Bivariate Causality between Exchange Rates and Stock Prices on Major Asian Countries

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Abstract

This paper studies the cointegration and the bivariate causality relationship between exchange rates and stock prices on the seven Asian countries badly hit by the Asian Financial Crisis. Our empirical results show that, before the 1997 Asian Financial Crisis, all countries, except the Philippines and Malaysia, experience no evidence of Granger causality between the exchange rates and the stock prices. However, the causality but not the cointegration between the capital and financial markets appear to become strong during the Asian Financial Crisis period. Surprisingly, after the 911-terrorist-attack, the causality relationship between the two markets returns to normal as in the pre-Asian-crisis period and the cointegration relationship weakens between exchange rates and stock prices. Thus, we conclude that (1) Asian Financial Crisis has a bigger and more direct impact on the causality relationship between stock prices and currency exchanges in Asian markets and the 911-terrorist-attack basically has no impact on the causality relationship between the two markets; and (2) the financial and capital markets have become more mature and efficient after the crisis.

Keywords: Asian Financial Crisis, 911-Terrorist-Attack, Dynamic Linkages, Cointegration, Bivariate Causality

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1. Introduction

High exchange rate and stock price fluctuations during the crisis are popular topics in the financial press and among academicians. We still can recall when financial crisis sparked in Thailand in July 1997, Asian countries started to experience a series of financial downfalls. For instance, the Hang Seng Index lost more than 1400 points in October 1997 as a result of big jump of short-term interest rate in Hong Kong in order to maintain its exchange rate against US dollar. Korean Won also dropped dramatically for about 56% against US dollar in December 1997 as compared to its value in January 1997. This currency crisis in South Korea caused further financial turmoil on its stock markets, with a downfall of over 50%.

The devaluation of Thai Baht in July 1997 ignited a financial avalanche in other Southeast Asian currencies. Indonesia, Malaysia, and Philippines experienced the most severe foreign exchange pressures in the end of 1997. In late October, the scale of the crisis had dampened the regional economy significantly as the pressure from depreciation of New Taiwan dollar spread to Hong Kong and Korea currencies. This financial storm continued to deteriorate Asian economy and did not slow down until the first quarter of 1998. This is known as the period of Asian Financial Crisis which is also called Asian flu.

When Asian countries are working hard to find medicines to cure the Asian flu, unfortunately in 2001, the world's economic super power, US was hit by terrorist attack. This may have big impact on Asian economy and delay the recovery from the Asian crisis in 2001 further. As we can recall, back on September 11, 2001, global financial markets went into tailspin in reaction to what has generally been described as a severe blow on the US. For example, in late afternoon trading, Nikkei 225 Average was down 6.5%, Hang Seng Index was down 9.5%, the Korea Composite Price Index was down 10.3%, Malaysia's KLSE lost 11.8%, Thailand Stock Exchange was also down 18% and Taiwan Price Weighted plummeted to about 15.38%. In contrast to the significant plunges in stock markets, currencies in major Asian markets were not affected by the terrorist attack on US.

After observing how severe economy conditions in Asian countries was during the Asian Financial Crisis and the 911-terrorist-attack, we are motivated to find out if stock market crash cause the exchange rate depreciation or currency depreciation leads to stock price downfall and whether the Asian Financial Crisis and the 911-terrorist-attack will alter this relationship. In fact, the relationship between exchange rates and stock prices can be seen as a reciprocal causal effect. This means that the fluctuation in exchange rates can substantially

affect the value of the firm, which in the end will have impact on stock prices. This is called the *traditional approach* (Frenkel and Rodriguez 1975, Boyer 1977). On the other hand, the movement of the stock market will cause capital movements in a particular country resulting exchange rate fluctuation. This phenomenon is also known as *portfolio approach.*[1] The majority of preceding studies support the traditional approach. Only a few indicate the existence of portfolio approach or the feedback relationship between the two markets.

This paper analyzes in detail the dynamic relationship between stock prices and exchange rates by employing both the cointegration and bivariate causality techniques on the seven Asian countries badly hit by the Asian Financial Crisis, namely Hong Kong, Indonesia, Singapore, Malaysia, Korea, Philippines, and Thailand. Japan is included in our study for control purpose. We analyze the relationship for the pre- and post-Asian Financial Crisis periods as well as pre- and post-911-terrorist-attack as to study the effects of the Asian Financial Crisis and the 911-terrorist-attack on the relationship. If this relation can be ascertained, practitioners can profit from the arbitrage especially during a severe financial crisis.

Our empirical results show that, in the period before Asian Financial Crisis, all countries except the Philippines and Malaysia, experience no evidence of Granger causality between the exchange rates and the stock prices. However, the causality but not the cointegration between the capital and financial markets appear to become strong during the Asian Financial Crisis period. In this period, all countries show evidence of causality between the two markets. Surprisingly, after the 911-terrorist-attack, the causality relationship between the two markets return to normal as in the pre-crisis period, where all countries, except Korea, are found to have no linkages between exchange rates and stock prices. In addition, we find that there is no specific cointegration relationship between the exchange rates and the stock prices before or during the 1997 Asian Financial Crisis but after the 911-terrorist-attack, there are weaker cointegration relationships between exchange rates and stock prices. Thus, we conclude that (1) the Asian Financial Crisis has bigger and more direct impact on the causality relationship between stock prices and currency exchanges in Asian markets; the 911-terrorist-attack basically has no impact on the causality relationship between the two markets and (2) the financial and capital markets has become more mature and efficient after the crisis.

[1] For an intuitive explanation of the portfolio approach, see Krueger (1983, pp.81-91). Other related works include, Frenkel and Rodriguez (1975) and Boyer (1977).

The organization of the paper is as follows: Section 2 reviews the literature while Section 3 describes about data; Section 4 discusses the methodologies by employing both cointegration and causality techniques; Section 5 elaborates upon our empirical results and Section 6 discuss the possible reasoning for the cointegration and causality relationship for each country. The last section concludes.

2. Literature Review

The effect of exchange rates on stock market volatility has received much attention lately, especially after the 1997 Asian Financial Crisis. As reported by Kamin (1999), Mishkin (1999) and Kwack (2000), the major causes of Asian Financial Crisis were the devaluation of local currencies, the short-term external debts and high interest rates and financial imbalances. In retrospect of the literature, there are quite a number of studies that attempted to determine the impact on stock prices and exchange rates changes. The findings, however, are not uniform across the various studies.

Many literatures have supported the phenomenon of traditional approach that exchange rates' fluctuation lead to stock prices movement. According to Dornbursh and Fisher (1980), changes in exchange rates affect firm's earning and hence impact its stock price. This study also explains that the reciprocal causal effect between exchange rates and stock prices depends on whether the firm is dealing with exporting or importing business. Aggarwal (1981) argued that a change in exchange rates could change stock prices of multinational firms directly and the domestic firms indirectly. Bodart and Reding (1999) showed that an increase in exchange rates volatility is accompanied by a decline in international correlation between bonds and to a lesser extent, the stock market. Kearney (1998) found that exchange rates volatility is a more significant determinant for volatility of stock prices rather than interest rates volatility. Phylaktis and Ravazzolo (2000) discussed the stock prices and exchange rates dynamics and found that the US stock market acts as a conduit through which the foreign exchange market and local stock market were linked. In addition, Pan et al. (2000) studied seven Asian emerging markets and concluded that in general, exchange rates Granger-cause stock prices. They also found that countries which have a higher trade to GDP ratio, exchange rate fluctuations tend to exhibit significant influence on the equity market, regardless of the exchange rate arrangement system and the degree of capital control.

Conversely, it has been argued that the demand for money equation, which is derived from the monetary portfolio allocation model, which makes it possible to make stock prices affect the exchange rates. Gavin (1989) suggested that movements in stock prices may influence exchange rates, and money demand could depend on the performance of the stock market. Qiao (1996) also agreed that changes in stock prices might affect the inflow and outflow of capital, which would result in changes in the currency values. In addition, Ajayi et al. (1998) explained in detail that changes in stock prices lead to an increase in the demand for real money and, subsequently the value of domestic currency.

Although all the above-mentioned theories suggested causal relations between stock prices and exchange rates, yet other studies concluded that the exchange rates changes have no significant impact on the stock prices (Solnik 1984). Jorion (1990, 1991), Bodnar and Gentry (1993), Amihud (1993) and Bartov and Bodnar (1994) failed to find a significant relationship between simultaneous dollar movements and stock returns for US firms. Griffin and Stulz (2001) showed that weekly exchange rate shocks have a negligible impact on the value of industry indices across the world. Using daily data in their study instead of monthly data as used in most prior studies, Chamberlain et al. (1997), however, found that the US banking stocks returns are very sensitive to exchange rates movements, but not for Japanese banking firms. On a macro level, Ma and Kao (1990) found that currency appreciation negatively affected the domestic stock market for an export-dominant country and positively affected domestic stock market for an import-dominant country, which is consistent with the goods-market theory.

In addition, Qiao (1996) found the stock price-exchange rate causality to be different across countries. Specifically, the direction of causation was bi-directional for Japan, was unidirectional from the exchange rates to stocks returns for Hong Kong and was non-causal for Singapore. He also noted the presence of a strong long-run relationship or cointegration existed in these three countries. Using daily data for eight countries, Ajayi and Mougone (1996) showed significant interaction between exchange rates and stock prices. Observations based on the emerging markets of India, Korea, Pakistan and the Philippines, Abdalla and Murinde (1997) suggested unidirectional causality from exchange rates to stock prices in all countries, except for the Philippines, where it was stock prices that Granger caused the exchange rates. Moreover, they found a long run relationship or cointegration existing in India and Pakistan. Using monthly data from July 1973 to December 1988, Bahmani-Oskooee and Sohrabian (1992) evaluated the interactions between the Standard and Poor's Composite Index and the effective exchange rate of the dollar and found the bi-directional causality

between them. However, there was no long run relationship or no cointegration between the two variables.

Malliaris and Urrutia (1992) analyzed the impact of 1987 crash on the relationships for six stock market indices and found no lead-lag relationships for the period before and after the market crash but there are feedback relationships and unidirectional causality during the month of crash. Recently, Granger et al. (2000) also suggested that different countries have different relationships between exchange rates and stock prices. They found that the Philippines was under portfolio approach with negative correlation. Hong Kong, Malaysia, Singapore, Thailand, and Taiwan indicated strong feedback relations, whereas those of Indonesia and Japan failed to reveal any recognizable pattern.

