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IMPACTS OF CRISES ON DYNAMIC LINKAGES BETWEEN FINANCIAL AND CAPITAL MARKETS

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Abstract

This paper studies the cointegration and bivariate causality relationships between capital and financial markets for the seven Asian countries, which were badly hit by the Asian Financial Crisis (AFC). Our empirical results show that, before the AFC, all countries, except the Philippines and Malaysia, experienced no evidence of Granger causality between the exchange rates and the stock prices. However, the appearance of the causality, but not the cointegration, between the capital and financial markets becomes stronger during the AFC period. Surprisingly, after the September 11 terrorist attack (911), the causality relationship between these two markets reverts back to normal as in the pre-AFC period and their cointegration relationship is weakened. From our findings, it can be inferred that: First, AFC has a bigger and more direct impact on the causality relationship between the financial and capital markets in Asia; Second, the 911 basically had no impact on the causality relationship between these two markets; and third, the Asian financial and capital markets have become more mature and efficient after the 911 crisis.

Keywords: Asian Financial Crisis; Terrorist Attack; Dynamic Linkages; Cointegration; Bivariate Causality.

1. Introduction

The study of relationships between the capital and financial markets is an important topic in finance, especially, before and after, any crisis. We can still recall the state of financial difficulties experienced by several Asian countries during the Asian Financial Crisis (AFC), which was sparked in Thailand in July 1997. By late October,

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the escalating scale of crisis and depreciation of New Taiwan dollar created further pressure which dampened the regional economies significantly, with effects spreading to the Hong Kong and Korean currencies. This financial storm continued to deteriorate Asian economies and showed no sign of slowing down until the first quarter of 1998. When the Asian countries were working hard to find medicines that would cure the Asian flu, unfortunately, the stock market in the USA, the world's largest economy, were hit by the September 11 terrorist attack (911) in 2001. This may have dampened the already-troubled Asian economies further, and delayed their recovery from the AFC. In addition, the global financial markets went into a tailspin in reaction to what has generally been described as the horrific 911 in the USA. However, in contrast to significant plunges in the stock markets, currencies in major Asian markets were not affected by the terrorist attack in the USA.

After observing the severe economic conditions prevailing in Asian countries during the AFC and 911 in the USA, we are motivated to find the linkages between financial and capital markets before and after these incidents, namely: (1) whether a stock market crash causes the exchange rate depreciation or (2) whether currency depreciation leads to a fall in stock prices and (3) whether the AFC and the 911 will alter their relationship. We note that the former is called the portfolio approach and the latter is called the traditional approach. To provide answers to these questions, 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 that were badly hit by the AFC, namely Hong Kong, Indonesia, Singapore, Malaysia, Korea, Philippines, and Thailand. In addition, we include Japan in our study for the control purpose. We would analyze the relationship for both pre- and post-AFC periods as well as pre- and post-911 periods so as to study the impact of these two events. If this relationship can be ascertained, our findings will be useful for policy makers to prevent any future crisis from happening and for practitioners to profiteer from the crises.

Previous literature on the subject has supported the phenomenon of the traditional approach that exchange rates fluctuation leads to stock prices movement. For example, 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 than interest rates volatility.

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

However, some studies have concluded that fluctuations in exchange rates have no significant impact on the stock prices. For example, Jorion (1990, 1991), Bodnar and

Gentry (1993) and Bartov and Bodnar (1994), failed to find any significant relationship between simultaneous dollar movements and stock returns for any US firm. Griffin and Stulz (2001) showed that weekly exchange rate shocks have a negligible impact on the value of industry indices across the world. Instead of employing monthly data as in most prior studies, Chamberlain *et al.* (1997) used daily data and found that the US banking stock returns are very sensitive to exchange rate movements, but this finding does not hold for any Japanese banking firm. On a macro level, Ma and Kao (1990) found that currency appreciation negatively affects the domestic stock market for an export-dominant country and positively affects the domestic stock market for an import-dominant country, which is consistent with the goods-market theory. Malliaris and Urrutia (1992) analyzed the impact of 1987 crash on six stock market indices and found no lead-lag relationships for the period before and after the market crash but there were feedback relationships and unidirectional causality during the month of the crash. Recently, Granger *et al.* (2000) found different relationships between exchange rates and stock prices in different countries. They observed that the Philippines were under portfolio approach, whereas Hong Kong, Malaysia, Singapore, Thailand, and Taiwan indicated strong feedback relations. Indonesia and Japan, on the other hand, failed to reveal any recognizable pattern.

