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A BIVARIATE CAUSALITY BETWEEN STOCK PRICES AND EXCHANGE RATES: EVIDENCE FROM RECENT ASIA FLU

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Abstract

This paper applies recently developed unit root and cointegration models to determine the appropriate Granger causality relations between stock prices and exchange rates using recent Asian flu data. Coupled with impulse response functions, it is found that data from Japan and Thailand are in agreement with this approach, so that exchange rates leads stock prices with positive correlation. On the other hand, data of Taiwan suggests the result predicted by the portfolio approach: stock prices lead exchange rates with negative correlation. Data from Indonesia, Korea, Malaysia, and the Philippines indicate strong feedback relations while that of Singapore fails to reveal any recognizable pattern.

JEL Classification: G15, C32
Keywords: Asian Flu, Causality, Stock Prices, Exchange Rates

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I. Introduction

The financial crisis sparked in Thailand in July, 1997 has sent shock waves throughout southeast Asia, South Korea and Japan. On October 27, the short-run interest rate in Hong Kong took a huge jump in order to maintain its pegged exchange rate to the U.S. dollars. As a result, the Hang Seng Index plummeted 1438 points, setting off the crash in the U.S. with the Dow Jones Industrial Averages down by 554.26 points. On November 24, Yamaichi – the fourth largest financial corporation - filed for bankruptcy which gave rises to a 854-point drop in Nikkei Index. In mid-December, the Korean won depreciated drastically from 888 wons (per dollar) in July 1 to more than 2000 wons. The currency crisis in South Korea set off a financial avalanche in its stock markets which witnessed a 50.3% freefall. Similar debacles also occurred in other Asian markets. Turmoils in both currency and stock markets are of paramount interest: Does currency depreciation lead to stock market downfall or vice versa? Such a study provides an opportunity for analyzing dynamics between stock prices and exchange rates. Practitioners can profit from the arbitrage from the crisis as well. If exchange rate market is found to lead the corresponding stock market, the emphasis of government policy ought to be placed on controlling the exchange rate. In contrast, domestic economic policies are the priority in stabilizing stock market in the case where stock market leads the exchange rate market.

From the viewpoint of microeconomics, a changes in the exchange rate is expected to change the portfolio of multinational firms. An appreciation of the local currency most likely will decrease the company's profit, hence its stock price. Likewise from the perspective of macroeconomics, an appreciation of the local currency under flexible exchange rate regime will lessen the competitiveness of its product, and lower its stock price. From both viewpoints, exchange rate change is expected to lead to stock price change, and it is known as the traditional approach.[1] However, as capital market become more and more integrated, changes in stock prices and exchange rates may reflect more of capital movement than current account imbalance. The central point of such a portfolio approach lies in the following logical deductions: A decrease in stock prices causes a reduction in wealth of domestic investors which in turn leads to lower demand for money with ensuring lower interest rates. The lower interest rates encourage capital outflows ceteris paribus, which in term is the cause of currency depreciation. The inverse relation between stock prices and exchange rates in the portfolio approach runs counter to the positive relation in the traditional approach. If a market is subject to the influences of both approaches simultaneously, a feedback loop is expected to be found with the sign dominated by the stronger effect.

In the case of the U.S. markets, empirical examinations of relation between stock returns and exchange rate changes have largely provided only weak evidence: Exchange rate changes are significantly related to either firm or portfolio stock returns (e.g., Jorion 1990; Bahmani-Oskooee and Sohrabian, 1992; Amihud, 1993; Bartor and Badnar, 1994). Similar tests are performed by Bondnar and Gentry(1993) for Japan and Canada. In the

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[1] The direction of correlation is regarded as positive, since a depreciation of the local currency is considered an increase in exchange rate.

case of emerging markets, only skimpy literature is available. For instance, the result of Abdalla and Murinde (1997) supports the traditional approach: Exchange rate changes lead stock prices. However, their study includes only India, South Korea, Pakistan and Philippines. The recent Asian flu exposes a rather puzzling question: In the wake of depressing stock and currency markets, which one is the culprit? The majority of prior studies support the traditional approach: exchange rate change leads stock return. Only a few indicate that opposite direction holds true or the feedback phenomenon exists. Well-known in the literature, using monthly data may not be adequate in describing the effect of capital movement, which is intrinsically a short-run occurrence. In this paper, we employ daily data in the emerging markets in the hope that it will capture such effects. In addition, we apply more advanced unit root and cointegration techniques, which account for structural break (e.g., the Asian flu), in order to avoid the potential estimation bias. The organization of the paper is as follows: The next section describes empirical models; section 3 introduces the unit root and cointegration models with structural break; section 4 discusses the empirical result; section 5 provides a conclusion.

II Discussion of Empirical Models

Since their well-known paper (Nelson and Plosser, 1982), the unit-root property of macroeconomic variables has been widely accepted. As such, a unit-root test is often necessary before empirical studies. Based on the result by Dickey and Fuller(1979), the Augmented Dickey and Fuller(ADF) test was generally employed as shown below:

$$\Delta y_t = \alpha + \beta t + (\rho - 1) y_{t-1} + \sum_{i=1}^{k-1} \theta_i \Delta y_{t-i} + a_t \qquad (1)$$

where $\Delta = 1 - L$ y_t is a macroeconomic variable such as exchange rate or stock price; t is a trend variable; a_t is a white noise term. The null hypothesis is $H_0\!:\rho = 1$ and y_t is said to possess the unit root property if one fails to reject H_0.

