

## THE DYNAMIC RELATIONSHIP BETWEEN THE FOREIGN EXCHANGE EXPOSURE AND STOCK MARKETS: EVIDENCE DURING THE GLOBAL ECONOMIC CRISIS

Nik Muhamad Naziman Ab RAHMAN<sup>1</sup>

Yusrina hayati Nik Muhd NAZIMAN<sup>2</sup>

Amri Ab. RAHMAN<sup>3</sup>

### ABSTRACT

*This paper examines the dynamic linkages between the foreign exchange and stock markets for five East Asian countries, including Hong Kong, Japan, Malaysia, Singapore, and Thailand. While the literature suggests the existence of significant Interactions between the two markets, our empirical results show that, in general, exchange rates Granger-cause stock prices with less significant causal relations from stock prices to exchange rates. Furthermore, this one-way Granger causality effect from exchange rates to stock prices becomes less significant during the US financial crisis of 2009. Our results also suggest that, there is insignificant long-run outlook (no cointegration) except for Hong Kong, implies that these financial assets share on common trends in their economy system and hence they will move apart in the long-run for countries that have higher trade size exchange rate fluctuations tend to exhibit significant influence on the equity market, regardless of the exchange rate arrangement system and the degree of capital controls during the US financial crisis of 2009.*

**Keywords:** Foreign exchange Exposure, Stock markets, Global crisis

### INTRODUCTION

Argument of whether stock prices and exchange rates are related or not, has received considerable attention after the East Asian crises. The financial crisis that affects the countries affected saw

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<sup>1</sup> Universiti Teknologi MARA (UiTM) Kelantan Campus, Bukit Ilmu, 18500 Machang, Kelantan, Malaysia

**E-mail:** [naziman925@kelantan.uitm.edu.my](mailto:naziman925@kelantan.uitm.edu.my)

<sup>2</sup> Universiti Teknologi MARA (UiTM) Kelantan Campus, Bukit Ilmu, 18500 Machang, Kelantan, Malaysia

**E-mail:** [yusrina@kelantan.uitm.edu.my](mailto:yusrina@kelantan.uitm.edu.my)

<sup>3</sup> Universiti Teknologi MARA (UiTM) Kelantan Campus, Bukit Ilmu, 18500 Machang, Kelantan, Malaysia

**E-mail:** [amri@kelantan.uitm.edu.my](mailto:amri@kelantan.uitm.edu.my)

turmoil in both currency and stock markets. If exchange rates and stock prices are related and the causation runs from exchange rates to stock prices then crises in the stock markets can be prevented by controlling the exchange rates. Likewise these developing countries can exploit such a link to attract/stimulate foreign portfolio investment in their own countries. Similarly, if there is a causal relationship from stock prices to exchange rates then authorities can focus on domestic economic policies to stabilize the stock market. Also these will benefit the investors if the two markets/prices are related then they can use this information to predict the behavior of one market using the information on other market.

Review from the related literature shows that the stock prices-exchange rate relationship has focused on examining this relationship for the developed countries with very little attention on the developing countries. The findings are ambiguous. Smith (1992), Solnik (1987), and Aggarwal (1981) found that is a significant positive relationship between stock prices and exchange rates while Soenen and Hennigar (1998) have reported a significant negative relationship between the stock prices-exchange rate relationship. On the other hand, Franck and Young (1972), Eli Bartov and Bodnor (1994) in their studies found that there is very weak or no association between stock prices and exchange rates. In relation to causation, the evidence is also mixed. Abdalla and Murinde (1997) have found causation runs from exchange rates to stock prices while Ajayi and Mougoue (1996) reported that a reverse causation. Bahmani-Oskooee and Sohrabian, (1992) exposed that the relationship between stock prices and exchange rates is bidirectional.