For the causality relationship, Yu (1996) found that the linkages between stock prices and exchange rates behave differently across countries; specifically, the direction of causation was bi-directional for Japan, unidirectional from the exchange rates to stocks returns for Hong Kong and non-causal for Singapore. He also noticed the presence of a strong cointegration in these three countries. Abdalla and Murinde (1997) suggested unidirectional causality from exchange rates to stock prices in India, Korea, and Pakistan, while stock prices Granger-caused exchange rates in Philippines. Moreover, they found existence of the cointegration relationship in India and Pakistan. 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, but not cointegration, between them.

Our empirical results show no evidence of Granger causality between the exchange rates and stock prices for all countries before the AFC, except for Malaysia and the Philippines. However, the causality, but not the cointegration, between capital and financial markets appears to be stronger during the AFC period. Surprisingly, after the 911, the causality relationship between the two markets go back to normal as in the pre-AFC 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 stock prices before or during the AFC. But, after the 911, there exists weaker cointegration relationship between exchange rates and stock prices. Based on these findings, we conclude that: (1) the AFC has bigger and more direct impact on the causality relationship between stock prices and currency exchanges in Asian markets; the 911, 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 911 crisis.

The organization of the paper is as follows: the next section describes the data and discusses the methodologies to employ both cointegration and causality techniques. Section 3 elaborates upon our empirical results. The last section discusses the possible reasoning for the cointegration and causality relationship for each country and summarizes our findings.

2. The Data and Methodology

For our data requirements, we use weekly[1] 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 starts from January 1, 1991 and runs till December 31, 2002; covering reasonably long period of twelve years.

To get a better understanding of the relationship between financial and capital markets before and after AFC, we, first, divide the entire period into two sub-periods. The first sub-period is the pre-AFC period from 1991 to 1996 and the second sub-period is the post-AFC period from 1997 to 2002. In order to investigate the effect of 911, the post-AFC period is further divided into two sub-periods: the pre-911 and post-911 periods. The pre-911 period is the period between the AFC and 911 i.e. from January 1, 1997 to September 10, 2001 and the post-911 period is the period after the 911 i.e. from September 11, 2001 to December 31, 2002.[2]

Cointegration tests are important in determining the presence and nature of an equilibrium economic relation (Stock, 1987). To examine the co-movements between stock indices and exchange rates, we adopt the cointegration tests to examine the relationship:

$$S_t = \alpha + \beta E_t + \mu_t \tag{1}$$

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

The cointegration tests are performed in two steps. The first step is to apply the Dickey-Fuller (DF) unit root test or the Augmented Dickey and Fuller (ADF) test (Dickey and Fuller, 1979, 1981) to examine the stationary properties of the exchange rates and stock indices series by testing the null hypothesis H_0: z_t = I(1) [3] versus the

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[1] The choice of weekly indices as opposed to daily indices is made to avoid the problems of non-synchronous trading, bid-ask spread and asynchronous prices (Lo and MacKinlay 1988). In addition, weekly data is known to have higher power in capturing the effect of capital movement, which is intrinsically a short-run occurrence.

[2] We note that while some studies used January 1, 1997 to separate the pre-crisis and post-crisis periods, others use July 1, 1997. In this paper, we use both dates to separate the pre- and post-AFC. We obtain similar results and hence we only report the results using January 1, 1997 as a cut-off point. The results of using July 1 as cut-off point are available on request.

[3] If a series, say $\boldsymbol{y_t}$, has a stationary, invertible and stochastic ARMA representation after differencing *d* times, it is said to be integrated of order *d*, and denoted as $\boldsymbol{y_t}$ = *I(d)*.

alternative hypothesis H_1: z_t = I(0). The DF test is conducted based on the regression equation:

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

and the ADF test is conducted 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 Equations (2) and (3) allow for a drift term, β_0, a deterministic trend, $\alpha_0 t$, and a stochastic trend, $\alpha_1 z_{t-1}$, and the lag , *p*, is chosen to achieve white noise residuals u_t.