3. The Data

The data used are weekly stock market indices and exchange rates from *Datastream* for eight major Asian countries, namely Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore and Thailand. The sample period runs from January 1, 1991 to December 31, 2002, which covers a reasonably long period of twelve years in our study. Instead of monthly data as in most literatures, weekly data from Wednesday closing index for the emerging markets is used so as to have higher power on the results and to capture the effect of capital movement, which is intrinsically a short-run occurrence. We abandon the use of daily data to avoid the biases associated with non-trading, bid-ask spread and asynchronous prices (Lo and MacKinlay 1988). If Wednesday index is missing, then Tuesday price (or Monday if Tuesday's is missing) is used.

To better analyze the relations between exchange rates and stock prices before and after Asian Financial Crisis, we first divide the entire period into two sub-periods and call the first sub-period which covered from 1991 to 1996 as pre-crisis period and the sub-period which covered from 1997 to 2002 as post-crisis period. In the post-crisis period, we further divided our sample into two sub-periods, pre-911 and post-911 periods, to look into the effect of 911-terrorist-attack: Pre-911 period is the period between the Asian Financial Crisis and 911-terrorist-attack (January 1, 1997 – September 10, 2001) and post-911 period is the period after the 911-terrorist-attack (September 11, 2001 - December 31, 2002). We note that some studies use January 1, 1997 to separate the pre-crisis and post-crisis periods while some use July 1, 1997. In this paper, we use both dates to separate the pre- and post-crisis. Since similar results

were obtained hence we only report the results using January 1, 1997 as a cut-off point.[2] We also note that the "Pre-911 period" can be treated as the "during-the-crisis period" as we have used different cutting end points before September 11, 2001 as the "during-the-crisis period" and the results are similar to that of the "Pre-911 period". In this connection, without loss of generality, we also call the "Pre-911 period" as "during-the-crisis period" or simply "during the crisis" and the "Post-911 period" is in fact referring to the actual "post-crisis period".

INSERT TABLE 1 ABOUT HERE

Table 1 shows the stock indices and exchange rates for all the countries in our study on different sub-periods with their changes respectively. During the pre-crisis period, Indonesia, Korea, and Thailand underwent currency depreciation and the other five countries have currencies appreciation with modest changes ranging from -20% to 24% while stock markets are basically in a bull run with increase ranging from 35% to more than 300% for all countries except Japan and Korea. However, all eight economies exhibit pronounced structural breaks during the crisis. All currencies suffered noticeable depreciations since January 1997. During the crisis period (January 1, 1997 – September 10, 2001), Indonesian Rupiah experienced the greatest loss in its value (74.01%), followed by Peso of the Philippines (48.73%), Thai Baht (42.58%), Won of South Korea (34.58%) and Malaysia Ringgit (33.52%). The rest of the currencies witnessed between 1% to 20% depreciation. Similar freefalls in stock prices were witnessed ranging from 17% of the Korea market to 60% of the Thailand market. In the post-crisis period, the currencies have appreciated for all countries except the Philippines in which the rate of depreciation (4.29%) is much smaller than during the crisis. Even though the stock markets remained down in the post-crisis period, the drop rates are smaller than during the crisis.

4. Methodology

Cointegration tests are important in determining the presence and nature of an equilibrium economic relation. To examine the co-movements between stock indices and exchange rates, we study the relationship:

$$S_t = \alpha + \beta E_t + u_t \qquad (1)$$

where S_t , E_t and u_t denote the stock index, exchange rate and error term respectively.

[2] The results of using July, 1 as cut-off point are available on request.

The cointegration tests are performed in two steps. The first step is to examine the stationary properties of the exchange rates and stock indices series. If a series has a stationary, invertible and stochastic ARMA representation after differencing *d* times, it is said to be integrated of order *d*, and denoted as *I(d)*. It is necessary to first conduct a pre-test of the order of integration for the series as a necessary condition for cointegration is that the two series be studied are of the same order, usually order one. We apply the Dickey-Fuller (1979, 1981) unit root test procedure to test the null hypothesis that Ho: z_t = I(1) versus the alternative hypothesis H_1: z_t = I(0) based on the OLS regression:

$$\nabla z_t = \beta_0 + \alpha_0 t + \alpha_1 z_{t-1} + u_t \tag{2}$$

or apply the Augmented Dickey and Fuller (ADF) test based on:

$$\nabla z_t = \beta_0 + \alpha_0 t + \alpha_1 z_{t-1} + \sum_{i=1}^{p} \beta_i \nabla z_{t-i} + u_t \tag{3}$$

where $\nabla z_t = z_t - z_{t-1}$ and z_t can be S_t or E_t as defined in equation (1).

The regressions in (2) and (3) allow for a drift term, a deterministic trend and a stochastic structure in the error term, u_t. The variable p is chosen to achieve white noise residuals. Testing the null hypothesis of the presence of a unit root in z_t is equivalent to testing the hypothesis that $\alpha_1 = 0$ in equation (2) and (3). If α_1 is significantly less than zero, the null hypothesis of a unit root is rejected. The test statistic used is the usual *t*-ratio, but the distribution is not the *t*-distribution under the null hypothesis. When p=0, the test is known as the Dickey-Fuller (DF) test. This test assumes that the residuals, u_t, are independently and identically distributed. If serial correlation exists in the residuals, then p>0 and the augmented Dickey-Fuller (ADF) test must be applied.

In addition, we test the hypothesis that z_t is a random walk with drift, i.e. $(\beta_0, \alpha_0, \alpha_1) = (\beta_0, 0, 0)$. The test statistic is the likelihood ratio, Φ_3, found in Dickey and Fuller (1981). The decision rule is to reject the null hypothesis if Φ_3 is larger than the critical value. We also test for the hypothesis of random walk without drift, i.e. $(\beta_0, \alpha_0, \alpha_1) = (0, 0, 0)$. This test statistic, given by Φ_2, also causes rejection of the hypothesis if it exceeds the critical value. If the hypotheses that $\alpha_1 = 0$, $(\beta_0, \alpha_0, \alpha_1) = (\beta_0, 0, 0)$ or $(\beta_0, \alpha_0, \alpha_1) = (0, 0, 0)$ are accepted, then we can conclude that z_t is an integrated process of order 1. If we fail to reject the hypotheses that z_t is I(1), then we test Ho: z_t = I(2) versus the alternative hypotheses H_1: z_t = I(1).

If both S_t and E_t are in the same order, the next step is to estimate the cointegrating parameter of regression (1) by OLS regression. If the residuals of the regression (1) are stationary, the two series are cointegrated. Otherwise, the two series are not cointegrated.

The three most common tests for stationarity of estimated residuals are Cointegrating Regression Durbin-Watson (CRDW), Dickey-Fuller (CRDF), and Augmented Dickey-Fuller (CRADF) tests. Only the more reliable CRDF and CRADF tests[3] are used on the OLS regression

$$\nabla \hat{u}_t = \gamma \hat{u}_{t-1} + \sum_{i=1}^{p} \gamma_i \nabla \hat{u}_{t-1} + \xi_t \qquad (4)$$

where u_t are residuals from the cointegrating regression (1) and p is chosen to achieve empirical white noise residuals. The null hypothesis of non-cointegration is rejected if the *t*-ratio is less than the relevant critical value.[4]

After determining cointegration, we test the causality between stock prices and exchange rates using the appropriate formulation for Granger causality analysis. This analysis needs to incorporate an error correction term into the test if variables are cointegrated (Granger, 1988). If exchange rates and stock price are cointegrated, than an error correction term should be included in the bivariate autoregression as follows:

$$\begin{aligned} \nabla S_t &= \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \nabla S_{t-i} + \sum_{i=1}^{m} \alpha_{2i} \nabla E_{t-i} + \delta_1 ECT_{t-1} + \varepsilon_{1t} \\ \nabla E_t &= \beta_0 + \sum_{i=1}^{m} \beta_{1i} \nabla S_{t-i} + \sum_{i=1}^{n} \beta_{2i} \nabla E_{t-i} + \delta_2 ECT_{t-1} + \varepsilon_{2t} \end{aligned} \qquad (5)$$

where ΔE_t is changes in exchange rate and ΔS_t is changes in stock price. ECT_{t-1}, which is $S_{t-1} - \gamma E_{t-1}$, is an error correction term derived from the long run cointegrating relationship in (1). The error correction term can be estimated by using the residual from a cointegrating regression. The estimates δ_1 and δ_2 denote the speed of adjustment. According to Engle and Granger (1987), the existence of cointegration implies causality among the set of variables as manifested by $|\delta_1| + |\delta_2| > 0$. Reject (accept) H_0: $\alpha_{21} = \alpha_{22} = \ldots = \alpha_{2m} = 0$ and $\delta_1 = 0$ suggests

[3] Engle and Granger (1987) suggest that the CRDW test might be used to obtain a quick approximate result. The power of the CRDW test is greater than the DF type tests for the case where the alternative hypothesis is a simple stationary first-order autoregressive process but is sensitive to the dynamic structure of the error term. Thus CRDW test is not a reliable test for cointegration.

[4] Engle and Granger have tabulated these critical values for the case where p=0 (CRDF) and for p>0 (CRADF) for the bivariate regression with a sample of 100 observations while Engle and Yoo (1987) have provided critical values for samples varying from 50 to 200 observations. One may refer to Manzur et al. (1999) for more detail in the cointegration modeling.

that exchange rates do (do not) Granger cause stock prices. Likewise, reject (accept) H_0: $\beta_{11} = \beta_{12} = \ldots = \beta_{1m} = 0$ and $\delta_2 = 0$ suggests that stock prices do (do not) Granger cause exchange rates.

If cointegration does not exist, we shall modify (5) without considering error correction term (ECT) to be:

$$\nabla S_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \nabla S_{t-i} + \sum_{i=1}^{m} \alpha_{2i} \nabla E_{t-i} + \varepsilon_{1t}$$
$$\nabla E_t = \beta_0 + \sum_{i=1}^{m} \beta_{1i} \nabla E_{t-i} + \sum_{i=1}^{n} \beta_{2i} \nabla S_{t-i} + \varepsilon_{2t} \qquad (6)$$

Similarly, reject (accept) H_0: $\alpha_{21} = \alpha_{22} = \ldots = \alpha_{2m} = 0$ suggests that exchange rates do (do not) Granger cause stock prices, while reject (accept) H_0: $\beta_{11} = \beta_{12} = \ldots = \beta_{1m} = 0$ suggests that stock prices do (do not) Granger cause exchange rates. These tests lead to no causality, unidirectional causality or feedback causality relationship between the stock prices and exchange rates.