Nevertheless, the ADF test is suspect when the sample period includes some major events (e.g., great depression, oil shocks). Failure to consider it properly can lead to erroneous conclusions in the case when the null is not rejected. To circumvent this problem Perron and Vogelsang (1992) introduce dummy variable into (1) and recalculate new set of critical values. However, as pointed out by Zivot and Andrew (1992, pp. 251), "A skeptic of Perron's approach would argue that his choices of breakpoints are based on prior observation of the data and hence problems associated with 'pre-testing' are applicable to his method,"

Consequently, they introduce an alternative formulation to overcome the pre-testing problems: [2]

$$\Delta y_t = \alpha + \beta t + (\rho - 1) y_{t-1} + \gamma DU_t(\lambda) + \sum_{i=1}^{k-1} \theta_i \Delta y_{t-i} + a_t \qquad (2)$$

where $DU_t(\lambda) = 1$ for $t > T\lambda$, otherwise $DU_t(\lambda) = 0$; $\lambda = T_B / T$ represents the location where the structural break lies; T is sample size; T_B is the date when the structural break occurred. Evident from (2), the estimation result hinges critically on the value λ as well. As is done in this paper, a set of simulated critical values is employed for hypothesis testing during the period of Asian flu. To investigate the stationarity assumption of several I(1) variables, majority of academicians still rely on the widely-accepted and easy to apply model proposed by Engle and Granger (1987) despite its normalization problem. Just as the ADF model fails to consider problems associated with structural breaks, the Engle-Granger formulation bypasses the same difficulty. Applying the similar approach by Zivot and Andrews (1992), Gregory and Hansen (1996) revise the Engle and Granger

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[2] There are three different models provided by Zivot and Andrew (1992). We adopt the unit-root model as shown in (2) due to the existence of a trend in the time series. Similar results are obtained using the other two models proposed by them.

(1996) model to consider the regime shift via residual-based cointegration technique. The Gregory and Hansen model is a two-stage estimation process of which the first step is to estimate the following multiple regression:

$$y_{1t} = \alpha + \beta t + \gamma DU_t(\lambda) + \theta_1 y_{2t} + e_t \tag{3}$$

in which y_{1t} and y_{2t} are of I(1) and y_{2t} is a variable or a set of variables; $DU_t(\lambda)$ has the same definition as that in (2). The second step is to test if e_t in (3) is of I(0) or I(1) via the ADF or Phillips-Perron technique. If e_t is found to be consistent with I(0), one may claim that cointegration exist between y_{1t} and y_{2t}. Once the statistical property of e_t is established, one may adopt the bivariate VAR model to test the Granger causality. If the cointegration do not exist, the following formulation is need in testing hypotheses:

$$\begin{aligned} \Delta y_{1t} &= \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta y_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta y_{2t-i} + \varepsilon_{1t} \\ \Delta y_{2t} &= \beta_0 + \sum_{i=1}^{k} \beta_{1i} \Delta y_{1t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta y_{2t-i} + \varepsilon_{2t} \end{aligned} \tag{4}$$

in which y_{1t} and y_{2t} represent stock prices and exchange rates. Failing to reject the $H_0: \alpha_{21} = \alpha_{22} = \cdots = \alpha_{2k} = 0$ implies that exchange rates do not Granger cause stock prices. Likewise, failing to reject $H_0: \beta_{11} = \beta_{12} = \cdots = \beta_{1k} = 0$ suggests that stock prices do not Granger cause exchange rates. If cointegration exists between y_{1t} and y_{2t}, an error correction term is required in testing Granger causality as shown below:

$$\begin{aligned} \Delta y_{1t} &= \alpha_0 + \delta_1 (y_{1t-1} - \gamma y_{2t-1}) + \sum_{i=1}^{k} \alpha_{1i} \Delta y_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta y_{2t-i} + \varepsilon_{1t} \\ \Delta y_{2t} &= \beta_0 + \delta_2 (y_{1t-1} - \gamma y_{2t-1}) + \sum_{i=1}^{k} \beta_{1i} \Delta y_{1t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta y_{2t-i} + \varepsilon_{2t} \end{aligned} \tag{5}$$

in which δ_1 and δ_2 denote speeds of adjustment. According to Engle and Granger (1987), the existence of the cointegration implies a causality among the set of variables as manifested by $|\delta_1| + |\delta_2| > 0$. Failing to reject $H_0: \alpha_{21} = \alpha_{22} = \cdots = \alpha_{2k} = 0 \quad and\ \delta_1 = 0$ implies that exchange rates do not Granger cause stock prices while failing to reject $H_0: \beta_{11} = \beta_{12} = \cdots = \beta_{1k} = 0 \quad and \quad \delta_2 = 0$ indicates stock prices do not Granger cause exchange rates.

III. Data, Time Series Trends, Unit Root and Cointegration Results

Included in this sample study are exchange rates and stock prices from Hong Kong (HKN), Indonesia (IND), Japan (JPN), South Korea (KOA), Malaysia (MAL), Philippines (PHI), Singapore (SIG), Thailand (THA) and Taiwan (TWN). The sample period starts from January 3, 1986 to November 14, 1997. Daily data (five days a week) in total of 3097 observations are from Datastream.[3] Three subperiods are used in order to better dissect the relations between exchanges and stock prices. Period 1 (87-Crash) cover from January 3, 1986 to November 30, 1987; Period 2 (After Crash) started on December 1, 1987 and ended on December 30, 1994; Period 3 (the Asian-Flu Period) continued from January 3 1995 through November 14, 1997. All data points are transformed into logarithmic scale and are shown in time series plots (see Figure 1).