In addition, we apply the likelihood ratio test, Φ_3, (Dickey and Fuller, 1981) to test the hypothesis that z_t follows a random walk model with drift, i.e. $(\beta_0, \alpha_0, \alpha_1) = (\beta_0, 0, 0)$, and employ the likelihood ratio test, Φ_2, to test the hypothesis that z_t follows a random walk without drift, i.e. $(\beta_0, \alpha_0, \alpha_1) = (0,0,0)$. If all the hypotheses i.e. $\alpha_1 = 0$, $(\beta_0, \alpha_0, \alpha_1) = (\beta_0, 0, 0)$ or $(\beta_0, \alpha_0, \alpha_1) = (0,0,0)$ are accepted, we conclude that z_t is an integrated process of order 1. If we fail to reject the hypotheses of z_t to be I(1), then we further test H_0: z_t = I(2) versus H_1: z_t = I(1) for the series.

If both S_t and E_t are of the same order, the next step is to estimate the cointegrating parameter by utilizing the regression in Equation (1). If its residuals are not rejected to be stationary, the two series are concluded to be cointegrated; otherwise, they are not cointegrated. The most common tests for stationarity of the estimated residuals are Dickey-Fuller (CRDF) and Augmented Dickey-Fuller (CRADF) tests, which are conducted based on the regression:

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

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

After testing the cointegration relationship, we test for causality between the stock prices and exchange rates. If exchange rates and stock price are cointegrated, an error correction term (ECT) is required to be included (Granger, 1988) in the following bivariate autoregression:

[4] Engle and Granger (1987) 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 the samples varying from 50 to 200 observations.

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

where ∇E_t is the change of exchange rate, ∇S_t is the change of stock price and the term ECT_{t-1} (= $S_{t-1} - \gamma E_{t-1}$) is an error correction term derived from the long run cointegrating relationship in Equation (1). We note that the estimates δ_1 and δ_2 can be interpreted as the speeds of adjustment. According to Engle and Granger (1987), the existence of cointegration implies the existence of the causality relationship between the variables S_t and E_t under the constraint $|\delta_1| + |\delta_2| > 0$. If cointegration relationship between S_t and E_t does not exist, the term ECT will be deleted and the bivariate autoregression (5) becomes:

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

Rejecting (accepting) H_0: $\alpha_{21} = \alpha_{22} = \ldots = \alpha_{2m} = 0$ in Equation (5) or (6) suggests that exchange rates do (do not) Granger cause stock prices. On the other hand, rejecting (accepting) H_0: $\beta_{11} = \beta_{12} = \ldots = \beta_{1m} = 0$ suggests that stock prices do (do not) Granger cause exchange rates. These tests enable us to reveal the relationship of no causality, unidirectional causality or feedback causality between the stock prices and exchange rates.

Lastly, we further employ the minimum final prediction error criterion (Hsiao 1979, 1981) 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 and ε_{1t} and ε_{2t} are disturbance terms. The final prediction error (FPE) statistic[5] of ∇S_t with n lags of ∇S_t and m lags of ∇E_t is:

$$FPE_{\nabla S_t}(n,m) = \frac{(N+n+m+1)\sum(\nabla S_t - \nabla \hat{S}_t)^2}{(N-n-m-1)N} \quad (7)$$

where N is the number of observations[6]. The FPE statistic for ∇E_t can be obtained similarly.

[5] Refer to Hsiao (1979, 1981) for the procedure to compute the FPE statistic.

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

3. Empirical Findings

Table 1 shows the stock indices and exchange rates at the beginning and ending for all the sub-periods and their corresponding changes for all the countries being studied in our paper. During the pre-AFC period, Indonesia, Korea, and Thailand encounter modest currency depreciation while the other five countries experienced modest currency appreciation; ranging from -20% to 24%. In this period, the stock markets are basically in a bull run with increases from 35% to more than 300% for all the countries except Japan and Korea. On the contrary, all eight economies exhibit pronounced structural breaks during the crisis, with their currencies suffering tremendous depreciation since January 1997. During the AFC period, the Indonesian Rupiah experienced the largest drop (74.01%) in its value, followed by the Philippines Peso (48.73%), Thai Baht (42.58%), South Korea Won (34.58%), and Malaysian Ringgit (33.52%). The rest of the currencies witnessed modest depreciation of between 1% and 20%. Similar freefalls in stock prices are also witnessed, ranging from 17% in the Korean market to 60% in the Thailand market. Nonetheless, in the post-AFC period, all other countries restored their economies by getting their currency to appreciate, except for the Philippines Peso which depreciated by 4.29%; although this figure is much smaller than during the AFC period.