To test the $H_0 : \alpha_{21} = \alpha_{22} = \ldots = \alpha_{2m} = 0$, we apply the *F* test:

$$F = \frac{(SSE_R - SSE_F)/m}{SSE_F/(N-m-n-2)}$$

where *N* is the number of observations, *n* and *m* are defined in (5), SSE_F, and SSE_R are the sum of square of residuals for the full regression and the restricted regression respectively in (5). The null hypothesis is rejected (accepted) at the α level of significance if $F >$ (<) $F(\alpha; m, N-m-n-2)$. Similarly, we can test for $H_0 : \beta_{21} = \beta_{22} = \cdots = \beta_{2m} = 0$ and then make decision on the causality from S to E. We apply the usual simple *t* statistics to test for H_0: $\delta_1 = 0$ and H_0: $\delta_2 = 0$.

The minimum final prediction error criterion (Hsiao 1979, 1981) is also employed in this paper to determine the optimum lag structures in the regressions (5) and (6), where *n* and *m* are the maximum lags of the corresponding variables to be used in the right hand side of Equations (5) and (6); and ε_{1t} and ε_{2t} are disturbance terms obeying the assumptions of the classical linear regression models. The final prediction error statistic of ∇S_t with *n* lags of ∇S_t and *m* lags of ∇E_t is

$$FPE_{\nabla S_t}(n,m) = \frac{(N+n+m+1)\sum(\nabla S_t - \nabla \hat{S}_t)^2}{(N-n-m-1)N}$$

where N is the number of observations[5]. The FPE statistic for ∇E_t is found by the same way. To determine the minimum $FPE_{\Delta S_t}$, the first step is to run the regression in first equation (5) excluded ∇E_t and only lags of ∇S_t be included. We start from m=0 and n=1 and calculate $FPE_{\Delta S_t}(1,0)$. We proceed the same step until n=n* where FPE is minimized for m=0. Then, by holding n=n*, we systematically lag m until m=m* minimizes the FPE. The same procedure is repeated with the second equation (5) where n=n** and m=m** minimize $FPE_{\Delta E_t}(n,m)$.

5. Empirical Findings

We first employ the unit root tests to check for stationarity for the exchange rate and stock index series of the eight countries being studied in this paper. The unit root results in Table 2 show that there are unit roots in all level series for all periods and for all countries except exchange rates for Indonesia and Hong Kong in the pre-crisis period and the exchange rates for Indonesia, Malaysia, Singapore and Hong Kong in the post-911 period.[6] We note that the non-unit root phenomenon for Malaysia and Hong Kong in the post-911 period and Hong Kong in the pre-crisis period is due to the peg of the currency to US dollar. We also note that in the pre-911 period (between 1997 Asian Financial Crisis and 911-terrorist-attack), Hong Kong dollar still encounter fluctuations and the Malaysian Ringgit consists of a non-peg period and hence both exchange rates appear to be I(1).

INSERT TABLE 2 ABOUT HERE

INSERT TABLE 3 ABOUT HERE

After performing the unit root tests, we then estimate the cointegrating equation in (1) and report the results in Table 3. The results show that Thailand is the only country in our study which has the cointegration effect of the exchange rate and stock index for all periods. The

[5] The conditions that ∇E_t and ∇S_t are stationary is necessary for the validity of the statistic.

[6] We tested for I(1) versus I(2) for all series and conclude that all series are I(1). The results are available on request.

exchange rate is cointegrated with stock index in the Philippines and Indonesia for the pre-crisis, post-crisis and pre-911 periods while the exchange rate is cointegrated with stock index in Japan, Hong Kong and Singapore only in the pre-crisis period. The exchange rate is also cointegrated with stock index in Malaysia and Korea for the post-crisis period. These findings support most of the previous literature that no definitive pattern on cointegration can be identified between the currency and stock index not only before the Asian Financial Crisis, but also during the Asian Financial Crisis (before the 911-terrorist-attack). However, our results also show that the cointegration between exchange rate and the stock index disappear for nearly all countries being studied in this paper[7] after the crisis, especially during the post-911-terrorist-attack. Thus, as opposed to the findings in most of the previous studies, we claim that the financial and capital markets in Asia have become more mature and efficient after the crisis.

We now turn to study the Granger causality relationship between exchange rate and stock index. The causality results are reported in Tables 4a to 4d.

INSERT TABLE 4 ABOUT HERE

Similar to the cointegration results, our causality findings before the Asian Financial Crisis are in line with most previous literatures (see for example Granger et al. 2000), which show that there is no causal relation between stock index and exchange rate for most of the Asian countries including Indonesia, Thailand, Korea, Singapore, Japan and Hong Kong. Only Malaysia and the Philippines are observed to have the causality relationship such that Malaysia appears to have a feedback relationship whereas the Philippines shows traditional approach.

However, our empirical results have demonstrated that this phenomenon is not going to continue after the crisis. There is strong presence of causal relationship between exchange rates and stock prices, especially in the period between the Asian Financial Crisis and the 911-terrorist-attack. These anomalies contradict with the previous literature. During the post-crisis period, Hong Kong and the Philippines followed the portfolio approach, which is stock prices lead currency rates, whereas Singapore is described to have a strong relationship in unidirectional causality particularly in agreement with the traditional approach. The rest of the

[7] All countries except Thailand and Korea both have marginally cointegration relationship at the 10% level.

countries in this period follow bi-directional relationship, which is currency rates lead stock prices and vice versa.

Our findings of the causality anomalies may be due to the fact that both exchange rates and stock prices fluctuate dramatically during the Asian Financial Crisis as our post-crisis period covers both "during the crisis" and "after the crisis". If this is true, the causality will eventually disappear after the crisis. Also, we question whether the 911-terrorist-attack has the same impact on the financial and capital markets. In this connection, we further study the behavior of relationship between exchange rates and stock prices by dividing the post-crisis period into two periods: pre-911 period (January 1, 1997 to September 10, 2001) and post-911 period (September 11, 2001 to December 31, 2002)[8].

Our findings show that in the pre-911 period, the relationship between stock prices and exchange rates basically exists for all countries in our study such that Malaysia, Indonesia, Singapore and Japan follow the traditional approach; Thailand and Korea experience feedback relationship while the Philippines and Hong Kong are observed to have portfolio approach. However in the post-911 period, we find that the causal relationship between exchange rates and stock prices returns to normal such that they vanish in all countries, except for Korea. This shows that the 911-terrorist-attack does not create any causality relationship in the Asian countries as the Asian Financial Crisis; and the causal relationship between exchange rates and stock prices in the post-911 period are back to normal as in the pre-crisis period. Based on all results of our analysis above, surprisingly the Asian Financial Crisis period appears to be the only period that the causality relationship between stock prices and exchange rates exist significantly as compared to other periods.

6. Discussion

We now focus on the possible reasons for both cointegration and causality relationships for each country. We first discuss the relationship for Indonesia. Table 3 shows that its exchange rate and stock index are cointegrated with a negative beta during the crisis.[9] This implies that the exchange rate and stock index are moving in a different direction during the Asian Financial Crisis. Figures 1b and 1c confirm this result. In addition, Table 4 shows that

[8] Refer to section 3.

[9] The results show that exchange rate and stock index are also cointegrated in the pre-crisis period but this results cannot be used as exchange rate is I(0) while Index is I(1) in this period (Table 2).

the capital and financial markets have no Granger causality relationship in both pre-crisis and post-911 periods but the exchange rate significantly Granger causes the stock index and the exchange rate marginally Granger causes the stock index in the pre-911 period. The possible explanation is that during the crisis, some big investors can foresee both the stock prices and the currency will drop continually and short sell both instruments while other investors follow too. Both the stock and the currency drop continuously for very long period during the crisis. Hence the stock index is falling while the exchange rate is rising continuously. Other factors such as political instability, weak law enforcements, deteriorated banking system, etc. may contribute to economic turmoil in Indonesia. Nasution (2000) argues that negative external shocks, weak fundamentals and incompetent management was paralyzed by indecision over adoption of currency board, reduction of large state-guaranteed investments and implementation of economic deregulations.

On the other hand, the short selling activities reduce after the crisis. Indonesia also tries to restore its economy and gradually reduce its dependency on IMF, and its government is not loosening its policy on capital control as well as intervention on its currency exchange. These imply that the impact on the influence on both markets reduces after the crisis and, hence it is not surprising our empirical research shows that there is no relationship between currency exchange and stock price movement in the post-911 period.

Before discussing the relationship on both markets for other Asian countries which are badly hit by the Asian Financial Crisis, we herewith first examine Japan which is not badly hit by the crisis. As we can observe from Table 3, Japan's stock price and exchange rate are cointegrated in the pre-crisis period, but neither in the pre-911 nor the post-911 period. Moreover, Table 4 also shows that Japan is the only country in our study where there is no evidence of causal relation between the foreign exchange and equity market in both periods before and after the Asian Financial Crisis.[10] This is consistent with previous studies (He and Ng 1998, Chamberlain et al. 1997). It is well known that Japan practices free floating exchange rate system together with no restriction in capital control. According to Pan et al. (2000), for a country that does not employ a freely floating exchange rate system, its exchange rates might not fully respond to stock prices movement. Similarly, capital control might reduce dynamic linkages between foreign exchange and equity prices. Another major possible reason is that there is no significant speculation activities occurs in Japan. These factors

[10] Table 3 shows that there is marginal causality from Exchange Rate to Stock Index during the crisis but no causality after the crisis period.

strengthen our argument that there is no integration on Japan's currency and stock prices as shown in Figure 7b.

For Malaysia, we notice that this is the only country that has feedback causality relationship between the capital market and stock market before the Asian Financial Crisis and the exchange rate strongly Granger causes stock index in the pre-911 period but not the post-911 period. This is because the Malaysian Government imposes capital control to anticipate speculation on its financial market. This sudden change of government policies costs Malaysia to missed out from most of the international capital that returned to the region in the beginning of quarter four 1998. During the pre-911 period, we observe from Table 4c that exchange rate Granger causes stock index. However, after the 911-terrorist-attack, there is no evidence of causal relation between exchange rate and stock price. This lack of significant relationship between the two markets may be result of intense government intervention on capital market after Asian Financial Crisis. Furthermore, our result in Table 3 also shows that cointegration between Malaysian Ringgit and KLCI exist only during post-crisis period. This finding is consistent with Ibrahim (2000).[11]

Although Singapore is an open city state economy and does not impose any capital control, its economy depends largely on trading and investment activities with neighboring countries, mainly Indonesia and Malaysia, as well as US and Europe. Singapore currency is pegged with a 'basket' of currencies; this means its currency is weighted in terms of the importance of the countries concerning Singapore's trade. The movements in short- and medium-term Singapore exchange rates are dominated by capital market adjustments in different currencies. If foreign portfolio holders expect the real return on Singapore financial assets to increase, they will buy Singapore dollar to buy asset and thereby increase the demand of Singapore dollar. This is true during the pre-911 period, as shown in Table 4c, Singapore dollar leads Singapore stock index. But this phenomenon does not last long. During the period of post-911, the Singapore economy has worsened. This is because of significant decrease in Foreign Direct Investment to Singapore. When faced with the bitter pill of capital outflows, Singapore maintained the managed floating exchange rate policy. As a result, we fail to observe any relationship between exchange rate and stock price after 911-terrorist-attack (Figure 6d). The lack of relationship between Singapore dollar and stock price can be attributed to Singapore's small, highly open economy, with low inflation relative to the rest of the world. Singapore government basically controls its currency exchange rate, which is pegged against "a basket of currency", in orders to serve the purpose of its economy and does

[11] Refer to Ibrahim (2000) for details explanation.

not allow future market speculation activities on its currency. These policies are set to safeguard the danger of the capital market crash, especially while the stock market plummeted during the crisis due to poor international sentiment. Hence, the capital market and stock market are not cointegrated nor have any causal relationship during the crisis like other Asian countries.

