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EAST ASIAN EQUITY MARKETS, FINANCIAL CRISES, AND THE JAPANESE CURRENCY

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Abstract

The paper studies the interactions between the U.S. and four East Asian markets. The focus is on the change in the information structure/flow between these markets triggered by the 1997 Asian financial crisis. It is shown that the information structure during the crisis period was different from that in the non-crisis periods. While the U.S. market led the four East Asian markets before, during, and after the crisis, it was Granger-caused by these markets during the financial crisis period but not in the post-crisis sample. Further, in accordance with concerns reported in the market, the Japanese currency is found to have affected these equity markets during the crisis period. The Japanese yen effect, however, disappeared in the post-crisis sample. The Japanese currency effect is quite robust as it is found from both local currency and U.S. dollar return data and in the presence of Japanese stock returns.

JEL Classification: F31, G11 and G14
Keywords: Causality, Yen Effect, Market Interaction, Financial Crisis.

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1. Introduction

The interaction of national equity markets is an active research area. Early studies usually focus on the comovement of national equity indexes; see, for example, Granger and Morgenstern (1970), Grubel and Fadner (1971), and Ripley (1973). Some of these studies are motivated by the benefits of international portfolio diversification (Grubel, 1968; Levy and Sarnat, 1970; Solnik, 1974). In addition to portfolio diversification, the pattern of interactions provides evidence on information flows between national markets and the relative dominance of individual markets. Hamao, Masulis and Ng (1990), for instance, study the interactions between the U.S., Japan, and UK stock markets and infer that information flow is uni-directional from New York to the other two markets. Apparently, the U.S. market plays a leading role in transmitting information to both developed and emerging markets (Eun and Shim, 1989; Ng, Chang and Chou, 1991; Cha and Cheung, 1998; Cheung and Ng, 1996). Obviously the pattern of market comovements has important implications for portfolio management and hedging activity.

During the 1980s the gradual liberalization of financial markets in Asia, including Korea, Taiwan and other emerging markets, has fostered considerable interest in investing in the East Asian equity markets. The creation of various mutual funds that have an investment focus on individual East Asian equity markets and on the region is evidence of the growing popularity of investing in these markets. For international investors, apart from sharing the growth prospect of the region, diversification is another reason for investing in these East Asian equity markets. Even though these East Asian equity markets suffered a major setback during the recent Asian financial crisis, these markets still represent good investment opportunities for international investors.

The current study investigates the interactions between the equity markets in the U.S. and four East Asian economies. Specifically, the study compares the interaction patterns before, during, and after the 1997 Asian financial crisis. These interaction patterns are important for investment decisions. Financial crises are characterized by extreme market conditions that may signal a different information transmission mechanism between financial markets during a crisis. Even after the financial crisis, informational linkages between markets can assume a different pattern depending on how the crisis is resolved. For instance, King and Wadhwani (1990) suggest that contagion effects lead to shock transmission during financial crises. On the other hand, Malliaris and Urrutia (1990) assert that there was no lead-lag relationship among the major national equity indexes during the October 1987 crash period. Jeon and Von Furstenberg (1990) report that the comovement between international equity indexes was stronger after October 1987 while Cha and Cheung (1998) show that the U.S. exerted a more pronounced effect on Asian markets after the 1987 crash. Tuluca and Zwick (2001) investigate 13 Asian and non-Asian equity markets before and after the 1997 Asian financial crisis and find that these markets experienced a stronger comovement after the crisis.

Besides the interaction between stock indexes, the current study also investigates the impact of Japanese currency movements on these markets. One predominant feature of the Asian crisis is its rippling effects on economies both within and outside the region. Given its economic dominance and trade and financial ties in the region, Japan was closely scrutinized during the crisis period. Specifically, a weak yen was conceived as a threat to recovery in the troubled region and the turnaround of the depressed stock markets. During that time, officials from various East Asian economies were quite vocal about the

possibility that a sharp yen depreciation might lead to a new round of 'competitive depreciation' and trigger another wave of financial crises. Equity market traders were looking to the yen exchange rate for clues on the stock market movements.[1]

The market's acute concern about the Japanese currency suggests a possible change of the fundamental information structure in equity markets during the crisis period. International investment risk has two components: the price risk in the local market movement and the exchange rate risk. Under normal circumstances, these two types of risk are priced in the equity market. During the Asian crisis, the Japanese yen exchange rate variability represented not only the usual standard exchange rate risk but also the likelihood that it could trigger another wave of financial disturbances in the region. Thus, the Japanese currency variation could have assumed a different role for the East Asian equity markets during the crisis. To empirically document such a phenomenon, the Japanese yen exchange rate will be explicitly included in our analysis of stock market interactions.