Based on the theoretical consensus, there is no proper relationship between stock prices and exchange rates either. In evaluating the portfolio balance models for examples, the exchange rate determination postulate a negative relationship between stock prices and exchange rates and that the causation runs from stock prices to exchange rates. The exchange rates play the main role in balancing the demand for and supply of assets. Due to an increase in domestic stock prices lead individuals to demand more domestic assets. Buying more domestic assets local investors would sell foreign assets (they are relatively less attractive now), causing local currency appreciation. Due to an increase in wealth can rise in domestic asset prices will also lead investors to increase their demand for money, which in turn raises domestic interest rates. Then this will again leads to appreciation of domestic currency by attracting foreign capital. In contrast for the same negative relationship is increase in foreign demand for domestic assets due to stock price increase would also cause a domestic currency appreciation. While the argument, if a positive relationship between stock prices and exchange rates with direction of causation running from exchange rates to stock prices can be explained as follows: a domestic currency depreciation makes local firms more competitive, leading to an increase in their exports and their stock prices. The factors that cause changes in exchange rates may be different from the factors that cause changes in stock prices. Under such scenario, it is clear that there is no empirical or theoretical consensus on the issue of

whether stock prices and exchange rates are related and the direction of causation if they are related.

### **Objectives of the study**

The primary objective of this study is to investigate the dynamics interactions between exchange rates and stock prices using recent developments in time series modelling. This study investigates whether these national stock markets in the periods are moving in tandem and in equilibrium or they depart permanently from each other in short and long run. The Asian emerging markets selected for analysis are Malaysia, Thailand Singapore and world major equity markets are Hong Kong and Japan in this region. The research employed the Johansen and Juselius (1990) multivariate approach to test for long-run market integration. The test is powerful to estimate the interdependence of multi-countries stock markets. Test on serial co-movement of stock prices will establish whether a stable long-run cointegrating relationship exists among the selected markets. The dynamic approach suggested by Johansen and Juselius (1990) allows market structure to change throughout the sample period. We extend the analysis to assess long and short-run market integration or to gain insight into the short-run and long run lead-lag or causal relationships between these major ASIAN emerging markets and world markets by using three separate model of five-dimensional vector autoregressive (VAR) model including vector error-correction modelling (VECM). The dynamic VECM representation provides us with a framework to test for the temporal causal dynamics in the Granger sense among the price indexes through both short-run and error-correction channels of causation (Granger, 1988). Short-run VAR market integration test will determine whether prices in different markets respond “immediately” to changes in other equity markets.

This study differs from most of the existing literature in the following aspects: (1) The study employs more recent daily observation covering the period of the US financial crisis from January 2008 to February 2009. (2) The study considers the dynamic relationships of market liberalisation on the long run relationships among the equity markets. (3) The multivariate Johansen and Juselius (1990) maximum likelihood procedure is supplemented by vector error correction modelling methods to analyse dynamic aspect of markets integration.

### **METHODOLOGY**

The prerequisite condition for the series to be cointegrated is that the series must have the same order of integration. The order of integration of a series is determined by the number of times that the series must be difference before achieving stationary. A series,  $Y_t$  is said to be integrated of order  $d$  if the series achieves stationary after differencing  $d$  times and denoted as  $Y_t \sim I(d)$ . For instance, if price series ( $Y_t$ ) is not stationary at its level but becomes so after first differencing, (i.e.  $Y_t - Y_{t-1}$  is stationary) we describe this as  $Y_t \sim I(1)$ . If  $Y_t$  is stationary at its level before first

difference, then we describe it as  $Y_t \sim I(0)$ . Thus the very beginning step in the cointegration analysis is to determine the order of integration of the series.

We ADF and PP unit root test to test the stationary properties of the variables. Schwert (1987) and latter on, Campbell and Perron (1991) noted that ADF is better for small-sample data set. In testing the order of integration using ADF approach, the following two ADF regression equations could be estimated:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^L \delta_i \Delta Y_{t-i} + v_t \quad (1)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 T + \sum_{i=1}^L \delta_i \Delta Y_{t-i} + \tau_t \quad (2)$$