We observe from Table 4a that the Philippines follows traditional approach in pre-crisis period. However, during the pre-911 period, the relationship turns out to follow portfolio approach. The reasons could be during the crisis, the Philippines faces the same situation as other Asian economies, massive capital outflow causes the stock exchange to experience a great blow of 67.87% which led the Peso to slide 50.93% during the crisis period (see Table 1). Moreover, trade deficit and inefficient banking system meant that the central bank was unable to maintain it's a strong currency value in the market. During the post-911 period, no evidence of causal relationship is found. Figure 2d confirms this analysis by showing significant change of the stock price movement and exchange rate fluctuation as compared to Figures 2a, 2b and 2c. As expected, the Philippines government also imposes capital control and tightens its currency policy in order to prevent further capital outflow and maintain economic stability. That is why we find that cointegration between exchange rate and stock price for the Philippines exist only up to the pre-911 period (see Table 3).

Korea is observed to possess long term strong relationship between stock price and exchange rate in both pre-911 and post-911 periods. Moreover, Korea is also the only country to be observed to have stock price Granger causeing exchange rate in the post-911 period (Table 4d). Our analysis is consistent with Min (1999). Korea controlled financial market tightly in early and late 1980s (Reisen and Yeches, 1991; Park, 1996). This is in line with our study that there is no linkage between exchange rate and stock price during the pre-crisis period. Evidence from Figure 5a clearly shows the Korean Won has a stagnant movement and is not fluctuating as much as the stock index does. However, in 1999 Korea fully implemented the reform plan for capital liberalization. As a result, the volume of international capital flow increase, particularly portfolio investment. Also, foreign direct investment (FDI) had been fluctuated and increased in 1996 but the amount was not significant compared to portfolio investment liabilities. This deregulation by Korean government strengthens our analysis about feedback relationship between exchange rate and stock price during the post-crisis period (see Table 4). Capital liberalization leads movement in capital market and demand for Korean Won. During post-911 period, the feedback relationship between the two markets still exists.

This is due to the capital flight that drags down stock price and currency depreciation simultaneously.

Thailand, like other developing countries, has not fully implemented an open equity market to foreigners and is also reluctant to adopt a completely free floating foreign exchange system. However, interestingly, Thailand is the only country in our study that has long term strong relationship between stock price and exchange rate in all periods (Table 3). This implies that the past information of exchange rate can be used to predict the stock price and vice versa. Since Asian Financial Crisis was first triggered in Thailand, Thai government has taken much concern about its economy and watched over its capital in- and out-flows. Although the government allowed the Thai Bath to float on July 2, 1997, we find feedback relationship during the crisis. But, this situation did not last long. During post-911 period, there is no relationship between stock price and exchange rate, back to the situation as pre-crisis.

In the pre-crisis period, Hong Kong experienced no interaction between stock index and exchange rate (see Tables 2 to 4). Even though Hong Kong dollar is pegged against US dollar and only depreciated 0.82% during the crisis period (see Table 1), Hong Kong has portfolio approach relationship during the crisis. But, we again find no causality relationship between the two markets in the post-911 period. As Hong Kong is also considered to be one of the highly open economies with no capital control, our results basically show that Hong Kong's exchange rate and stock price has no interaction with each other. This is mainly because its currency is pegged against US dollar. For long term, Hong Kong is speculated to have no relationship between its currency and stock index. Our empirical results show that there is no evidence of cointegration between the two markets in the post-crisis period (Table 3).[12]

In general, we find in our study that the relationship between exchange rate and stock prices become more intense during the Asian Financial Crisis as compared to pre-crisis period. However, the phenomenon in the post-911 is somewhat reminiscent of the pre-crisis period. This implies that the Asian Financial Crisis has a more significant and direct impact on relationship between currency exchanges and stock prices in Asian markets and the 911-terrorist-attack basically has no effect on these markets. During Asian Financial Crisis, there are strong factors that caused economic collapse in major Asian countries. Woo (2000)

[12] Table 3 shows that the financial market and capital market in Hong Kong are cointegrated in the pre-crisis period but this results cannot be used as Table 2 shows that Exchange Rate is I(0) while Stock Index is I(1).

elaborated factors such as: investor panic, tightening macroeconomic policies and improper handling of the insolvent banks in Indonesia, Korea and Thailand have been accused to cause a mess in major Asian economies. Besides, Wong et al. (2003) found that strong tendency of co-movement after Asian Financial Crisis between emerging markets in Asia has also contributed to regional financial woes. This statement is also in agreement with the notion contagion effects (or tequila effects) which means exchange rate crisis in one country that contaminates other countries with proximity and/or similar level of economic development with economic structure. In particular, we notice that this effect can be more detrimental to the economy if improper co-ordination occurs in the remedy of the crisis. Inappropriate government policies during the turmoil will also contribute panic in the market and lead to sharp withdrawal of funds in a country or a region. The economy will deteriorate further if political stability in that particular country follows. Min (1999) called this phenomenon the coordination failure effects.

The cause of Asian Financial Crisis was also highlighted by Krugman (1998a, 1998b). The crisis also causes many firms to bankruptcy and this magnified vulnerability of financial sector and at the end, decreases investor confidence. On the other hand, the 911-terrorist-attack is viewed to have indirect impact from US economy. Further tightening of capital control and government intervention in financial market has led us to conclude that there is no linkage between stock prices and currency exchanges at least for short period of time in near future.

7. Conclusion

Prior studies based on monthly data have found either little relation can be established between the two markets or exchange rate leads stock price. In this paper, we apply weekly data to analyze the problem in the Asian economies. The result indicates that during the pre-crisis and post-911 periods, markets in general are largely characterized by the phenomenon predicted under no relationship between stock prices and currency exchanges or at least no special patterns in the cointegration and causality relationships. However, all markets exhibit significant evidence of either change in exchange rates leads that in stock prices or either market can take the lead (feedback or bilateral causality) during the Asian Financial Crisis period. This specific phenomenon during the crisis is mainly due to investor panic, tightening macroeconomic policies and improper handling of the insolvent banks. The notion of contagion effect also cannot be downplayed. This financial tsunami in 1997 that cause the

collapse of stock prices and currency values in major East Asia countries are believed to be contaminated by Thailand and Korea.

We also find interesting evidences in our study that the relationship between stock prices and currency rates in post-911 period has somewhat returned to the situation during pre-crisis period., We believe this is because major Asian governments have reverted to their policies to tighten capital movement as compared to early 1990s when barriers to capital movement are gradually removed. Most Asian countries have experienced capital outflow during the crisis and imposed regulation that prevent further capital flight in order to restore their economy. Capital movement in and out of the Asian economies is as beneficial as it is detrimental. The Asian Financial Crisis certainly has put the stock and the currency markets in a spotlight that suggests financial markets in the Asian economies need an overhaul.

Last but not least, our empirical research also finds that cointegration or long term relationship between exchange rates and stock prices in Asian market weakened during the post-911 period. This leads to the conclusion that the stock markets in this region have become more efficient after the 911 event.

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Table 1: Comparison of Exchange Rates and Stock Indices between Sub-periods

Panel A: Exchange Rate							
	I	II	III	IV	Changes from		
Country	01-01-1991	01-01-1997	11-09-2001	31-12-2002	I to II	II to III	III to IV
Hong Kong	7.7983	7.7345	7.7998	7.7987	0.82%	-0.84%	0.01%
Indonesia	1889.0000	2362.2500	9090.0000	8950.0000	-20.03%	-74.01%	1.56%
Japan	135.8000	115.8500	119.8200	118.7750	17.22%	-3.31%	0.88%
Korea	714.5000	844.5498	1291.0000	1185.7000	-15.40%	-34.58%	8.88%
Malaysia	2.6983	2.5264	3.8000	3.8000	6.80%	-33.52%	0.00%
Philippines	27.2000	26.3000	51.3000	53.6000	3.42%	-48.73%	-4.29%
Singapore	1.7355	1.3995	1.7502	1.7364	24.01%	-20.04%	0.79%
Thailand	25.3000	25.7000	44.7600	43.1050	-1.56%	-42.58%	3.84%

Note: Negative sign (-) in Changes column indicates % of currency depreciation during respective periods of time.