Daily equity returns on Hong Kong, Korea, Singapore, Taiwan and the U.S. markets from three sample periods are considered. The sample from January 1995 to June 1997 constitutes the pre-crisis period. The crisis period extends from July 1997 to June 2000. The post-crisis period is from July 2000 to July 2001. The causality test confirms the prominent role of the U.S. in the international equity market. It is found that the U.S. index led the East Asian market indexes in all the sample periods under consideration. The East Asian market indexes, on the other hand, had the strongest effect on the U.S. market during the crisis period but had no effect after the crisis. Most interestingly, our empirical results attest the effect of the Japanese currency on equity markets. The Japanese currency effect was widely felt during the crisis period but was not found in the post-crisis sample - even after controlling for the returns on the Japanese Nikkei 225 index and the currency conversion effect. As conceived by market participants, yen depreciation is found to have induced a downward drift in these equity markets during the crisis.

The remainder of the paper is organized as follows. Section 2 presents the basic data analysis. The causal relationships between the stock markets are examined in Section 3. Section 4 considers the Japanese yen effects. Additional analyses including the regression results from dollar-based return data are reported in Section 5. Section 6 offers some concluding remarks.

2. Data and Preliminary Analyses

Daily stock indexes for Hong Kong, Korea, Singapore, Taiwan, and the U.S. were retrieved from Datastream. These indexes are the Hong Kong Hang Seng Index, the Korea Composite Index, the Singapore Strait Times Index, the Taiwan Weighted Index, and the U.S. Dow Jones Industrial Average Index. All data were transformed to the logarithmic form. Three sample periods are considered. The pre-crisis sample is from January 1995 to June 1997, the crisis sample from July 1997 to June 2000, and the post-crisis sample from July 2000 to July 2001. The end of the crisis period is set to 2000 to

[1] See, for example, The Economist (1998). On June 16, 1998, the China finance minister, Xiang Huaicheng, said that the pressure for a devaluation of the yuan (the Chinese currency) was mounting as the yen/U.S.$ exchange rate was weakening. Such devaluation was seen to be a substantial threat to the stability and recovery in the region.

accommodate the total and lingering effects of the 1997 and 1999 crises. Also, a general recovery from the financial crises began in 2000.[2]

Before analyzing the interactions between these stock indexes, we apply the standard unit root and cointegration tests to the data.[3] Table 1 reports the results of the augmented Dickey-Fuller unit root test that allows for a trend and an intercept. The combined sample is also included for comparison purposes. The Akaike information criterion and residual correlation are used to determine the lag parameter used in the augmented Dickey-Fuller regression. Together, results for stock indexes in log levels (Panel A) and in first log differences (Panel B) suggest that the stock indexes are I(1) processes - a result in accordance with similar studies in the literature. One observation is in order. For each stock index series, the lag parameter is not the same across sample periods. The observed parameter instability is indicative of shifting of dynamics across the samples and casts doubt on the use of the combined sample to infer interactions between these markets.

Since the stock indexes are individually I(1), the appropriate first-difference specification depends on whether the indexes are cointegrated or not. The Johansen procedure is employed to test for the cointegration property of country pairs that consist of the U.S. and one respective East Asian economy. In Table 2, these country pairs display different cointegration results across samples. The Johansen statistic shows that the U.S. index and the East Asian market indexes are pair wise cointegrated during the pre-crisis period. The result is consistent with some earlier studies on the cointegration of national equity markets (Leachman and Francis, 1995; Masih and Masih, 2001). Nonetheless, there is no evidence of cointegration from the crisis and post-crisis samples. The results in the crisis and post-crisis periods are likely to be the reason for finding no cointegration in the combined sample. Given these results, an error correction term will be included in specifications for the pre-crisis analysis.

3. Causality Patterns

Following the literature, we adopt the causality test as the tool to determine the lead-lag relationship between stock indexes. Essentially, the test examines whether one series contains useful information about the evolution of another series. Let X_t be the return on one of the East Asian market indexes at time t, as measured by the first log difference, and Y_t be the return on the U.S. stock index. To test the hypothesis that the U.S. market did not Granger-cause the East Asian market, we first consider the regression

$$X_t = C + \sum_{j=1,\ldots,k} \alpha_j X_{t-j} + \varepsilon_t, \qquad (1)$$

[2] Varying the starting and ending points of the three sample periods by a few months does not have any material implications for results reported in the subsequent sections. The additional results are available upon request.