Where  $\Delta Y_t$  is the first difference of the series,  $\alpha_0$  is intercept,  $\alpha_1$  and  $\alpha_2$  are constant,  $v_t$  and  $\tau_t$  are disturbance terms,  $T$  is time or trend variable and  $L$  is the number of lagged terms. To ensure disturbance term  $v_t$  and  $\tau_t$  are approximately white noise, a sufficient number of lagged differences  $L$  should be estimated. The optimum lag length  $L$  may be determined by using the Akaike Information Criteria (AIC) suggested by Akaike (1977). The null hypothesis is that the level of the series,  $Y_t$  contains a unit root  $H_0: Y_t$  is  $I(1)$  and the alternative hypothesis is that  $H_1: Y_t$  is not  $I(1)$ . We reject the null hypothesis when  $\alpha_1$  is found to be negative and statistically significant. The rejection (or acceptance) of the null hypothesis is made by calculating a t-ratio of  $\alpha_1$  to its standard error. The critical value for the test is compared to critical values provided by Fuller (1976). The unit root test in level is only necessary but not sufficient condition for the series to be integrated of order one,  $I(1)$ . To conform that the series is  $I(1)$ , then the sufficient condition has to be tested using unit root test on the first difference for equations 1 and 2. We follow given regression for empirical analysis:

$$\Delta^1 Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^L \delta_{1,i} \Delta^1 Y_{t-i} + v_t \quad (3)$$

$$\Delta^1 Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 T + \sum_{i=1}^L \delta_i \Delta^1 Y_{t-i} + \tau_t \quad (4)$$

Where  $\Delta^1 Y_t$  is the first difference of the series. The null hypothesis is  $H_0: Y_t \sim I(1)$ , which is rejected in favour of  $I(2)$  if  $\alpha_1$  is found to be negative and statistically significant from zero. This test is known as unit root test in first difference. Phillips Perron (PP) unit root test proposed by Phillips and Perron (1988) is more robust in the sense that PP allows for wide variety of serial correlation and time dependent heteroskedasticity. It is also has been considered to be powerful test to moderate and small sample size. The PP test estimates the following equations for a series  $Y_t$ :

$$\Delta Y_t = \mu_1 + \alpha_1 Y_{t-1} + \varepsilon_t \tag{5}$$

$$\Delta Y_t = \mu_t + \alpha_1 Y_{t-1} + \alpha_2 t + \varepsilon_t \tag{6}$$

Where  $\Delta Y_t$  is the first difference of  $\Delta Y_{t-1}$ ,  $t$  is trend variable. In equation 5, for  $Y_t$  to be stationary, the adjusted t-statistic  $Z(t^*_\alpha)$  should be negative and significantly difference from zero. For  $Y_t$  to be stationary around linear trend in equation 5, the adjusted t-statistic  $Z(t^\wedge_\alpha)$  should be negative and significantly different from zero. The critical value for PP tests is given in MacKinnon (1991). Like the ADF test, the PP test is also sensitive to the choice of truncated lag parameters. The criteria discussed in Schwert (1989) may be used to determine the appropriate lag length in the PP tests.

**Johansen cointegration approach**

We apply the Johansen maximum-likelihood approach to examine the cointegration between the variables. This approach permits in examining linear restriction for cointegrating estimates (Perman, 1991). To illustrate this approach, let  $Y_t$  be a vector of  $N$  time series variables, each of which is integrated of order 1. Assume that  $Y_t$  can be modelled by the vector autoregression,

$$Y_t = \beta_1 Y_{t-1} + \dots + \beta_k Y_{t-k} + \alpha + v_t \quad \text{Where } t=1 \dots T \tag{7}$$

Here  $Y_t$  is  $N \times 1$  vector of stochastic variables; all  $Y_{t-k}$  are assumed predetermined;  $\alpha$  is a  $N \times 1$  vector of constant;  $v_t$  is a vector of normal distributed error with zero mean and constant variance; and  $k$  is the maximum number of lag length processing the white noise. The lag length of  $k$  is chosen by using the Akaike Final Prediction Errors (FPE) criterion. In brief, the technique chooses the length which minimise the forecast error of the series. The following formulation is used:

$$FPE = [(T + k)/(T - k)]\sigma^2 \tag{8}$$

where  $T$  is the number of observations,  $k$  is the number of lags and  $\sigma^2$  is variance. The system of equation 7 can be rewritten in the first difference and in the reduce form as follows:

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \dots + \Gamma_{k-1} \Delta Y_{t-k-1} + \Pi Y_{t-k} + e_t \tag{9}$$

Where  $\Gamma_i = -[I - \Pi_1 - \dots - \Pi_i]$  , (  $i = 1, \dots, k-1$  )

And  $\Pi = -[I - \Pi_1 - \dots - \Pi_k]$

Equation 9 is in the form of traditional VAR model of Sims (1980) in first differences except for the  $\Pi Y_{t-k}$  term. The matrix  $\Pi$  is called the long-run impact matrix. This term determines whether or not, and to what extent, the system of equation is cointegrated. The rank of the  $\Pi$  matrix shows the

number of cointegrating vectors. If the value of the matrix  $\Pi$  is  $r$ , then there are  $r$  cointegrating relationships among the elements of  $Y_t$ . When  $r = 0$ , there is no long run relationship among the price series. In the case of  $0 < \text{rank}(\Pi) = r < p$ , where  $r$  is the rank of the matrix and  $p$  is the number of variables in the system, there exist one or more cointegrating relationship among the variables. Johansen's procedure is to determine the rank of the  $\Pi$  matrix by testing whether the eigenvalues of  $\Pi$ , the estimated of  $\Pi$ , are significantly different from zero. If the matrix  $\Pi$  is full rank, then any linear combination of  $Y_t$  is stationary. If the rank  $(\Pi) = 0$ , the matrix  $\Pi$  is null matrix then equation 9 collapse to the traditional VAR model with first differences. To test the null hypothesis that are at most  $r$  cointegrating vectors in a set of  $p$  variables, first regress  $\Delta Y_t$  on  $Y_{t-1}, Y_{t-2}, \dots, Y_{t-k+1}$  and output the residuals,  $D_t$ . For each  $t$  and  $D$  has an  $n$  element. Second, regress  $Y_{t-k}$  on  $\Delta Y_{t-1}, Y_{t-2}, \dots, Y_{t-k+1}$  and output the residuals,  $L_t$ . For each  $t$  and  $L_t$  has  $n$  elements. Then compute squares of the canonical correlation between the two residual, denoting them as  $Q^2_i$  ( $Q^2_1 > Q^2_2 > \dots > Q^2_i$ ). The likelihood-ratio test of the null hypothesis is obtained by the trace test defined as:

$$\text{Trace Tests} = -T \sum_{i=r+1}^p \ln(1 - Q_i^2) \tag{10}$$

Where time period is denoted by  $T$ . The null hypothesis of trace test is to find either cointegrating vector is equal to  $r$  or not. The null of  $r = 0$  is test against the alternate one of  $r \leq 1, r \leq p$ . This leads us to apply the maximal eigenvalue test. It is defined as:

$$\text{Maximal Eigenvalue Tests} = -T \ln(1 - Q_{r+1}^2) \tag{11}$$

We compare critical values developed Osterwald-Lenum (1992) with the trace and maximum eigenvalues.

**Empirical results**

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are employed to test for the stationarity of the macroeconomic series at level and then first difference of each series. The results of the ADF and PP tests at level are reported in Table-1, by taking into consideration of trend variable and without trend variable in the regression. Based on Table-1, the t-statistics for all series from both ADF and PP tests are statistically insignificant to reject the null hypothesis of non-stationary at 0.05 significance level. This indicates that these series are non-stationary at their level form. Therefore, these variables are containing a unit root process or they share a common stochastic movement. This is consistent with some previous studies that have been demonstrated the most of the macroeconomics and financial series expected to contain unit root and thus are integrated of order one,  $I(1)$ . When the ADF test is conducted at first difference of each variable, the null hypothesis of non-stationary is easily rejected at 0.05 significance level as shown in Table-

1. A similar conclusion also comes from PP test. Therefore, we can conclude that the series are integrated of order one, and a higher order of differencing is not required to execute.