Panel B: Stock Indices							
	I	II	III	IV	Changes from		
Country	01-01-1991	01-01-1997	11-09-2001	31-12-2002	I to II	II to III	III to IV
Hong Kong	3024.55	13451.45	10417.36	9321.29	344.74%	-22.56%	-10.52%
Indonesia	417.79	637.43	445.48	424.95	52.57%	-30.11%	-4.61%
Japan	23848.71	19361.35	10292.95	8578.95	-18.82%	-46.84%	-16.65%
Korea	696.11	651.22	540.57	627.55	-6.45%	-16.99%	16.09%
Malaysia	505.92	1237.96	690.54	646.32	144.69%	-44.22%	-6.40%
Philippines	651.42	3170.00	1294.09	1018.41	386.63%	-59.18%	-21.30%
Singapore	947.49	1991.68	1566.76	1341.03	110.21%	-21.33%	-14.41%
Thailand	612.86	831.57	330.37	356.48	35.69%	-60.27%	7.90%

Table 2a: Unit Root Test Results of Stock Indices and Exchange Rates for the Pre-crisis and Post-crisis periods

Country	Variable	Period	DF	ADF	Φ_2	Φ_3
Indonesia	Index	Pre-crisis	-2.39	-2.45	2.61	4.44
		Post-crisis	-2.06	-2.67	0.52	2.21
	Exchange Rate	Pre-crisis	-5.15**	-5.15**	12.18**	13.80**
		Post-crisis	-1.97	-1.86	0.59	2.94
Philippines	Index	Pre-crisis	-2.54	-2.54	3.54	4.61
		Post-crisis	-2.30	-2.85	1.44	2.68
	Exchange Rate	Pre-crisis	-2.39	-2.08	0.24	3.00
		Post-crisis	-2.17	-2.36	2.06	3.05
Thailand	Index	Pre-crisis	-0.60	-0.60	2.09	2.33
		Post-crisis	-2.49	-2.70	2.47	4.08
	Exchange Rate	Pre-crisis	-2.35	-2.35	0.11	2.80
		Post-crisis	-2.22	-2.22	1.06	3.61
Malaysia	Index	Pre-crisis	-2.14	-2.14	1.41	2.34
		Post-crisis	-2.16	-2.40	1.60	2.81
	Exchange Rate	Pre-crisis	-1.76	-2.31	0.46	1.64
		Post-crisis	-2.12	-2.25	0.72	3.68
Korea	Index	Pre-crisis	-1.02	-1.02	0.22	0.82
		Post-crisis	-1.80	-1.86	0.35	1.64
	Exchange Rate	Pre-crisis	-1.94	-1.56	1.19	1.91
		Post-crisis	-2.12	-2.78	0.65	3.04
Singapore	Index	Pre-crisis	-2.08	-2.08	1.94	2.70
		Post-crisis	-1.46	-1.52	0.22	1.07
	Exchange Rate	Pre-crisis	-2.13	-2.13	2.94	2.29
		Post-crisis	-2.27	-2.27	2.49	4.16
Japan	Index	Pre-crisis	-2.14	-2.14	0.33	2.46
		Post-crisis	-1.69	-1.69	1.26	1.75
	Exchange Rate	Pre-crisis	-0.49	-0.49	1.35	1.20
		Post-crisis	-1.97	-1.97	0.01	1.94
Hong Kong	Index	Pre-crisis	-2.41	-2.41	3.52	3.25
		Post-crisis	-1.54	-1.70	0.13	1.24
	Exchange Rate	Pre-crisis	-4.54**	-3.94*	0.41	10.60**
		Post-crisis	-2.35	-1.50	1.01	2.88

Table 2b: Unit Root Test Results of Stock Indices and Exchange Rates for the Pre-911 and Post-911 periods

Country	Variable	Period	DF	ADF	Φ_2	Φ_3
Indonesia	Index	Pre-911	-1.80	-2.31	0.53	1.69
		Post-911	-1.01	-1.01	0.20	0.52
	Exchange Rate	Pre-911	-1.71	-1.71	0.50	2.18
		Post-911	-3.72*	-3.72*	0.51	8.37*
Philippines	Index	Pre-911	-2.07	-2.48	1.18	2.19
		Post-911	-0.89	-0.89	0.33	0.60
	Exchange Rate	Pre-911	-1.99	-2.16	1.80	2.28
		Post-911	-1.32	-1.32	0.70	1.12
Thailand	Index	Pre-911	-2.19	-2.39	2.28	3.20
		Post-911	-1.43	-1.43	0.68	1.03
	Exchange Rate	Pre-911	-1.94	-1.94	0.93	2.53
		Post-911	-1.32	-1.32	0.56	1.09
Malaysia	Index	Pre-911	-1.85	-2.07	1.84	2.36
		Post-911	-0.95	-0.95	0.07	0.65
	Exchange Rate	Pre-911	-1.73	-1.75	1.27	2.69
		Post-911	-7.71**	-7.71**	0.00	29.70**
Korea	Index	Pre-911	-1.46	-1.39	0.22	1.07
		Post-911	-1.78	-1.78	0.53	4.03
	Exchange Rate	Pre-911	-1.88	-2.47	0.49	2.18
		Post-911	-1.70	-1.70	0.43	1.63
Singapore	Index	Pre-911	-1.49	-1.76	0.32	1.14
		Post-911	-1.15	-1.15	0.33	1.71
	Exchange Rate	Pre-911	-2.25	-2.25	4.04	3.51
		Post-911	-3.48*	-3.48*	0.02	9.19**
Japan	Index	Pre-911	-1.28	-1.28	1.05	1.20
		Post-911	-1.99	-1.99	0.37	2.99
	Exchange Rate	Pre-911	-1.88	-1.88	0.04	1.77
		Post-911	-1.77	-1.77	0.18	2.34
Hong Kong	Index	Pre-911	-1.47	-1.47	0.06	1.11
		Post-911	-2.51	-2.51	0.32	4.37
	Exchange Rate	Pre-911	-2.71	-2.28	0.96	3.69
		Post-911	-7.19**	-7.19**	0.02	25.85**

DF is the Dickey-Fuller t-statistic; ADF is the augmented Dickey-Fuller statistic.
Φ_2 and Φ_3 are the Dickey-Fuller likelihood ratios.
*denotes $p<0.05$, ** denotes $p<0.01$.

Note that pre-crisis period is from January 1, 1991 to December 31, 1996, post-crisis period is from January 1,1997 to December 31, 2002 which are further divided into two periods: pre-911 period (January 1, 1997 – September 10, 2001) and post-911 period (September 11, 2001 - December 31, 2002).

Table 3: Cointegration Results of Weekly Stock Indices and Exchange Rates

Country	Period	Model	R^2	CRDF	CRADF
Indonesia	Pre-crisis	$S_t = -20.1874 + 3.4208E_t$	0.5799	-2.59**	-2.40*
	Post-crisis	$S_t = 8.7484 - 0.2894E_t$	0.4082	-2.48*	-3.29**
	Pre-911	$S_t = 8.6567 - 0.2781E_t$	0.4038	-2.23*	-2.94**
	Post-911	$S_t = 12.2458 - 0.6745E_t$	0.1131	-1.01	-1.01
Philippines	Pre-crisis	$S_t = 5.6181 + 0.5973E_t$	0.0030	-2.64**	-2.64**
	Post-crisis	$S_t = 12.5169 - 1.3594E_t$	0.8154	-2.48*	-2.48*
	Pre-911	$S_t = 11.8550 - 1.1727E_t$	0.7719	-2.57*	-2.57*
	Post-911	$S_t = 23.5179 - 4.1716E_t$	0.4532	-1.85	-1.85
Thailand	Pre-crisis	$S_t = 53.2934 - 14.353E_t$	0.2915	-3.02**	-3.02**
	Post-crisis	$S_t = 10.8307 - 1.3318E_t$	0.5634	-2.74**	-2.74**
	Pre-911	$S_t = 10.9307 - 1.3619E_t$	0.5617	-2.42*	-2.42*
	Post-911	$S_t = 21.2058 - 4.0761E_t$	0.5688	-2.21*	-2.21*
Malaysia	Pre-crisis	$S_t = 10.5247 - 4.0209E_t$	0.2492	-1.21	-1.21
	Post-crisis	$S_t = 8.2663 - 1.3257E_t$	0.4549	-2.11*	-2.00*
	Pre-911	$S_t = 8.2937 - 1.3558E_t$	0.4702	-1.86	-1.86
	Post-911	$S_t = 66.8047 - 45.1453E_t$	0.0047	-1.14	-1.14
Korea	Pre-crisis	$S_t = -2.8455 + 1.4247E_t$	0.0759	-1.19	-1.19
	Post-crisis	$S_t = 12.3519 - 0.8343E_t$	0.1783	-1.90	-2.51*
	Pre-911	$S_t = 13.2676 - 0.9701E_t$	0.2561	-1.76	-2.34*
	Post-911	$S_t = 6.6588 - 0.0143E_t$	0.0000	-2.44*	-2.44*
Singapore	Pre-crisis	$S_t = 8.4249 - 2.4866E_t$	0.6934	-2.20*	-2.20*
	Post-crisis	$S_t = 7.7586 - 0.6376E_t$	0.0411	-1.40	-1.34
	Pre-911	$S_t = 7.7026 - 0.5022E_t$	0.0214	-1.30	-1.44
	Post-911	$S_t = 5.7190 + 2.7685E_t$	0.2914	-1.64	-1.64
Japan	Pre-crisis	$S_t = 7.6016 + 0.4858E_t$	0.2317	-2.36*	-2.36*
	Post-crisis	$S_t = 14.8736 - 1.1043E_t$	0.1316	-0.63	-0.63
	Pre-911	$S_t = 12.3303 - 0.5526E_t$	0.0999	-0.74	-0.74
	Post-911	$S_t = 4.6967 + 0.9377E_t$	0.1581	-1.24	-1.24
Hong Kong	Pre-crisis	$S_t = 256.3082 - 120.8997E_t$	0.5041	-3.25**	-2.53*
	Post-crisis	$S_t = -19.4329 + 14.0636E_t$	0.0464	-1.56	-1.56
	Pre-911	$S_t = -72.1517 + 39.8107E_t$	0.3100	-1.74	-1.74
	Post-911	$S_t = 41.7576 - 15.8235E_t$	0.0005	-1.61	-1.61

CRDF is the cointegration regression Dickey-Fuller statistic for stationary of the estimated residuals.
CRADF is the comparable test statistic for the augmented Dickey-Fuller.
*denotes $p<0.05$, ** denotes $p<0.01$.

Note that pre-crisis period is from January 1, 1991 to December 31, 1996, post-crisis period is from January 1, 1997 to December 31, 2002 which is further divided into two periods: pre-911 period (January 1, 1997 – September 10, 2001) and post-911 period (September 11, 2001 - December 31, 2002).

Table 4a: Granger Causality Results of Weekly Stock Indices and Exchange Rates in the Pre-crisis period

Country	Granger Cause	n	m	p-values [a]	p-values [b]
Indonesia	Ex → Ix	2	1	0.5095	0.2835
	Ix → Ex	2	1	0.4940	0.3846
Philippines	Ex → Ix	1	3	0.0771	0.0060**
	Ix → Ex	1	1	0.2762	0.7375
Thailand	Ex → Ix	1	1	0.5069	0.0741
	Ix → Ex	1	6	0.0889	0.6671
Malaysia	Ex → Ix	1	2	<.0001**	n.a.
	Ix → Ex	3	6	0.0362*	n.a.
Korea	Ex → Ix	1	1	0.6110	n.a.
	Ix → Ex	6	2	0.0726	n.a.
Singapore	Ex → Ix	1	1	0.5346	0.2323
	Ix → Ex	1	3	0.1240	0.4461
Japan	Ex → Ix	1	1	0.2056	0.8223
	Ix → Ex	2	1	0.2487	0.0616
Hong Kong	Ex → Ix	2	3	0.2325	0.1208
	Ix → Ex	5	1	0.8615	0.1317

Table 4b: Granger Causality Results of Weekly Stock Indices and Exchange Rates in the Post-crisis period

Country	Granger Cause	n	m	p-values [a]	p-values [b]
Indonesia	Ex → Ix	3	2	0.0015**	0.0480*
	Ix → Ex	6	1	0.0215*	0.1182
Philippines	Ex → Ix	4	1	0.4378	0.1650
	Ix → Ex	5	6	0.0131*	0.0779
Thailand	Ex → Ix	4	3	0.0542	0.0122*
	Ix → Ex	2	6	0.0117*	0.0746
Malaysia	Ex → Ix	5	2	0.0066**	0.0475*
	Ix → Ex	3	1	0.3680	0.0185*
Korea	Ex → Ix	6	5	0.0480*	0.0601
	Ix → Ex	3	1	0.0006**	0.3539
Singapore	Ex → Ix	5	1	<.0001**	n.a.
	Ix → Ex	2	1	0.6719	n.a.
Japan	Ex → Ix	1	2	0.0630	n.a.
	Ix → Ex	1	1	0.2387	n.a.
Hong Kong	Ex → Ix	4	1	0.2008	n.a.
	Ix → Ex	6	3	0.0011**	n.a.