Insert Figure 1 Here

Evident from Figure 1, all the nine economies exhibit pronounced structural breaks. That is, barring the Hong Kong dollar that maintained its peg to the U.S. dollars, all other

[3] We are extremely grateful for the generosity extended by the economics department of the UCSD in providing the data.

eight currencies suffered noticeable depreciations since July, 1997. During the period of July 1 ~ November 14, 1997, the Thai Bhat experienced the greatest slide in its value (56.83%), followed by Rupiah of Indonesia (41.87%), Ringgit of Malaysia (31.37%), and the peso of Philippines (27.89%). The rest of currencies witnessed between 9% ~ 11% depreciation (Table 1).[4] Similar freefalls in stock markets were witnessed ranging from 13.4% of the Thailand market to 40.3% of the Indonesia market. As the Asian flu worsened, the performance of Pacific funds outside Japan fell 35.5% on average. As the existence of the structural break is patently clear from both Table 1 and Figure 1, the revised model is necessary to explore the subtle relations between exchange rates and stock prices.

Insert Table 1 about Here

To account for the structural change, we employ the Zivot and Andrew model (1992) to test the unit root property for the nine economies, and the result is reported in Table 2.

Insert Table 2 about Here

A perusal of Table 2 reveals that the null hypothesis of a unit root in stock indexes cannot be rejected using Zivot and Andrew approach. Nonetheless, the same cannot be said about exchange rate markets. More specifically, the Hong Kong market lacked the unit root property for the entire sample period; the Rupiah in period 1; Ringgit and Bhat in period 3 as shown in Figure 2.[5]

Insert Figure 2 about Here

The lack of the unit root property within the sample periods enables us to apply the

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[4] The Korean won lost its value drastically to over 2000 wons per US dollar in December of 1997.

[5] Note that values in six of the eighteen unit root tests exceed the 95% value whereas one of them is less than the 5% value, indicating that the Asian financial debacles have indeed caused structural changes. Such structures break toward the either end of data could cast a doubt on the testing power of the Zivot and Andrew unit root test statistic. It remains as an interesting research topic in the future.

statistical model readily in terms of exchange rates and rate of change in stock price. Note that from prior studies, rate of change in exchange rates was found to mirror exchange rate exposure, hence it may have better economic interpretation. It is to be pointed out that the cointegration analysis is not needed for the time periods in which the logrithmic exchange rates are of I(0). Given the outcome of the unit root test, we present the cointegration results based on the Gregory and Hansen model (1996) in Table 3.

Insert Table 3 about Here

The first line in Table 3 lists the statistics when y_{1t} (stock prices) is regressed on y_{2t} (exchange rate) whereas the statistics of the reverse-order regressions are reported in the second line. In all cases except Thailand (y_{2t} =stock prices, y_{1t} =exchange rates), we fail to reject the null hypothesis that no cointegration exists between exchange rates and stock prices. Note that if y_{1t} denotes stock prices and y_{2t} denotes exchange rates in the case of Thailand, we fail to reject the null hypothesis as we did in all other cases. For this reason, we assume that no definitive cointegration exists even in the Thai market.[6] This being the case, we employ equation (4) to explore the subtle relations between exchange rates and stock prices in the Asian markets.

IV. Discussion of Empirical Results

Despite the pronounced structural break in these Asian markets, traditional Granger causality test or equation (4) would suffice for studying the relations between exchange rates and stock prices. We assume the optimum value for k (k=5) as there are normally five trading days in a week for each of the nine economies. The causality results for the three sub-periods are reported in Table 4.

Insert Table 4 about Here

During period 1 (Jan. 3, 1986 ~ Nov. 30, 1987), there existed little interactions between currency and stock markets except Hong Kong and South Korea. An

[6] The null hypothesis is rejected in period 2 with the Bhat exchange rate being the dependent variable. The

examination indicates changes in the exchange rates lead that of stock prices in Hong Kong whereas changes in stock prices lead that of the exchange rates in South Korea. The result of the Hong Kong market is in agreement with the existing literature; however, the Korean result runs counter to that by Abdalla and Murinda (1997), who employ monthly data (January 1985 through July, 1994).

In period 2 (or After-Crash period), there is no definitive pattern of interactions between the two markets. As is shown in Table 4, changes in exchange rates lead that in stock prices in both Malaysia (α<5%) and Philippines (α>5%). Additionally changes in stock prices are found to lead in exchange rate changes in Taiwan (α<5%). The result of Philippines market differs from that by Abdalla and Murinda (1997) in which no definitive relation was found. The finding indicates again that using higher frequency data could reveal more insight that would have been missed.

No definitive pattern have been identified between currency and stock markets according to the previous literature. However, such is not the case during period 3 (the Asian flu period) based on our analysis. All nine economies manifest significant relations between the two markets. In the case of Japan, Thailand, Singapore and Hong Kong, changes in the exchanges rates lead that in stock prices.[7] The reverse direction is found for Taiwan. The rest of the markets (Indonesia, South Korea, Malaysia and Philippines) are characterized by feedback interaction in which change in exchange rates can take the lead and vice versa. Given the definitive patterns, the Granger causality test does not provide signs of these relations. To examine the short run dynamic relation of Asian markets during period 3, we take advantage of the impulse-response (IR) functions and calculate standard deviation for each forecasting period.[8] The IR (10 periods) from shocks of each variable are shown in Table 5.

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causality result using either (4) or (5), however, remain the same.