**Table 1: Unit root analysis**

Country	Variable	Aug.Dickey-Fuller	Phillips-Perron	Lags
Hong Kong	E	-2.5909	-5.66940	1
	S	-2.1695	-5.0736	1
	$\Delta E$	-4.9526*	-30.874*	1
	$\Delta S$	-5.2699*	-30.907*	1
Japan	E	-2.7653	-5.4117	1
	S	-1.4442	-5.0117	1
	$\Delta E$	-5.7814*	-31.299*	1
	$\Delta S$	-6.2595*	-31.346*	1
Malaysia	E	-2.9043	-6.0124	1
	S	-2.3949	-5.9801	1
	$\Delta E$	-4.7788*	-29.977*	1
	$\Delta S$	-5.0346*	-30.017*	1
Singapore	E	-1.0479	-1.1290	1
	S	-0.7738	-0.9136	1
	$\Delta E$	-4.3906*	-6.4638*	1
	$\Delta S$	-4.8097*	-6.7951*	1
Thailand	E	-2.1959	-4.8294	1
	S	-2.3604	-5.0031	1
	$\Delta E$	-4.9124*	-32.789*	1
	$\Delta S$	-5.1100*	-31.346*	1

**Note:** The null hypothesis is that the series is non-stationary, or contains a unit root.

The rejection of null hypothesis for both ADF and PP tests are based on the MacKinnon critical values.

\* indicates the rejection of the null hypothesis of non-stationary at 5% significance level.

The number of lag is set equal to one in order to avoid the problem of autocorrelation that is to ensure the error terms are uncorrelated and enhance the robustness of the results. Since the variables are integrated of order one, and then we can proceed to conduct the multivariate cointegration test.

**Table 2: Multivariate cointegration analysis**

Country	Null hypothesis	Trace	Max- $\lambda$	Critical values (5%)	
				Trace	Max - $\lambda$
Hong Kong	$p=0$	19.544**	17.655**	15.197	14.036
	$p \leq 1$	2.333	2.333	3.962	3.962
Japan	$p=0$	7.899	6.788	15.197	14.036
	$p \leq 1$	2.113	2.113	3.962	3.962
Malaysia	$p=0$	12.677	12.908	15.197	14.036
	$p \leq 1$	0.988	0.988	3.962	3.962
Singapore	$p=0$	9.880	8.677	15.197	14.036
	$p \leq 1$	1.988	1.988	3.962	3.962
Thailand	$p=0$	11.788	10.678	15.197	14.036

$p <= 1$	1.677	1.677	3.962	3.962
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**Note:** The critical values are obtained from Johansen and Juselius (1990). \*\* indicates significant at 1% level.\* indicates significant at 5% level.

**Table 3: Granger causality analysis**

Country	Null Hypothesis	F-value	P-value
Hong Kong	$\Delta S \neq \Delta E$	0.204	0.887
	$\Delta E \neq \Delta S$	18.654***	0.000
Japan	$\Delta S \neq \Delta E$	0.476	0.789
	$\Delta E \neq \Delta S$	2.578	0.344
Malaysia	$\Delta S \neq \Delta E$	0.914	0.362
	$\Delta E \neq \Delta S$	2.745	0.211
Singapore	$\Delta S \neq \Delta E$	2.421	0.253
	$\Delta E \neq \Delta S$	5.431**	0.003
Thailand	$\Delta S \neq \Delta E$	1.986	0.161
	$\Delta E \neq \Delta S$	3.503**	0.013

The symbol “ $\neq$ ” implies does not Granger-cause. \*, \*\*, and \*\*\* denote rejections of the null hypothesis at 10% ,5%, and 1% significance levels, respectively.

We employ Johansen’s (1991) maximum likelihood method to examine whether or not the exchange rate and stock price series for each country are cointegrated. Table-2 reports the Johansen cointegration test statistics. As can be seen in the table, there is only one cointegration vector between the exchange rate and stock price series for Hong Kong, suggesting the Hong Kong dollar is cointegrated with the Hang Seng stock market index. For the other four countries, no cointegrating vector is found. Therefore, the results suggest a long-run equilibrium between exchange rates and stock prices in Hong Kong. Consequently, an error correction term should be included in the Granger causality test equations for Hong Kong.