Table 4c: Granger Causality Results of Weekly Stock Indices and Exchange Rates in the Pre-911 period

Country	Granger Cause	n	m	p-values [a]	p-values [b]
Indonesia	Ex → Ix	3	2	0.0018**	0.0555
	Ix → Ex	1	1	0.0583	0.1879
Philippines	Ex → Ix	4	1	0.4888	0.0814
	Ix → Ex	5	5	0.0360*	0.2122
Thailand	Ex → Ix	5	3	0.0634	0.0466*
	Ix → Ex	1	3	0.0333*	0.0947
Malaysia	Ex → Ix	3	2	0.0213*	n.a.
	Ix → Ex	3	1	0.4039	n.a.
Korea	Ex → Ix	5	6	0.0275*	0.0905
	Ix → Ex	2	1	0.0043**	0.4773
Singapore	Ex → Ix	5	3	<.0001**	n.a.
	Ix → Ex	1	1	0.7880	n.a.
Japan	Ex → Ix	1	1	0.0291*	n.a.
	Ix → Ex	1	1	0.3347	n.a.
Hong Kong	Ex → Ix	4	1	0.2484	n.a.
	Ix → Ex	6	3	0.0012**	n.a.

Table 4d: Granger Causality Results of Weekly Stock Indices and Exchange Rates in the Post-911 period

Country	Granger Cause	n	m	p-values [a]	p-values [b]
Indonesia	Ex → Ix	3	1	0.9275	n.a.
	Ix → Ex	3	1	0.9705	n.a.
Philippines	Ex → Ix	6	1	0.8730	n.a.
	Ix → Ex	1	1	0.5722	n.a.
Thailand	Ex → Ix	1	1	0.5524	0.0724
	Ix → Ex	1	1	0.1332	0.9263
Malaysia	Ex → Ix	2	5	0.1731	n.a.
	Ix → Ex	4	1	0.5345	n.a.
Korea	Ex → Ix	2	1	0.4607	0.0006**
	Ix → Ex	2	4	0.0442*	0.9926
Singapore	Ex → Ix	3	1	0.1372	n.a.
	Ix → Ex	4	1	0.2962	n.a.
Japan	Ex → Ix	5	3	0.0730	n.a.
	Ix → Ex	1	1	0.2082	n.a.
Hong Kong	Ex → Ix	3	1	0.0562	n.a.
	Ix → Ex	3	2	0.0879	n.a.

→ Implies Granger cause, e.g. Ex → Ix implies exchange rate Granger causes stock index.
a) p-values of F test on H_0: $\alpha_{21} = \alpha_{22} = \ldots\ldots = \alpha_{2m} = 0$ or H_0: $\beta_{11} = \beta_{12} = \ldots\ldots = \beta_{1m} = 0$
b) p-values of t test on H_0: $\delta_1 = 0$ or H_0: $\delta_2 = 0$ in ECM model.
*denotes p<0.05, ** denotes p<0.01.
Note that pre-crisis period is from January 1, 1991 to December 31, 1996, post-crisis period is from January 1,1997 to December 31, 2002 which are further divided into two periods: pre-911 period (January 1, 1997 – September 10, 2001) and post-911 period (September 11, 2001 - December 31, 2002).