[7] The significance level is greater than 10% in the case of Hong Kong. The impulse—response functions indicate that either variable can take the lead. As such, the Hong Kong market can be characterized by feedback interaction.

[8] For the definition of impulse response function and calculations of its standard deviation, readers are

Insert Table 5 about Here

An inspection of Table 5 reveals that the results from the IR analysis is in conformity with that of the Granger causality test. This is to say, if the Granger causality test indicates change in stock prices lead that in exchange rates, the responses of stock prices from one-unit shock of exchange rates are insignificant. Such is the case for Taiwan as shown in lower part of Table 5. Overall, three distinguishing patterns can be identified from Table 5 from the IR analysis of the nine economies in Asia.

First, one-unit shocks from the exchange rates have very discernible positive responses on their corresponding stock prices. This is clearly the case for Japan and Thailand. As their currencies depreciate, which makes their exports competitive, increasing profit is certainly conductive to higher stock prices. The IR analysis provides further short-run dynamic relations (sign and timing) above and beyond that obtained from the Granger causality test. For instance, it takes Japanese stocks within the first three days to respond (positively). The positive responses are found to be in day 2,3,6,7, and 8 after the one-unit shock was administered in Thailand. The negative responses in day 5 and 9 were more than offset so that overall response of stock prices in Thailand was positive in two-week span. The IR analysis for Japan and Thailand confirms the validity of the traditional approach. On the other hand, changes in exchange rates, according to the analysis, led that of stock prices in the case of Singapore. However, the impact on stock price (next day) is negative based on the IR analysis (one unit change in exchange rates). The unexpected sign might be attributed to well-structured financial system and needs to be explored for future analysis.

According to the portfolio approach, changes in stock prices lead changes in exchange rates. The typical example is found in Taiwan markets where one standard deviation decrease in stock prices gave rise to the depreciation of the Taiwan dollar in the first two days. Such a negative relation between the stock and the exchange rate markets has manifested itself readily since period 2. As is known in the Asian markets, the Taiwan stock market reached its peak at 12,000 points in February 1990, and fell to as

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referred to chapter 21 of Hamilton (1994).

low as 4,000 points in the ensuing recession. It rebounded again back to about 10,000 points, and fell to 7,100 points in the midst of the Asian flu. The exchange rate of the Taiwan dollar, built on large foreign exchange surplus from export-led economic growth, had remained fairly stable (at approximately 38 to 40 dollar per U.S. dollar) before 1988. Since then its currency began to appreciate in value owing to the pressure from the U.S. The appreciation took place gradually so to minimize the impact on firms. Such a policy was indeed considered suitable to alleviate adverse effect for domestic manufacturers, but served as an open invitation to “hot money” that flowed into Taiwan’s financial market. The overflow of the hot money inevitably led to the overheated stock market and overvalued prices. In addition, the overflow of the hot money noticeably increased the demand for the Taiwan dollar which in turn exerted the pressure for its currency appreciation. During the Asian flu period, rapid selling of international (institution) investors in the Taiwan stock market clearly caused the downfall. The depreciation of the Taiwan dollar was simply expected as the investors converted Taiwan dollars into U.S. dollars. The result is in total agreement with that predict by the portfolio approach.

The feedback interaction between exchange rate and stock markets is an interesting result when both the traditional and the portfolio approaches run their courses. The sign of the relations between two markets depends on the strength of the two approaches. Capital flow beings a short-run phenomenon, can be readily detected from daily data. As such, the result predicted by the portfolio approach prevailed as shown by the negative sign in Table 5. However, the positive relation as predicted by the traditional approach cannot be ignored either. This is observed from the IR analysis for the markets of Hong Kong, Indonesia, South Korea, Malaysia and Philippines. Note that the result from the Hong Kong markets suggests that the exchange rate market led the stock market with positive response on day 2, 5, and 8. Nonetheless, it is a borderline case due to its larger significant level (α>10%).

One of the most frequently addressed problems in security price is the existence of predictable portion of changes in stock prices. Based on the Granger causality, in eight of the nine nations, variations in exchange rates could be used to predict stock prices changes in time segment 3 as shown in Table 6.[9] Reported in Table 6 are comparisons of adjusted R-squares($\overline{R}^2$) between the regression in which current stock price changes is the dependent variable and its lagged (k=5) variables are independent and the regression in which current stock price change is the dependent variable and lagged (k=5) variables of exchange rate changes and stock price changes are independent variables.[10] An examination of Table 6 indicates that past information (within a week) on exchange rate variations is useful in predicting stock price changes in the eight markets.

Insert Table 6 about Here

To test for robustness of the results, we have tried several alternative specifications in which stock prices changes of the U.S. and Japan are included. Trades with the U.S. and Japan historically play an important role in the region. A recent study by Wei et al. (1995) indicates that U.S. stock market exerts more impact on Asian stock markets than does the Japanese market. For this reason, we include stock price changes of the U.S. market in equation (4) to reexamine the Granger causality model (Table 7).[11] As is evident from Table 7, with the exception of Singapore, the lead-lag structures remain virtually unchanged. The result is indicative of the robustness of our empirical findings.

Insert Table 7 about Here

V. Conclusion

Prior studies based on monthly data have found either little relation can be established between the two markets or exchange rate market leads stock market. In this paper, we apply the recently advanced statistical techniques coupled with daily data to analyze the problem in the Asian economies. The result indicates that barring Japan,

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[9] In the case of Taiwan, the analysis indicates that exchange rate changes lead that of stock prices, and as such the predictable portion of stock price changes cannot be improved upon noticeably.