[3] Since both the augmented Dickey-Fuller and Johansen tests are standard procedures, they were not discussed in the text for brevity. See, for example, Dickey and Fuller (1979) and Johansen (1991) for an excellent description of these procedures.

where the lag parameter k is selected to make ε_t a white noise process, that is, (1) represents the specification in which X_t is best explained by its own history. Then, we consider

$$X_t = C + \sum_{j=1,\ldots,k} \alpha_j X_{t-j} + \sum_{j=1,\ldots,n} \beta_j Y_{t-j} + \varepsilon_t \quad (2)$$

and use the joint significance of β_js to test the causality hypothesis. Specifically, the null hypothesis that the U.S. market did not Granger-cause the East Asian market is not rejected if β_js are jointly insignificant. In other words, the U.S. market is said to have caused the East Asian market if the lagged values of Y_t provide additional explanatory power for X_t after controlling for X_t's own history. In estimating (2), we consider n = 1, ..., 10 and report the statistic based on the value of *n* determined by the Akaike information criterion.[4]

To test the hypothesis that the U.S. market was not Granger-caused by the East Asian market, we consider the regression equations

$$Y_t = C + \sum_{j=1,\ldots,k} \alpha_j Y_{t-j} + \varepsilon_t, \quad (3)$$

and

$$Y_t = C + \sum_{j=1,\ldots,k} \alpha_j Y_{t-j} + \sum_{j=0,\ldots,n} \beta_j X_{t-j} + \varepsilon_t, \quad (4)$$

which are analogous to (1) and (2). Note that in (4) the second summation index j starts from 0 instead of 1. This is because the U.S. and East Asian markets operate in different time zones. On a given business day, the U.S. market opens after the close of these East Asian equity markets. Thus, X_t is predetermined relative to Y_t and can be legitimately used to test the causality hypothesis. If X_t is excluded from (4), the test will tend to under-state the influence of East Asian markets. Further, as mentioned in the previous section, an error correction term is added to (2) and (4) for the pre-crisis sample.

There is a technical issue of testing for causality in the current setting. It is well known that monthly equity returns display substantial conditional heteroskedasticity, which is commonly modeled as a GARCH process. In fact, for our data set, preliminary analyses of equations (2) and (4) confirm the presence of GARCH effects in the error term ε_t.[5] The presence of GARCH implies the error term and lagged dependent variables are not independent. The dependence between explanatory variables and error terms invalidates one of the assumptions underlying the standard F-test. Thus, the standard F-test statistic for causality can yield spurious results in the presence of GARCH effects. To circumvent the adverse effect of conditional heteroskedasticity on testing for causality, we adopt a maximum likelihood procedure that allows for GARCH effects and construct the likelihood ratio statistic to test the hypothesis that β_js are

[4] In general the results reported in the text are quite insensitive to the choice of n.

[5] The estimated GARCH effects for all the specifications are available upon request.

jointly insignificant. Cheung and Fujii (2001), for example, illustrate that the explicit treatment of GARCH effects can considerably improve the test performance.

The causality test results are summarized in Table 3. The joint significance of β_js is usually considered as evidence of a causation relationship. We also test for the significance of the error correction term in regressions considered in the pre-crisis period. Since the error correction term represents the deviation from the (empirical) long-run relationship, its significance can be interpreted as a causal response to deviation from the long-run equilibrium relationship. To conserve space, only the likelihood statistics and their p-values are presented. Other estimation results and diagnostics are available upon request. Panel A of Table 3 contains results for testing the hypothesis that the U.S. did not Granger-cause the individual East Asian markets. During the pre-crisis period, the movement in the U.S. stock index significantly affected two of the four East Asian markets. Apparently, the Taiwan and the South Korea market did not respond to developments in the U.S.. For the pre-crisis period in which an error correction term is included, the error correction term is significant in all the four regression equations - that is, these East Asian markets did respond to deviations from the cointegrating relationships. During both the crisis and post-crisis periods, there is strong evidence that the U.S. market led the other markets. The evidence on the U.S. influences is largely consistent with other studies in the literature.

Panel B presents the results of testing the hypothesis that the U.S. was not Granger-caused by an East Asian market. The evidence is quite intriguing. While the U.S. market responded to movements in Hong Kong, Singapore and South Korea during the pre-crisis period, it significantly reacted to all four East Asian markets during the crisis. The same set of markets, however, appears to have had no effect on the U.S. stock market after the crisis. In Panel B the error correction term is not significant at the 5% level. Since the error correction term measures the deviation from the empirical long-run relationship, its significance patterns in Table 3 indicate that it is the East Asian market, and not the U.S., that responded to the deviation from the empirical long-run relationship. When the combined sample is considered, these East Asian markets exhibit significant effects on the U.S..