Figure 1: Time Series Plot of Exchange Rate and Stock Index in Indonesia

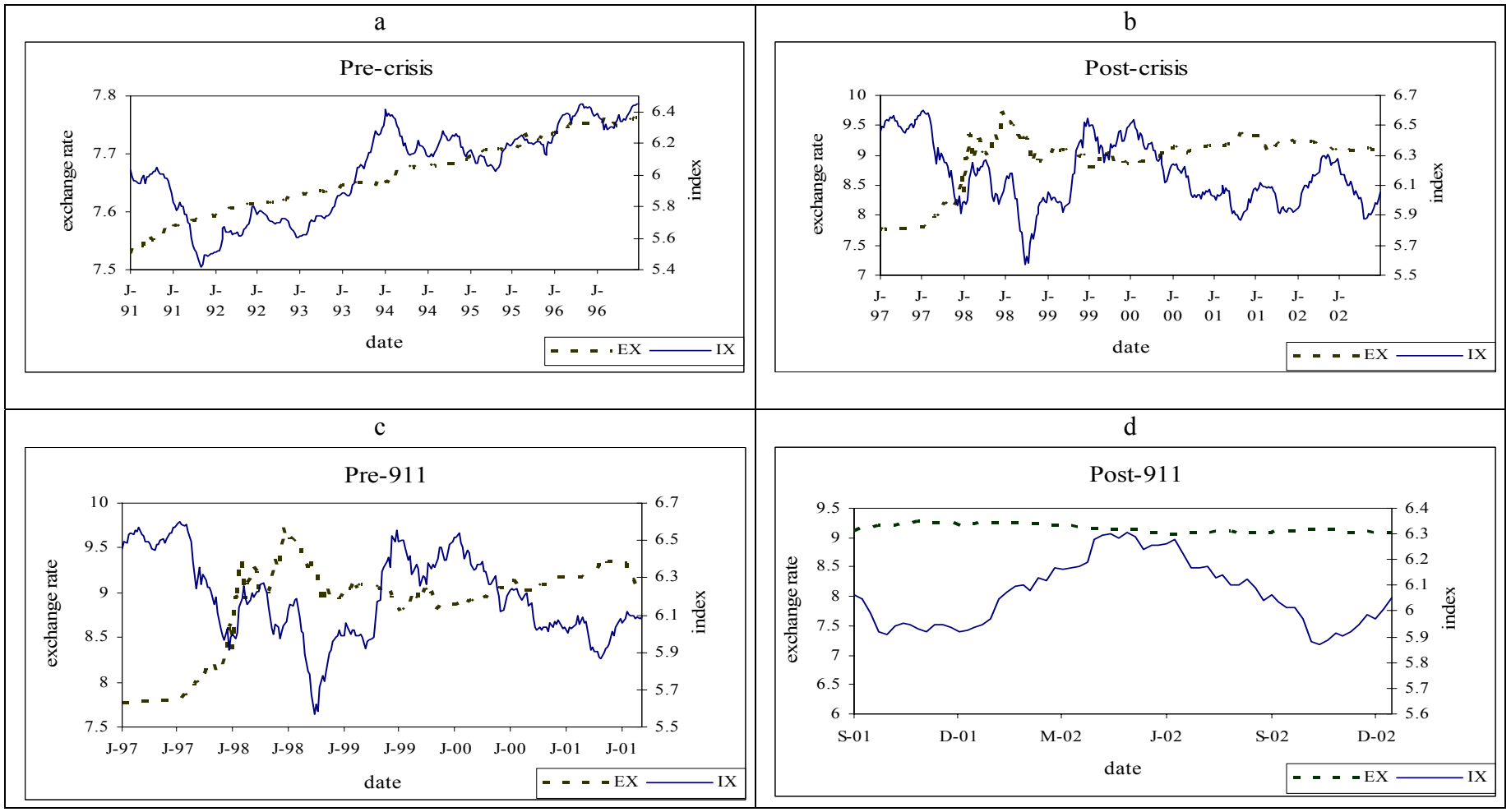

Figure 2: Time Series Plot of Exchange Rate and Stock Index in Philippines

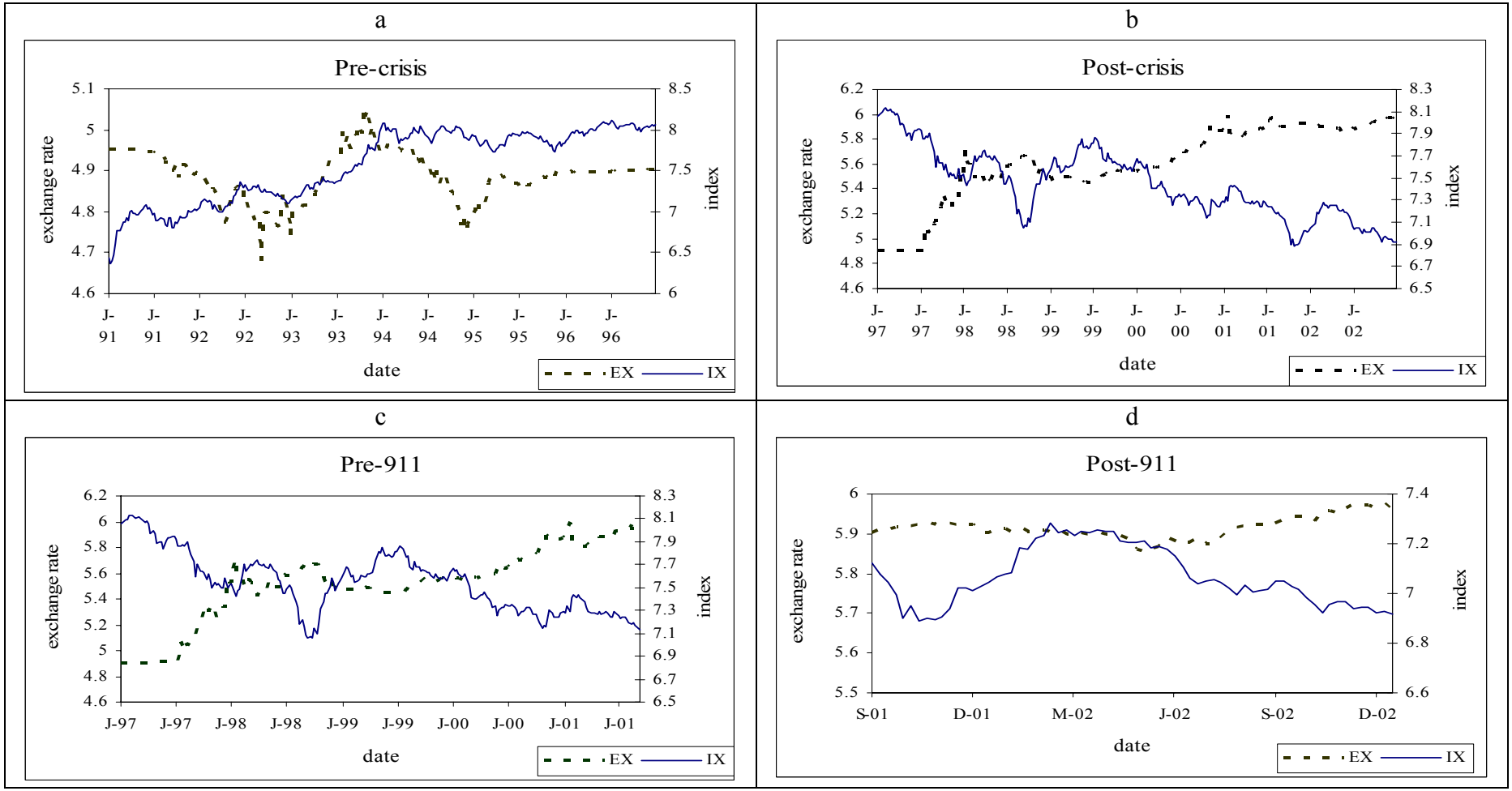

Figure 3: Time Series Plot of Exchange Rate and Stock Index in Thailand

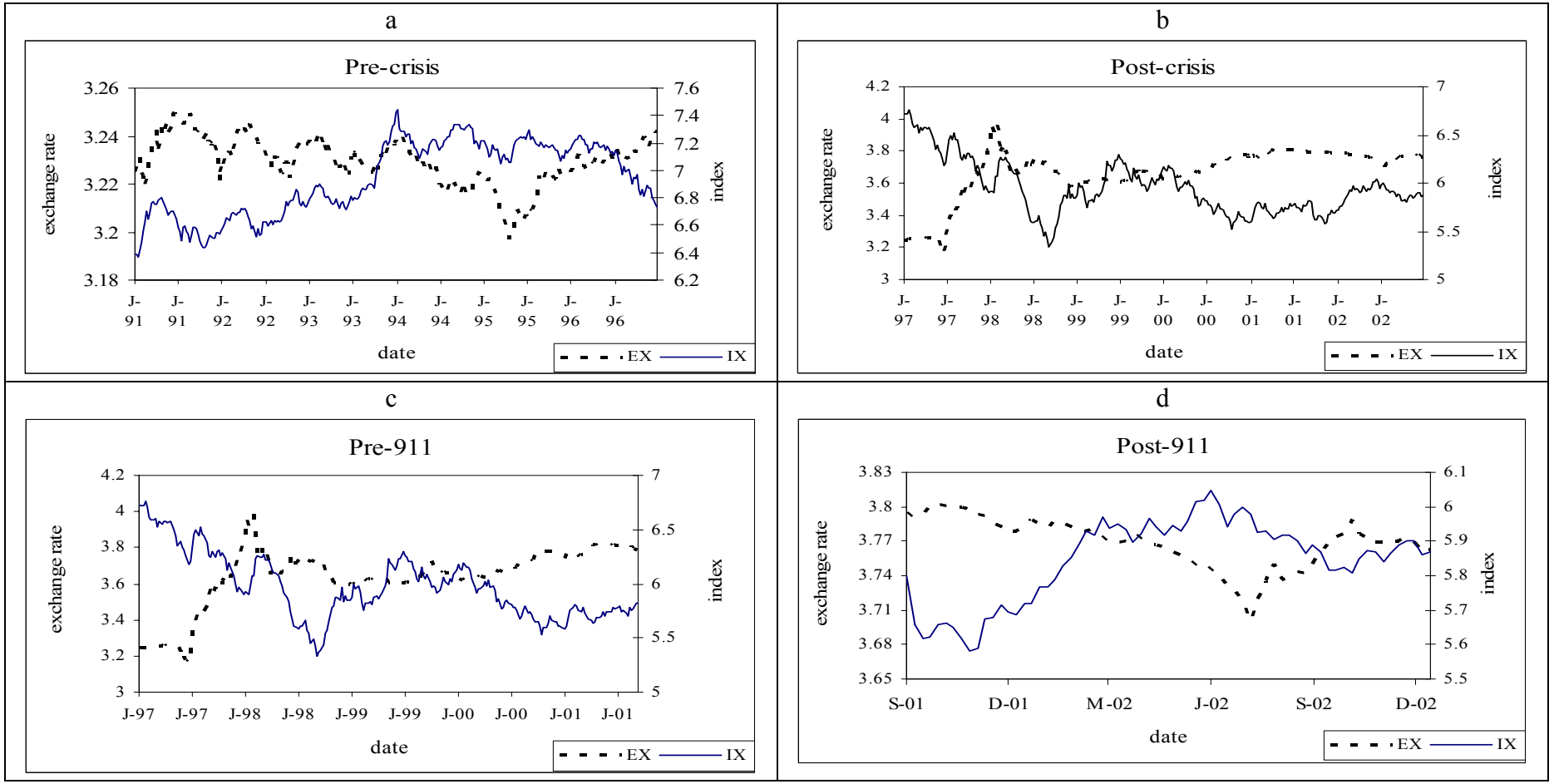

Figure 4: Time Series Plot of Exchange Rate and Stock Index in Malaysia