[10] Harvey(1995) employs adjusted R-square to investigate the predictability of stock prices for both emerging and developed markets.

[11] To conserve space, we present only the results in which changes in the U.S. stock prices are included. The lead-lag structures remain unchanged as well if Japanese data are included in equation (4).

Singapore and Thailand whose markets were characterized by the phenomenon predicted by the traditional approach, most markets exhibit either changes in stock prices lead that in exchange rates or either market can take the lead (feedback interaction). Built on the result of the Granger causality test, the IR analysis lends its further support to the importance of stock market as the leader or the existence of feedback interaction especially during the Asian flu period. Likewise, the inclusion of exchange rate variations (within a week) is found to have improved predictable portion of stock price changes in the eight Asian markets. In the early 1990s as barriers to capital movement are being gradually removed, the role of the portfolio approach cannot be downplayed. Capital movement into and out of the Asian economies can be as beneficial as it can be detrimental. The Asian flu certainly has put the stock and the exchange rate markets in a spotlight that suggests financial markets in the Asian economies need an overhaul.

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Table 1 A Comparison of Daily Stock Prices and Exchange Rates Between July 1 and November 14, 1997

exchange rate	HKN	IND	JPN	KOA	MAL	PHI	SIG	THA	TWN
11/14/97	7.73	3439.97	125.34	986.19	3.32	33.75	1.58	38.34	31.24
07/01/97	7.75	2431.32	114.90	888.10	2.52	26.37	1.43	24.45	27.81
% Change	-0.23%	41.49%	9.09%	11.05%	31.37%	27.98%	10.68%	56.83%	12.34%
stock index	HKN	IND	JPN	KOA	MAL	PHI	SIG	THA	TWN
11/14/97	9957.33	436.84	15082.52	520.01	677.47	1844.95	425.89	456.87	7482.92
7/1/97	15196.79	731.61	20175.52	758.03	1078.90	2815.54	494.00	527.28	9030.28
% Change	-34.48%	-40.29%	-25.24%	-31.40%	-37.21%	-34.47%	-13.79%	-13.35%	-17.14%

Note: HKN = Hong Kong, IND = Indonesia, JPN = Japan, KOA = Korea, MAL = Malaysia, PHI = Philippines, SIG = Singapore, THA = Thailand, TWN = Taiwan. All prices are based on daily market close; all exchange rates are expressed as number of local currencies per U.S. dollar.

Table 2: Zivot and Andrew Unit Root Results

	HKN	IND	JPN	KOA	MAL	PHI	SIG	THA	TWN
exchange rate	-7.18* [0.45]	-6.45* [0.05]	-3.20 [0.81]	-2.44 [0.07]	-4.67* [0.99]	-3.14 [0.98]	-2.39 [0.97]	-16.30* [0.98]	-3.39 [0.09]
stock index	-3.56 [0.14]	-3.12 [0.19]	-3.63 [0.38]	-3.18 [0.06]	-2.76 [0.08]	-3.29 [0.96]	-3.00 [0.95]	-2.28 [0.89]	-3.32 [0.08]

Note: The estimation result is based on $\Delta y_t = \alpha + \beta t + (\rho - 1) y_{t-1} + \gamma DU_t(\lambda) + \sum_{i=1}^{k-1} \theta_i \Delta y_{t-i} + a_t$, where $DU_t(\lambda) = 1$ for $t > T\lambda$;otherwise, $DU_t(\lambda) = 0$. $\lambda = T_B/T$ denotes the location of the structural break, T= sample size, T_B = the date of structural break; * = 1% significance level; critical value for various λ are from Table 3 provided by Zivot and Andrew(1992). Value of λ are in brackets. For λ = 0.1, 0.2,0.3 ,0.4 ,0.5 ,0.6 ,0.7,0.8, 0.9, the 5% critical values are -3.65, -3.80, -3.87, -3.94, -3.96, -3.95, -3.85, -3.82, -3.68, respectively.

Table 3: Results of Gregory and Hansen Cointegration Test

	IND	JPN	KOA	MAL	PHI	SIG	THA	TWN
y_{1t} on y_{2t}	-4.57	-3.28	-4.06	-4.12	-3.46	-4.07	-5.72**	-2.93
y_{2t} on y_{1t}	-3.71	-3.57	-4.66	-3.63	-4.06	-3.42	-3.59	-3.40

Note: The first-stage estimation is based on $y_{1t} = \alpha + \beta t + \gamma DU_t(\lambda) + \theta_1 y_{2t} + e_t$. The second-stage estimation is to apply traditional ADF or Phillips-Perron approach to test if e_t is of I(0) or I(1). The y_{1t} on the first row represents exchange rate and y_{2t} denotes stock price. The reverse is true for the second row. * = 5% significance level; the critical values are taken from Table 1 in Gregory and Hansen(1996).

