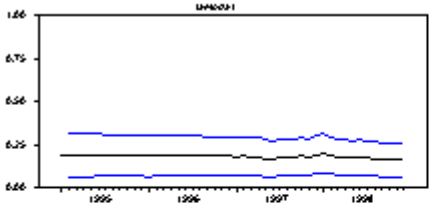
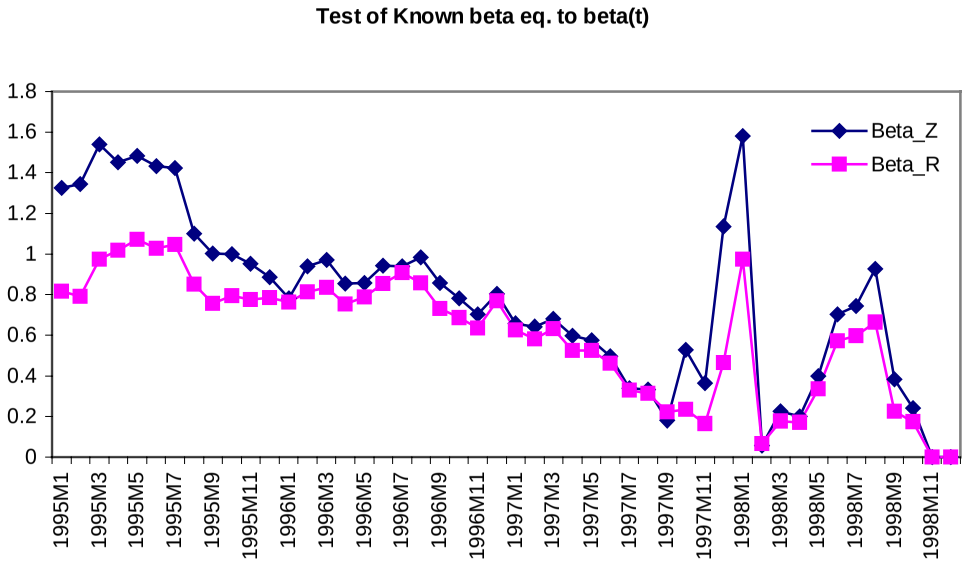


Figure 5a: Singapore



1 is the 5% significance level

Figure 5b: Singapore

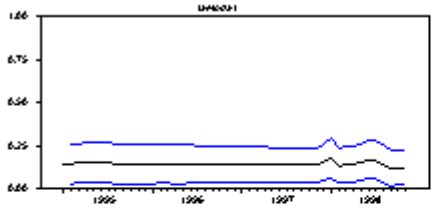
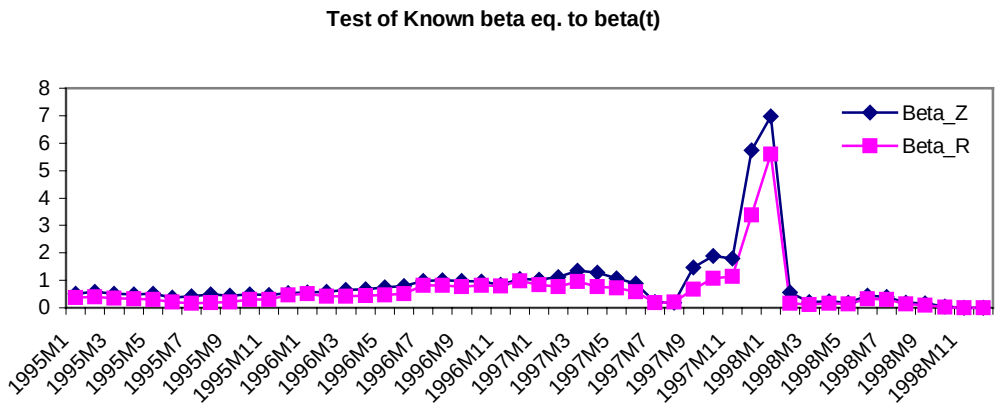


Figure 6a: Thailand



1 is the 5% significance level

Figure 6b: Thailand