Table 1
Comparison of Exchange Rates and Stock Indices in the 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%

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%

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

Table 2a: Unit Root Test Results for Stock Indices and Exchange Rates in the Pre-AFC and Post-AFC Periods

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

Notes: * $p<0.05$, ** $p<0.01$. We note that 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. The pre-AFC period is from January 1, 1991 to December 31, 1996, the post-AFC period is from January 1, 1997 to December 31, 2002. The latter period 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).

We then examine the integration between the financial and capital markets. To do this, we first report the unit root tests in Table 2 (a&b), which shows that there are unit roots[7] in all level series for all periods and countries, except the exchange rates for Indonesia and Hong Kong in the pre-AFC period and the exchange rates for

[7] We further test for I(1) versus I(2) for all the series and conclude that all series are I(1). The results are available on request.

Indonesia, Malaysia, Singapore and Hong Kong in the post-911 period. We can attribute the non-unit-root phenomenon for the exchange rates, of Malaysia and Hong Kong in the post-911 period and Hong Kong in the pre-AFC period, to the currency peg that these countries maintained with the US dollar.

Table 2b: Unit Root Test Results for Stock Indices and Exchange Rates in 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**

Note: See Table 2a.

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

Country	Period	Model	R^2	CRDF	CRADF
Indonesia	Pre-AFC	$S_t = -20.1874 + 3.4208E_t$	0.5799	-2.59**	-2.40*
	Post-AFC	$S_t = 8.7484 - 0.2894E_t$	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-AFC	$S_t = 5.6181 + 0.5973E_t$	0.0030	-2.64**	-2.64**
	Post-AFC	$S_t = 12.5169 - 1.3594E_t$	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-AFC	$S_t = 53.2934 - 14.353E_t$	0.2915	-3.02**	-3.02**
	Post-AFC	$S_t = 10.8307 - 1.3318E_t$	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-AFC	$S_t = 10.5247 - 4.0209E_t$	0.2492	-1.21	-1.21
	Post-AFC	$S_t = 8.2663 - 1.3257E_t$	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-AFC	$S_t = -2.8455 + 1.4247E_t$	0.0759	-1.19	-1.19
	Post-AFC	$S_t = 12.3519 - 0.8343E_t$	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-AFC	$S_t = 8.4249 - 2.4866E_t$	0.6934	-2.20*	-2.20*
	Post-AFC	$S_t = 7.7586 - 0.6376E_t$	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-AFC	$S_t = 7.6016 + 0.4858E_t$	0.2317	-2.36*	-2.36*
	Post-AFC	$S_t = 14.8736 - 1.1043E_t$	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-AFC	$S_t = 256.3082 - 120.8997E_t$	0.5041	-3.25**	-2.53*
	Post-AFC	$S_t = -19.4329 + 14.0636E_t$	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

Notes: * $p<0.05$, ** $p<0.01$. We note that 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. The pre-AFC period is from January 1, 1991 to December 31, 1996, the post-AFC period is from January 1, 1997 to December 31, 2002. The latter period 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).

The cointegrating equation in Equation (1) is then estimated and reported in Table 3. The results show that Thailand is the only country in our study to possess integration relationship between its financial and capital markets in all periods. For other countries, we have: the exchange rates are cointegrated with their corresponding stock indices for the Philippines and Indonesia in the pre-AFC, post-AFC and pre-911 periods while the exchange rates are cointegrated with their corresponding stock indices for Japan, Hong Kong and Singapore only in the pre-AFC period and cointegrated with their corresponding stock indices for Malaysia and Korea in the post-AFC period. These findings not only support most of the previous literature- that no definitive pattern on cointegration could be identified between the financial and capital markets before the AFC- but also during the AFC (before 911). However, our results differ from the literature by proving that the cointegration relationship between the exchange rates and their corresponding stock indices disappear for nearly all countries being studied in this paper[8] after the AFC, especially after 911. Thus, our conclusion differs from the previous studies by indicating that the financial and capital markets in Asia have become more mature and efficient after the crisis and thus, are not cointegrated.