Thus far the analysis shows that the interaction between stock indexes can change quite substantially across a financial crisis. While feedback is detected among some index pairs in the pre-crisis sample and in all index pairs during the crisis, only a uni-directional causality pattern is revealed in the post-crisis period. On the other hand, the causality inferences based on the combined sample are quite different from those based on individual samples. Thus, a study of the interaction between equity markets should recognize the possible change in the comovement pattern around a crisis period.

4. Effects of the Japanese Currency

As one of the major economies, Japan plays an important role in both Asian and world markets. Some speculate that the wild fluctuation of the yen value before 1997 was one of the culprits of the recent Asian finance crisis.[6] During the crisis, both officials of the East Asian governments and market

[6] See, for example, Corsetti, Pesenti and Roubini (1999), Ito, Ogawa and Sasaki (1998), Radelet and Sachs (1998) for some discussion on the causes of the Asian financial crisis.

practitioners were critical of the yen exchange rate movement. Yen depreciation is deemed to be harmful to the recovery of East Asian markets. For instance, the Japanese economy is viewed as the growth engine to lead the region out of the slump. A weak yen is considered a sign that the Japanese economy is still far from recovery. Further, a weak yen is a threat to other Asian economies because it can shrink the market share of Asian exporters or force them to compress profit margins. Thus a weak Japanese currency is an adverse factor for these stock markets. In this section, we attempt to determine whether the East Asian stock markets respond to the Japanese currency. If they do, do they react differently before and after the crisis?[7]

To investigate the effect of the Japanese currency on the causal relationship between the stock indexes, we augment (2) and (4) with an exchange rate term and estimate

$$X_t = C + \sum_{j=1,\ldots,k} \alpha_j X_{t-j} + \sum_{j=1,\ldots,n} \beta_j Y_{t-j} + \sum_{j=1,\ldots,m} \gamma_j S_{t-j} + \varepsilon_t, \quad (5)$$

and

$$Y_t = C + \sum_{j=1,\ldots,k} \alpha_j Y_{t-j} + \sum_{j=0,\ldots,n} \beta_j X_{t-j} + \sum_{j=1,\ldots,m} \gamma_j S_{t-j} + \varepsilon_t, \quad (6)$$

where S_t is the daily dollar-yen exchange rate in first log differences. The lag parameter m is again selected using the Akaike information criterion from the set m = 1, ..., 10. The results are quite robust to the choice of m. Table 4 presents only the likelihood ratio statistics and their p-values for the respective tests of the (joint) significance of β_js, the error correction term, and γ_js for brevity. Comparing Table 3 and Table 4, it is revealed that the presence of S_{t-j}s does not have any discernable effects on the significance of β_js and the error correction term.

The role of the Japanese currency in (5) and (6) depends on the sample period. During the pre-crisis period, the dollar-yen exchange rate, at the 5% significance level, provides some incremental explanatory power for two cases in Table 4. The number of significant cases increases to five if a 10% level is considered. In general, the Japanese yen effect on these stock markets was quite limited before the financial crisis.

There is a noticeable change in the role of the Japanese currency during the crisis period. For all the bivariate causation equations in Panel A, the added exchange rate term is highly significant. The dollar-yen exchange rate term has almost uniformly a positive coefficient estimate, implying that a yen depreciation leads to a lower stock index. The results are in accordance with the perception that, during the financial turmoil, a weak yen raised the concern about a weak Japanese economy and an erosion of export competitiveness among East Asian economies, which, in turn, exerted pressure on these stock markets. It is interesting to observe that the inclusion of S_{t-j}s does not alter the previous causality results

[7] There is a related, but different literature on the effect of a country's exchange rate on its own stock market. The empirical results documented in these studies are quite mixed - positive, negative and zero exchange rate effects are reported. See, for example, Jorion (1990) and Bartov and Bodnar (1994)

based the significance of β_js. In addition to the usual lagged stock price factor commonly investigated in the literature, the equity return is affected by the Japanese currency movement.

Compared with its effects on East Asian economies, the impact of the yen on the U.S. market is weaker; the exchange rate terms are only significant at the 10% but not at the 5% level. The economic repercussions of a weak yen for the U.S. are smaller than for the East Asian economies. Thus, the lesser U.S. response is consistent with the Japanese currency effect during the crisis described above.