Table 4: The Causality Test Between Changes in Exchange Rates and Changes in Stock Prices for the Nine Asian Economies

H_0: stock -/--> exch	86.1.3~87.11.30		87.12.1~94.12.30		95.1.3~97.11.14	
H_0: exch -/--> stock	F Value	P Value	F Value	P Value	F Value	P Value
SHKN -/--> HKN	0.9168	0.4697	1.1490	0.3323	1.7840	0.1138
HKN -/--> SHKN	2.0868***	0.0658	1.2894	0.2656	10.5991*	0.0000
SIND -/--> IND	0.2135	0.9568	0.4372	0.8228	23.6468*	0.0000
IND -/--> SIND	0.1936	0.9650	0.0742	0.9961	3.8697*	0.0018
SJPN -/--> JPN	0.4283	0.8290	0.4660	0.8018	0.3285	0.8959
JPN -/--> SJPN	0.5422	0.7444	1.2523	0.2821	3.8991*	0.0017
SKOA -/--> KOA	2.0886***	0.0656	0.6117	0.6910	7.3366*	0.0000
KOA -/--> SKOA	1.7495	0.1218	0.3173	0.9028	3.6350*	0.0030
SMAL -/--> MAL	1.1712	0.3223	1.5665	0.1663	3.4736*	0.0041
MAL -/--> SMAL	0.4738	0.7958	2.6642**	0.0209	4.7385*	0.0003
SPHI -/--> PHI	0.1112	0.9899	1.8260	0.1046	4.6446*	0.0004
PHI -/--> SPHI	1.6248	0.1518	1.9505***	0.0831	2.1075***	0.0626
SSIG -/--> SIG	0.3173	0.9026	0.4895	0.7843	1.6971	0.1329
SIG -/--> SSIG	1.4672	0.1990	1.3894	0.2252	2.9233	0.0127
STHA -/--> THA	0.1688	0.9740	0.2763	0.9263	1.3030	0.2606
THA -/--> STHA	0.6565	0.6566	0.3506	0.8821	10.0328*	0.0000
STWN -/--> TWN	0.7376	0.5955	2.2477**	0.0473	3.3507*	0.0053
TWN -/--> STWN	0.2232	0.9525	0.9695	0.4351	1.0197	0.4048

Note: -/--> implies does not Granger cause. * = 1% significance level; ** = 5% significance level; *** = 10% significance level. The abbreviation for each market denotes exchange rate variations (e.g., HKN= rate of changes of the Hong Kong dollar or simply Hong Kong exchange rate variations) of the market. The prefix S represents rate of changes in stock prices of the market (e.g., SHKN = rate of changes of Hong Kong stock prices or simply stock prices changes of the Hong Kong market).

Table 5: Estimation Result of Impulse-Response Function

Panel A: Response of Exchange Rates from One-Unit Shock in Stock Price Change

Period	HKN	IND	JPN	KOA	MAL	PHI	SIG	THA	TWN
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0525**
2	0.0004	0.0477	-0.0102	-0.0571**	-0.0409**	-0.0290	-0.0102	-0.0479	-0.0453**
3	-0.0003	-0.1481**	-0.0314	0.0122	-0.0209	-0.0464	0.0024	0.0393	-0.0057
4	0.0036**	-0.1761**	0.0077	0.0001	0.0030	-0.0555**	-0.0035	-0.0293	-0.0094
5	0.0014	0.1608**	0.0003	0.0155	0.0318	-0.0265	0.0303	0.0153	-0.0052
6	-0.0007	0.0099	0.0056	0.0343**	-0.0493**	-0.0722**	-0.0111	0.0321	0.0139
7	0.0004	0.0377**	-0.0007	-0.0009	-0.0193**	-0.0050	0.0004	0.0226	-0.0024
8	-0.0002	0.0171	0.0004	-0.0009	-0.0017	0.0210**	-0.0008	-0.0072	0.0004
9	-0.0007	0.0163	0.0002	-0.0009	-0.0053	0.0099	-0.0024	-0.0068	-0.0012
10	0.0002	-0.0237	0.0000	-0.0057	0.0058	0.0110	0.0003	0.0014	-0.0017

Panel B: Response of Stock Prices from One-Unit Shock in Exchange Rate Change

Period	HKN	IND	JPN	KOA	MAL	PHI	SIG	THA	TWN
1	-0.2185**	-0.2288**	0.0969**	-0.1064**	-0.3548**	-0.0024	-0.0006	0.0467	0.0000
2	0.1113**	-0.1401**	0.1894**	-0.0805	-0.1355**	0.0316	-0.0914**	0.1733**	-0.0086
3	-0.0269	-0.0990**	0.0038	-0.1516**	-0.0567	-0.0956**	-0.0470	0.2642**	0.0591
4	-0.4142**	0.1186**	-0.0320	0.0747	0.0762	0.0132	0.0339	0.0009	0.0095
5	0.1586	0.0041	0.0208	0.0275	-0.1216**	0.0986**	-0.0642	-0.2068**	0.0717
6	-0.1170**	-0.0301	-0.0214	0.1022**	0.0404	-0.0485	0.0092	0.1224**	-0.0728
7	-0.0251	-0.0102	0.0035	0.0542**	0.0269	-0.0123	0.0057	0.0655**	-0.0100
8	0.0922**	-0.0163	-0.0001	-0.0226	-0.0165	0.0049	0.0006	0.0484**	0.0018
9	-0.0039	-0.0160	-0.0010	0.0020	0.0197**	-0.0140	0.0063	-0.0652**	0.0018
10	-0.0123	-0.0016	0.0002	-0.0143	-0.0081	0.0021	0.0009	0.0105	0.0115

Note: **= 5% significance level.