The test results of Granger-causality between exchange rates and stock prices are given in Table 3. For the sample period, the reported F-values suggest that exchange rates significantly lead stock prices for five countries, including Hong Kong, Malaysia, Singapore, and Thailand. It is noteworthy that these five countries are also the ones that have a larger size of international trade. Thus, our findings seem to support the prediction that stock prices for countries with a high trade size tend to be affected more by exchange rate fluctuations. Except Hong Kong, these five countries also show a feedback effect from stock prices to exchange rates, although some of the F-statistics are significant only at a marginal level. No evidence of causal relation between the foreign exchange and equity markets for Japan is found, which is consistent with previous studies that focus on industrialized countries.



## CONCLUSIONS AND DEVELOPMENT

In this paper, we examine dynamic linkages between foreign exchange and stock markets in Hong Kong, Japan, Malaysia, Singapore, and Thailand. These five economies are significantly different in terms of the size of each economy, degree of development, rate of growth, and maturity of financial markets. Except for Japan, which is a developed country, the other four economies are usually referred as semi- or newly industrialized countries and all adopt export (or trade) promotion strategies for economic development (see Frankel, Romer, and Cyrus (1996)). Regarding the maturity of financial markets, Hong Kong, Japan, and Singapore are considered developed markets, while Malaysia and Thailand are considered to be emerging markets. There are also differences in terms of capital market liberalization and capital control. Hong Kong, Japan, and Singapore have no or little restrictions on foreign investments in their equity markets, but Malaysia and Thailand still do not have a completely open equity market to foreigners.

First, existing studies rely primarily on evidence from analyzing industrialized countries, with less attention paid to non-industrial economies. The four newly industrialized economies included in our study all pursue an export-led or trade-led approach to stimulate economic growth, except for Japan--an industrialized country, all have a very high share of trade in their GDP. According to the goods market theory, firms in these countries may face higher exchange rate exposures than those of industrialized countries because of the size of trade and hence their firm values would be affected more by exchange rate fluctuations. Therefore, the robustness of previous studies' findings that mainly relies on industrialized Countries can be examined against evidence from newly industrialized countries that expected to have higher exchange rate exposures. Second, unlike developed countries, most developing countries tend not to adopt a freely Floating exchange rate system and have more capital controls. None of the economies included in our study, with the exception of Japan, follow a freely floating exchange rate arrangement. It seems reasonable to expect that for a country that does not employ a freely floating exchange system, exchange rates might not fully response to stock price movements. Similarly, capital control might reduce dynamic linkages between foreign exchange and equity markets. Thus, examining these East Asian economies enables us to check the impact of the degree of financial market liberalization and exchange rate arrangement on the linkages between foreign exchange and equity markets.

Third, a crisis in an economy, such as the US financial crisis of 2009, may alter the Nature of stock price-exchange rate relations. Beginning in the early July of 2007 and over the subsequent one or two years, several East Asian countries have been through a major depreciation in their currencies as well as a stock market avalanche. The tumbling down stock price and the plunging currency value during the crisis reinforce the conventional impression that stock prices and exchange rates tend to move in a tandem, though it is not clear whether a causal relation exists from exchange rates to stock prices or the other way around. Except for Japan, our empirical results show a strong

causal relation from Exchange rates to stock prices, despite that several of these countries such as Hong Kong follow a pegged exchange rate system. On the other hands, there also exists a causal relation from the equity market to the foreign exchange market for Malaysia, Singapore, and Thailand. However, for economies that exhibit a bi-directional causal relation, it appears that the impact from the foreign exchange market to the equity market is much stronger than that from the equity market to the foreign exchange market. We also find a one-way causal relation from exchange rates to stock prices for these economies after the US financial crisis of 2009. Our results remain similar when different econometric methods are used.

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