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

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

Notes: * $p<0.05$, ** $p<0.01$. $\rightarrow$ is "Granger cause", e.g. $E_t \rightarrow S_t$ means that exchange rate Granger causes stock index.
[a] p-values of F test on H_0: $\alpha_{21} = \alpha_{22} = \ldots = \alpha_{2m} = 0$ or H_0: $\beta_{11} = \beta_{12} = \ldots = \beta_{1m} = 0$.
[b] p-values of t test on H_0: $\delta_1 = 0$ or H_0: $\delta_2 = 0$ in ECM model.
Refer to Table 2 for the definition of different sub-peirods.

[8] Thailand and Korea show marginally cointegration relationship at the 10% level.

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

Country	Granger Cause	*n*	*m*	*p*-values [a]	*p*-values [b]
Indonesia	$E_t \rightarrow S_t$	3	2	0.0015**	0.0480*
	$S_t \rightarrow E_t$	6	1	0.0215*	0.1182
Philippines	$E_t \rightarrow S_t$	4	1	0.4378	0.1650
	$S_t \rightarrow E_t$	5	6	0.0131*	0.0779
Thailand	$E_t \rightarrow S_t$	4	3	0.0542	0.0122*
	$S_t \rightarrow E_t$	2	6	0.0117*	0.0746
Malaysia	$E_t \rightarrow S_t$	5	2	0.0066**	0.0475*
	$S_t \rightarrow E_t$	3	1	0.3680	0.0185*
Korea	$E_t \rightarrow S_t$	6	5	0.0480*	0.0601
	$S_t \rightarrow E_t$	3	1	0.0006**	0.3539
Singapore	$E_t \rightarrow S_t$	5	1	<.0001**	n.a.
	$S_t \rightarrow E_t$	2	1	0.6719	n.a.
Japan	$E_t \rightarrow S_t$	1	2	0.0630	n.a.
	$S_t \rightarrow E_t$	1	1	0.2387	n.a.
Hong Kong	$E_t \rightarrow S_t$	4	1	0.2008	n.a.
	$S_t \rightarrow E_t$	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	$E_t \rightarrow S_t$	3	2	0.0018**	0.0555
	$S_t \rightarrow E_t$	1	1	0.0583	0.1879
Philippines	$E_t \rightarrow S_t$	4	1	0.4888	0.0814
	$S_t \rightarrow E_t$	5	5	0.0360*	0.2122
Thailand	$E_t \rightarrow S_t$	5	3	0.0634	0.0466*
	$S_t \rightarrow E_t$	1	3	0.0333*	0.0947
Malaysia	$E_t \rightarrow S_t$	3	2	0.0213*	n.a.
	$S_t \rightarrow E_t$	3	1	0.4039	n.a.
Korea	$E_t \rightarrow S_t$	5	6	0.0275*	0.0905
	$S_t \rightarrow E_t$	2	1	0.0043**	0.4773
Singapore	$E_t \rightarrow S_t$	5	3	<.0001**	n.a.
	$S_t \rightarrow E_t$	1	1	0.7880	n.a.
Japan	$E_t \rightarrow S_t$	1	1	0.0291*	n.a.
	$S_t \rightarrow E_t$	1	1	0.3347	n.a.
Hong Kong	$E_t \rightarrow S_t$	4	1	0.2484	n.a.
	$S_t \rightarrow E_t$	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	$E_t \rightarrow S_t$	3	1	0.9275	n.a.
	$S_t \rightarrow E_t$	3	1	0.9705	n.a.
Philippines	$E_t \rightarrow S_t$	6	1	0.8730	n.a.
	$S_t \rightarrow E_t$	1	1	0.5722	n.a.
Thailand	$E_t \rightarrow S_t$	1	1	0.5524	0.0724
	$S_t \rightarrow E_t$	1	1	0.1332	0.9263
Malaysia	$E_t \rightarrow S_t$	2	5	0.1731	n.a.
	$S_t \rightarrow E_t$	4	1	0.5345	n.a.
Korea	$E_t \rightarrow S_t$	2	1	0.4607	0.0006**
	$S_t \rightarrow E_t$	2	4	0.0442*	0.9926
Singapore	$E_t \rightarrow S_t$	3	1	0.1372	n.a.
	$S_t \rightarrow E_t$	4	1	0.2962	n.a.
Japan	$E_t \rightarrow S_t$	5	3	0.0730	n.a.
	$S_t \rightarrow E_t$	1	1	0.2082	n.a.
Hong Kong	$E_t \rightarrow S_t$	3	1	0.0562	n.a.
	Ix → Ex	3	2	0.0879	n.a.