Table 6 A Comparison of Predictable Portion of Stock Price Changes

	HKN	IND	JPN	KOA	MAL	PHI	SIG	THA
(1) $\overline{R}^2$	0.0608	0.0856	0.0038	0.0344	0.0380	0.0290	0.0337	0.0291
(2) $\overline{R}^2$	0.1177	0.1028	0.0228	0.0512	0.0615	0.0362	0.0460	0.0846
(2) vs. (1)	93.48%	20.20%	496.79%	48.76%	61.97%	24.69%	36.56%	190.53%

Note: $\overline{R}^2$ = adjusted R-square. (1) $\overline{R}^2$ from the regression in which current stock price change is the dependent variable and its lagged variables (one to five periods) are independent variables. (2) $\overline{R}^2$ from the regression in which current stock price change is the dependent variable and lagged variables (one to five periods) of exchange rate variations and stock price changes are independent variables(2) vs. (1) = percentage increases in $\overline{R}^2$.

Table 7: The Causality Test Between Changes in Exchange Rates and Changes in Stock Prices for the Nine Asian Economies After Adding Changes in the US Stock Price

H_0: stock -/--> exch	86.1.3~87.11.30		87.12.1~94.12.30		95.1.3~97.11.14	
H_0: exch -/--> stock	F Value	P Value	F Value	P Value	F Value	P Value
SHKN -/--> HKN	0.8927	0.4857	1.1519	0.3308	1.7610	0.1186
HKN -/--> SHKN	1.9481***	0.0850	1.3138	0.2553	10.6836*	0.0000
SIND -/--> IND	0.2082	0.9590	0.4473	0.8155	23.5491*	0.0000
IND -/--> SIND	0.1960	0.9640	0.0728	0.9963	3.8164*	0.0020
SJPN -/--> JPN	0.4008	0.8483	0.4154	0.8383	0.3312	0.8942
JPN -/--> SJPN	0.4628	0.8040	1.2411	0.2872	3.8949*	0.0017
SKOA -/--> KOA	2.0530***	0.0701	0.6017	0.6987	7.3057*	0.0000
KOA -/--> SKOA	1.7139	0.1298	0.3140	0.9048	3.3066*	0.0058
SMAL -/--> MAL	1.1751	0.3203	1.5570	0.1691	3.3246*	0.0056
MAL -/--> SMAL	0.5938	0.7047	2.7695**	0.0169	4.8207*	0.0002
SPHI -/--> PHI	0.1237	0.9871	1.8553***	0.0991	4.6082*	0.0004
PHI -/--> SPHI	1.6058	0.1569	1.9266***	0.0869	2.1042***	0.0630
SSIG -/--> SIG	0.3776	0.8641	0.4995	0.7768	1.5726	0.1654
SIG -/--> SSIG	1.9902***	0.0787	1.3096	0.2570	2.9201**	0.0128
STHA -/--> THA	0.1557	0.9783	0.2883	0.9197	1.2990	0.2623
THA -/--> STHA	0.6496	0.6619	0.4036	0.8466	10.0296*	0.0000
STWN -/--> TWN	0.7466	0.5889	2.2404**	0.0480	3.3347*	0.0055
TWN -/--> STWN	0.2405	0.9444	0.9651	0.4378	1.0308	0.3982

Note: All the notations remain the same as that of Table 4. Reported in Table 7 are the test results when current stock price changes of the U.S. market are included in equation (4).

Figure 1 Time Series of the Nine Asian Stock Indexes (in Logrithm)