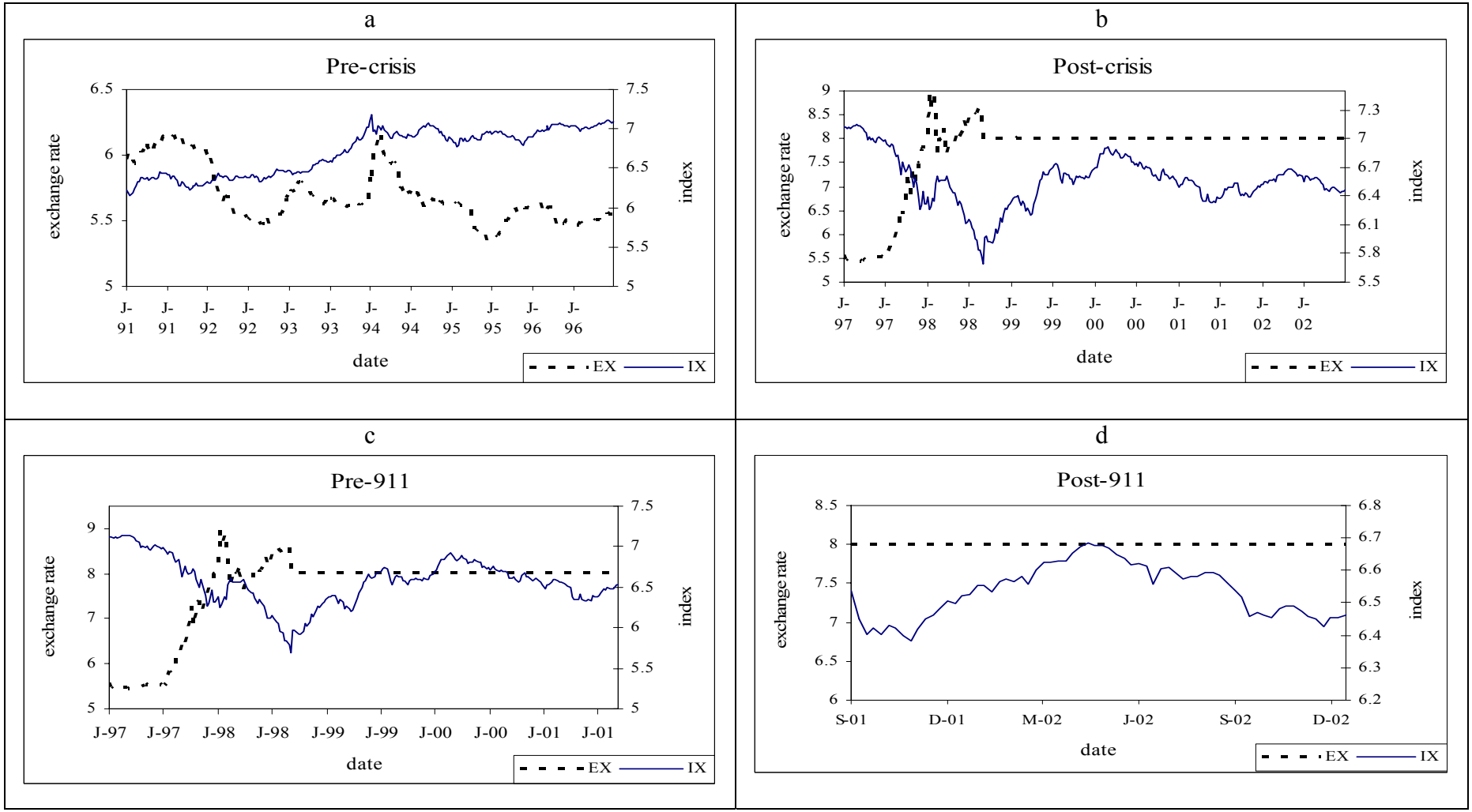

Figure 5: Time Series Plot of Exchange Rate and Stock Index in Korea

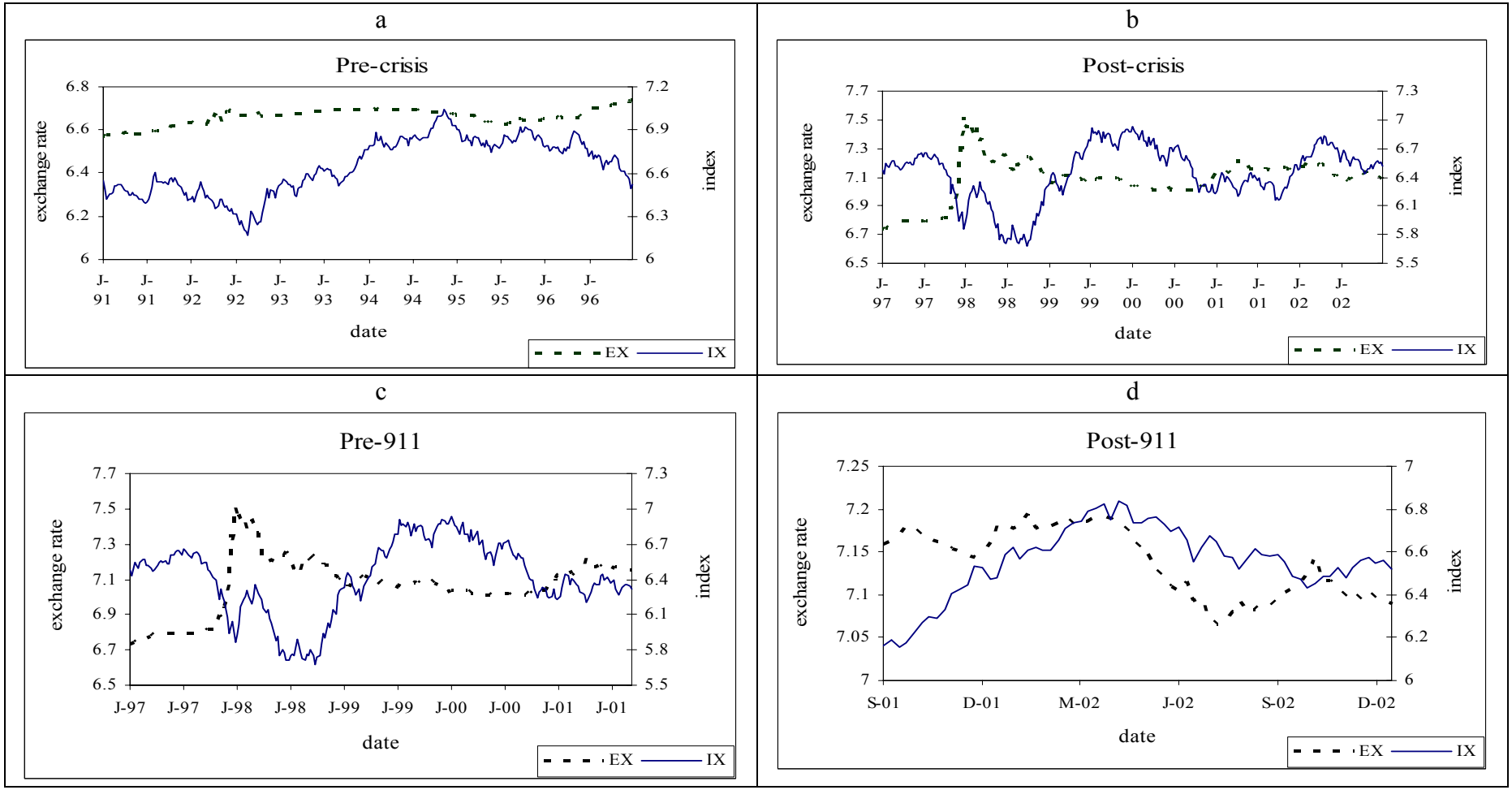

Figure 6: Time Series Plot of Exchange Rate and Stock Index in Singapore

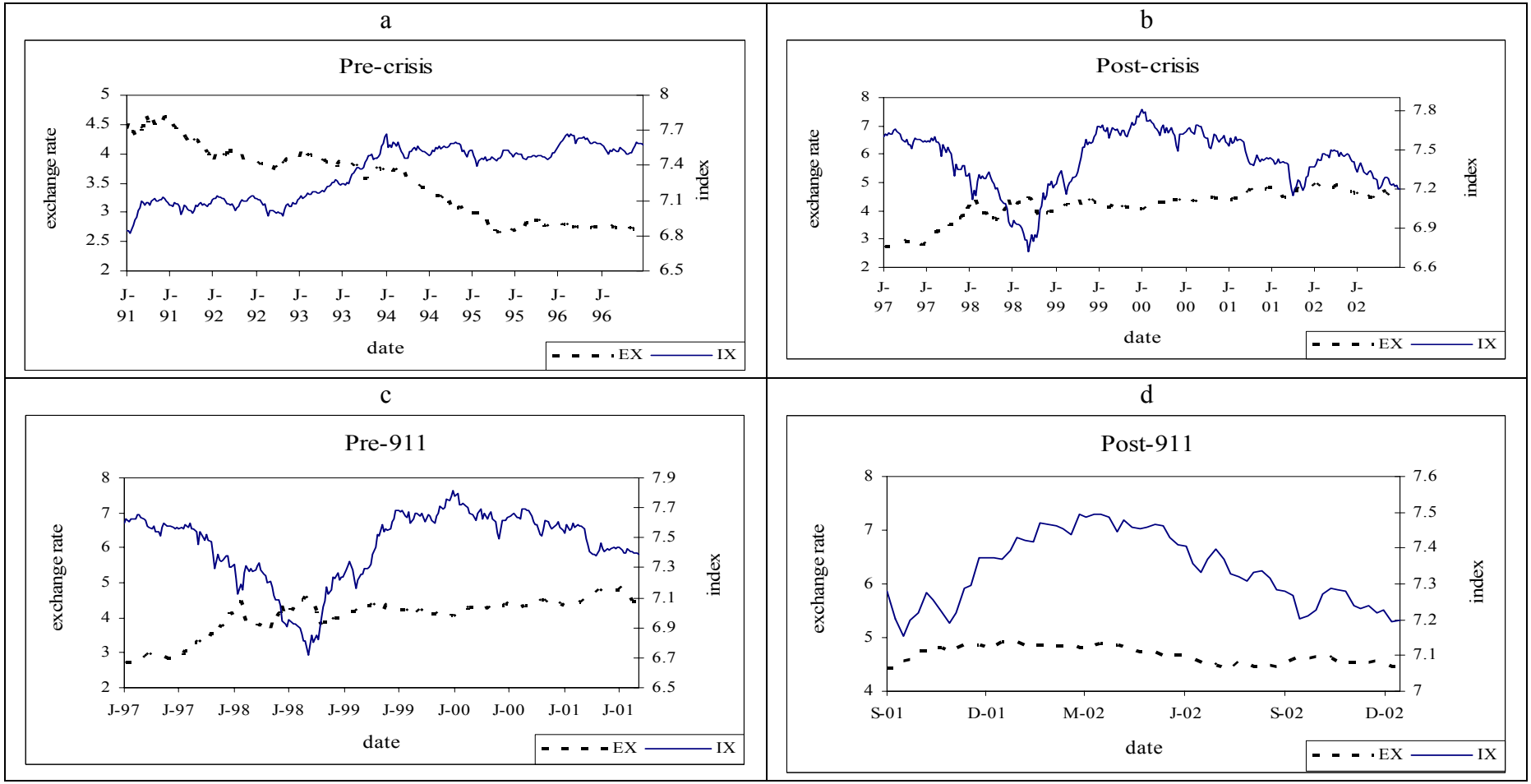

Figure 7: Time Series Plot of Exchange Rate and Stock Index in Japan

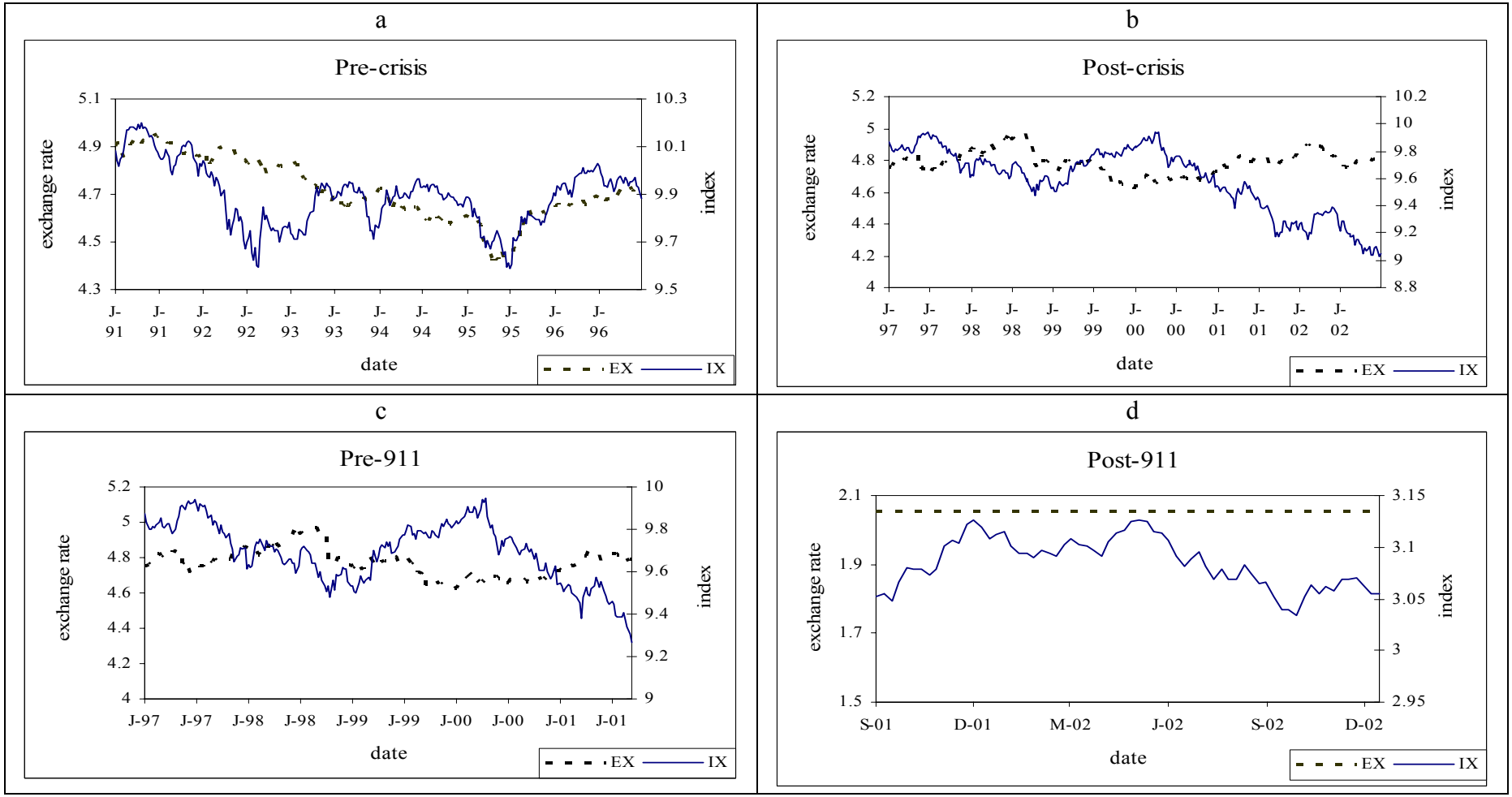

Figure 8: Time Series Plot of Exchange Rate and Stock Index in Hong Kong