Next, we study the causality relationship between the exchange rates and their corresponding stock indices. Similar to our findings in the cointegration relationship, our causality results reported in Tables 4a to 4d show that the causality findings before AFC are in line with most of the previous literature, (see, for example, Granger *et al.* 2000) that there is no causal relationship between financial and capital markets for most of the Asian countries. Only Malaysia and the Philippines are observed to have causality relationship, where Malaysia appears to have feedback relationship between financial and capital markets; the Philippines show that their exchange rate leads their stock price in the long run.

However, our empirical results have demonstrated that this phenomenon disappears in the post-AFC period. Our findings show a strong presence of causal relationship between the exchange rates and the stock prices, especially in the period during the AFC. These anomalies contradict the previous literature on the subject. In addition, during the post-AFC period, Hong Kong and the Philippines follow the portfolio approach. Singapore, on the other hand, is observed to have a strong relationship in unidirectional causality, particularly in agreement with the traditional approach. The remaining countries in this period follow the bi-directional relationship, in which currency rates lead stock prices and vice versa.

Our findings on the causality may be influenced by the fact that both exchange rates and stock prices fluctuate dramatically during the AFC. If this is true, then the causality will eventually disappear after the crisis. Nonetheless, it is also our interest to investigate whether the 911 has the same impact on the financial and capital markets. In this connection, we further study the relationship between exchange rates

and stock prices by dividing the post-AFC period into two periods: pre-911 period and post-911 period.[9]

Our findings show that in the pre-911 period, the causality relationship between stock prices and exchange rates basically exists for all countries being studied in this paper. For example, we find that Malaysia, Indonesia, Singapore and Japan follow the traditional approach; Thailand and Korea experience the 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 the exchange rates and stock prices goes back to normal and that the causality relationship disappears in all countries, except for Korea. This shows that the 911 does not create any causality relationship in the Asian countries and the causal relationship between exchange rates and stock prices in the post-911 period are back to their normal behavior as in the pre-AFC period. To round up the analysis and findings of our paper, we find, surprisingly, that the AFC period appears to be the only period that had a great impact on the financial and capital markets, and that there exists significant causality relationship between stock prices and exchange rates among nearly all the countries being studied in our paper.

4. Discussion and Conclusion

During the crisis, some big investors could foresee a continuous drop in stock and currency markets and therefore, decided to short sell both instruments; other investors, who did not have this information, also decided to follow suit. This created a contagious effect that led to sharp drop in stock prices and massive currency depreciation. The combined influence results in an economy where the stock prices are falling while the exchange rates are rising continuously. Other factors such as political instability, weak law enforcements, deteriorated banking system, etc. may have contributed to the economic turmoil in many Asian countries. This results in the appearance of the causality and/or cointegration relationships between their financial and capital markets. On the other hand, the speculation activities decrease after the crisis and all Asian countries tried to restore their economies. Thus, the cointegration and causality relationships are expected to go back to their normal behavior as in the pre-AFC period. The following is our discussion on the cointegration and causality relationships between financial and capital markets and their implication on respective economies.

Indonesia was the most affected economy during the AFC. It has since tried to restore its economy and gradually reduced its dependency on IMF. Although the Indonesian government does not impose capital controls, it does, however, intervene in the currency exchange market. This implies that the impact or the influence on both markets reduces after the crisis and, hence it is not surprising that there is no relationship between currency exchange and stock price movement in the post-911 period.

On the contrary, Japan is the only country in our study that provides no evidence of causal relation between the foreign exchange and equity market in both periods,

[9] Refer to Section 3 for the definitions.

before and after the AFC. Japan is practicing the free-floating exchange rate system together with no restriction on capital flows. According to Pan *et al.* (2000), if a country does not employ a free-floating exchange rate system, the exchange rates might not fully respond to stock prices movement. Similarly, capital controls might reduce dynamic linkages between foreign exchange and equity prices. Another major reason could be that no significant speculation activities occurred in Japan. These factors strengthen our argument that there is no integration between Japan's currency and stock prices.