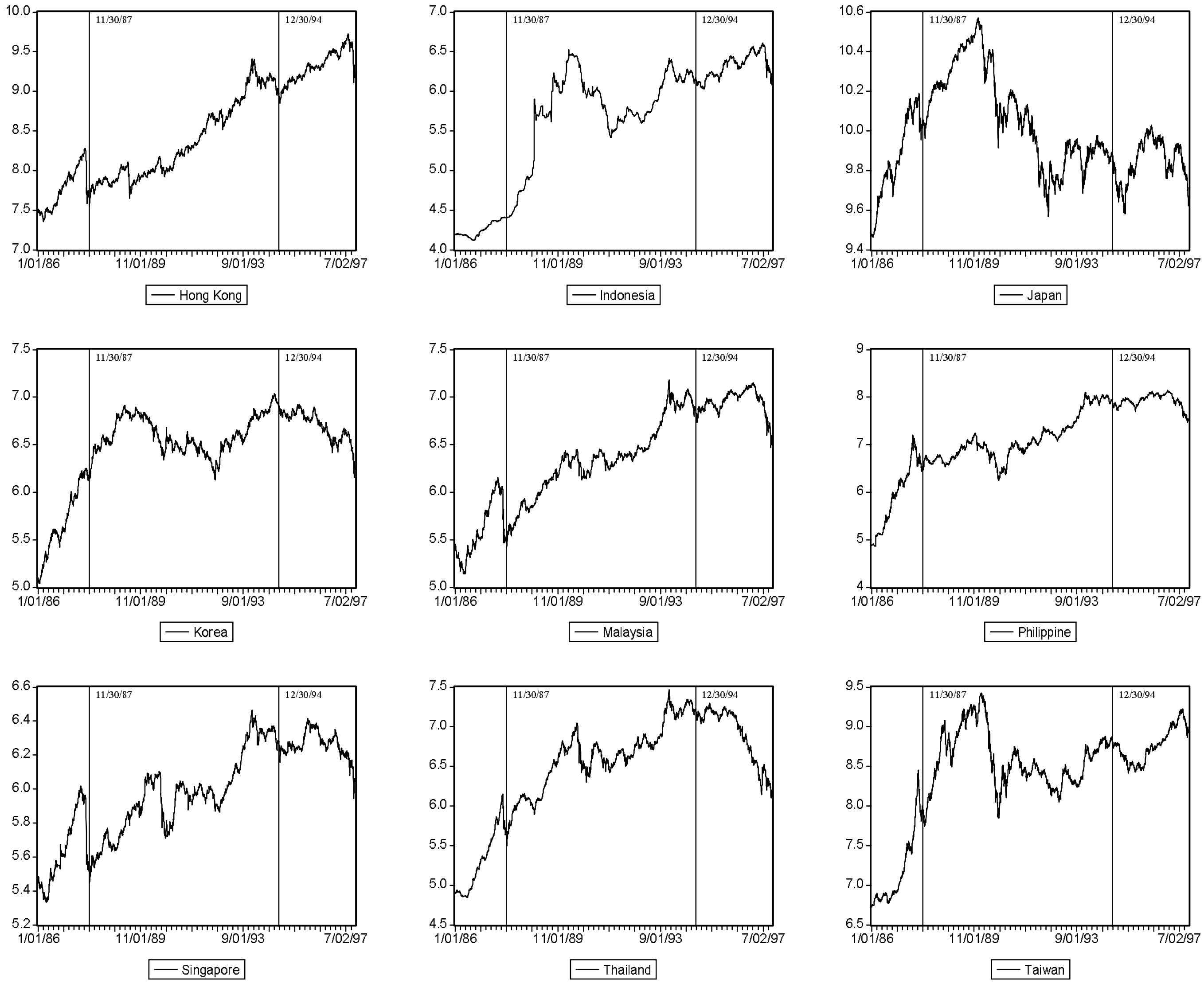

Figure 1 Time Series of the Nine Asian Exchanges Rates (in Logrithm)

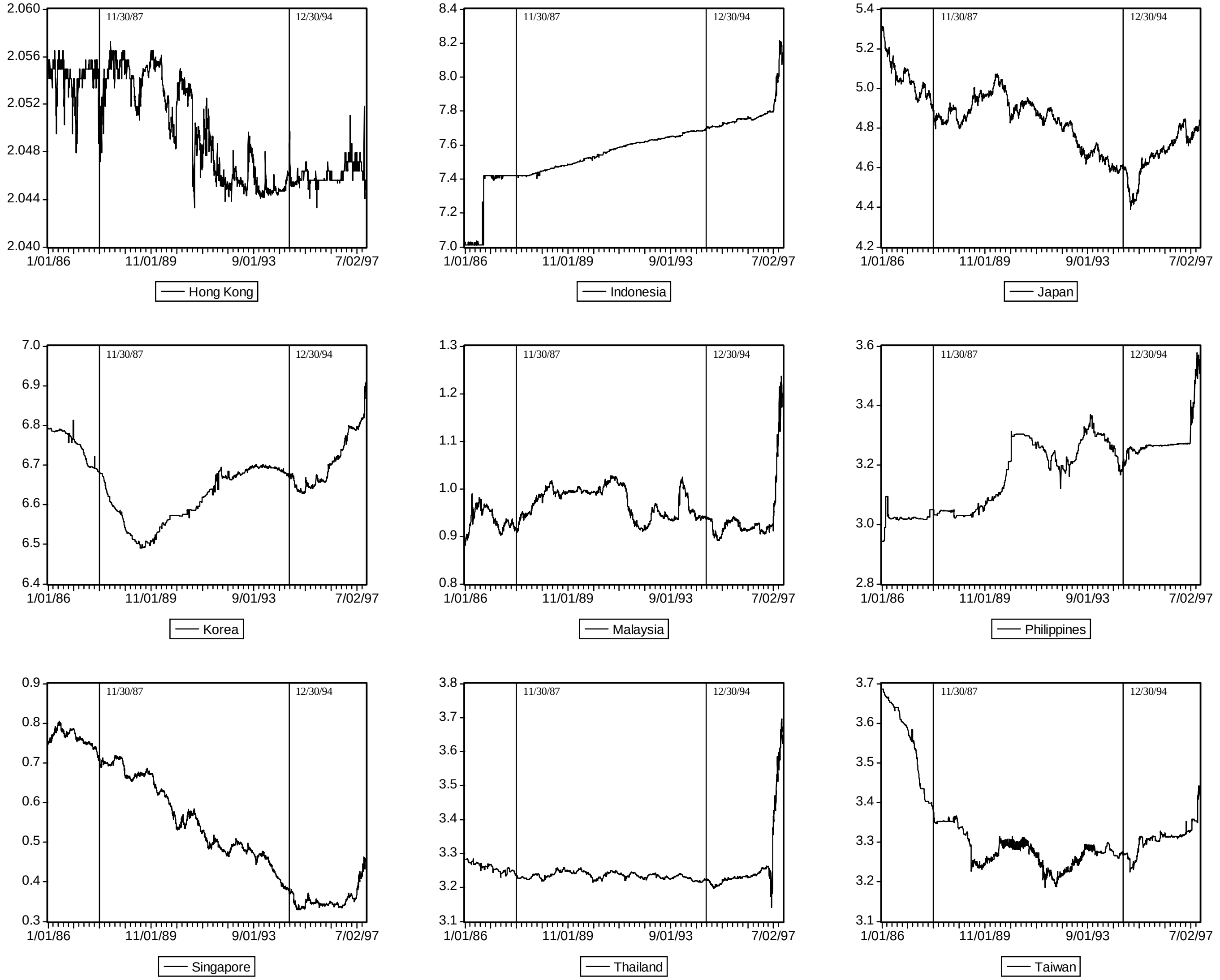

Figure 2 The Estimation Results of the Zivot & Andrew Unit Root Test on Exchanges Rates