Malaysian Government imposed capital control in anticipation of speculation in its financial and capital markets. This sudden policy reversal was the main reason behind the loss of international capital, which has returned to the region since the fourth quarter of 1998. After 911, there is no evidence of a causal relation between exchange rate and stock price. This lack of significant relationship between the two markets may be due to intense government intervention in the capital markets after the AFC. Furthermore, our findings show that the cointegration relationship between Malaysia Ringgit and KLCI exists only during the post-AFC period.

Singapore economy depends largely on trading and investment activities with neighboring countries. Its exchange rate is basically formed by a basket of several foreign currencies in order to serve the purpose of its economy and hence, it does not allow futures market speculation activities on its currency. Thus, the movement of Singapore dollar is dominated by capital market adjustments in several different currencies. After 911, Singapore economy has worsened. Even when facing the bitter pill of capital outflows, Singapore still maintained the managed-floating exchange rate policy. As a result, we fail to observe any relationship between exchange rate and stock price after 911. The lack of relationship between Singapore dollar and stock price could be due to Singapore's small and highly open economy with low inflation relative to the rest of the world.

During the crisis period, Philippines economy suffers massive capital outflows which leads to a 67.87% drop in its stock exchange and cumulates into a 50.93% slide in Peso. Moreover, trade deficit and inefficient banking system makes it tougher for the central bank to maintain her currency value, in order to remain strong in the market. During the post-911 period, no evidence of a causal relationship is found. As expected, the Philippines government also imposes capital control and tightens her currency in order to prevent further capital outflow and maintain economic stability. That is why, for the Philippines, we find cointegration between exchange rate and stock price exists only up to pre-911 period.

Korea is the sole country where we find their stock price Granger causes exchange rate in the post-911 period. Korean financial markets were heavily controlled in the early and late 1980s (Park, 1996). It is well known that the Korean Won has a stagnant movement and does not fluctuate as much as the stock index. However, in 1999, the Korean government implemented the reform plan for capital market liberalization that caused the volume of international capital flow to increase, particularly portfolio investment. Even though the foreign direct investment was volatile, it did increase in 1996 but the increase was insignificant compared to portfolio investment liabilities. During post-911 period, the feedback relationship

between the two markets still existed. This is mainly due to the fact that capital flight dragged down stock price and currency depreciation simultaneously.

Thailand, like other developing countries, is not in the process of introducing completely open equity markets to foreigners and is reluctant to adopt completely free-floating foreign exchange system. Interestingly, we found Thailand to be the only country that exhibits strong long term relationship between stock price and exchange rate in all the periods; implying that the past information of exchange rates can be used to predict the stock prices and vice versa. Since AFC was first triggered in Thailand, Thai government has shown concern about its economy and watched over its capital in- and out-flows.

Even though Hong Kong dollar is pegged against US dollar and only depreciated 0.82% during the crisis period, Hong Kong is found to follow the portfolio approach relationship during the crisis. But, again, we find no causality relationship between the two markets in the post-911 period. As Hong Kong is considered one of the most open economies with no capital controls, our result basically shows no linkage between its exchange rate and stock prices. This is chiefly because its currency is pegged against the US dollar.

In general, the linkages between exchange rates and stock prices are stronger during the AFC as compared to pre-AFC period. However, after the 911, the relationship, somewhat, reverts back to normal as in the pre-AFC period. This implies that the AFC has a more direct impact on relationship between currency exchanges and stock prices in Asian markets and the 911 basically has no effect on these markets. Woo (2000) described factors such as: investor panic, tightening macroeconomic policies, improper handling of the insolvent banks in Indonesia, Korea and Thailand, as the ones causing a mess in major Asian economies during the crisis. We notice that the contagion or tequila effect could have a more deteriorating effect on the economy if improper co-ordination occurs in the remedy of the crisis. Inappropriate government policies during the turmoil will also contribute to the panic in the market and results in sharp withdrawal of funds from a country or a region. The economy will deteriorate further if any political instability follows. Last but not the least, our empirical research also finds that cointegration or long-term relationship between exchange rates and stock prices in the Asian market becomes weak during the post-911 period. This leads us to conclude that the stock markets in this region became more efficient after the 911 event.

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