The yen exchange rate effect on these stock markets after the crisis is quite different from the other two periods. Essentially, in the presence of the lagged U.S. stock index, the Japanese currency has no significant explanatory power for any one of the four East Asian markets. Similarly, the post-crisis U.S. market is not affected by the yen exchange rate. The results from the combined sample indicate that some of these markets are influenced by the yen exchange rate. If the focus is on the market behavior in the post-crisis period, then the combined sample results are spurious and offer erroneous information on market interactions for investment and portfolio management analyses.

In sum, the empirical results corroborate the contention that the Japanese currency is a factor that affected the East Asian stock markets during the crisis. Further, the yen effect for these markets differs across the samples.

5. Additional Analyses

In this section, we investigate the robustness of the yen effect reported in the previous section. First we consider whether the results are sensitive to the use of return data expressed in the U.S. dollar unit. Specifically, we transform the equity return data from local currency units to returns in U.S. dollars and re-do the exercise. One interpretation is that we consider the stock market interaction from the perspective of a U.S. investor. The results from the regression equations

$$X_{\text{U.S.},t} = C + \sum_{j=1,\ldots,k} \alpha_j X_{\text{U.S.},t-j} + \sum_{j=1,\ldots,n} \beta_j Y_{t-j} + \sum_{j=1,\ldots,m} \gamma_j S_{t-j} + \varepsilon_t \quad (7)$$

and

$$Y_t = C + \sum_{j=1,\ldots,k} \alpha_j Y_{t-j} + \sum_{j=0,\ldots,n} \beta_j X_{\text{U.S.},t-j} + \sum_{j=1,\ldots,m} \gamma_j S_{t-j} + \varepsilon_t \quad (8)$$

are reported in Table 5. $X_{U.S.,t}$ is the return on an East Asian stock market index expressed in U.S. dollar terms. The lag parameters k, n, and m are determined using the approach discussed in the previous sections.

The use of dollar return data has limited implications for the general inference of yen effects reported in the previous section. The patterns of significance of β_js and the error correction term in Table 5 are essentially the same as those in Table 4. With the dollar-based returns, the Japanese yen currency effect appears slightly stronger during the crisis period. An exception is the Singapore case in Panel A. Nonetheless, the currency effect is mostly observed during the crisis period and evaporates in the post-

crisis sample. The coefficient estimates (which are available upon request), again, suggest that a yen depreciation tended to lower these equity markets during the crisis period. Overall, data on both local currency and U.S. dollar returns yield similar inferences on the variation of information flows across these samples. Thus, currency conversion is not likely to be the cause of the reported Japanese yen effect.

As argued above, a weak yen may impact the East Asian equity markets because it connotes a weak Japanese economy and represents a threat to exports of the East Asian economies during the crisis period. Is it possible that the reported Japanese currency effect captures the markets' responses to implied developments in the Japanese economy rather than some effects specific to the crisis experience? To investigate this possibility, we include the return on the Nikkei 225 index in the exercise and check if the Japanese currency variable is crowded out by the stock return variable. The Japanese stock index is used as an indicator of the well-being of the Japanese economy because the stock market is commonly perceived to be a barometer of the economy. If the yen exchange rate variable is a proxy for economic conditions that are captured by the stock market, then the presence of the Japanese stock variable will render the yen variable insignificant. We consider the following regression equations

$$X_t = C + \sum_{j=1,\ldots,k} \alpha_j X_{t-j} + \sum_{j=1,\ldots,n} \beta_j Y_{t-j} + \sum_{j=1,\ldots,m} \gamma_j S_{t-j} + \sum_{j=1,\ldots,p} \phi_j JP_{t-j} + \varepsilon_t, \quad (9)$$

and

$$Y_t = C + \sum_{j=1,\ldots,k} \alpha_j Y_{t-j} + \sum_{j=0,\ldots,n} \beta_j X_{t-j} + \sum_{j=1,\ldots,m} \gamma_j S_{t-j} + \sum_{j=1,\ldots,p} \phi_j JP_{t-j} + \varepsilon_t, \quad (10)$$

where JP_t is the return on the Japanese Nikkei 225 index. Since the dollar return data give a stronger Japanese yen currency effect, using equations (9) and (10) will not over-state the importance of the currency effect.[8]

The likelihood ratio test results are presented in Table 6. In general, conditional on other variables, these equity markets do not exhibit much response to the Japanese stock market. The JP_t variable is significant in some cases during the crisis period - a result that can be ascribed to contagion effects commonly documented during a crisis (King and Wadhwani, 1990). The effects of lagged Y_ts (X_ts) on X_t (Y_t) across the samples are essentially the same as those reported in the previous tables. The presence of lagged Japanese equity returns does not qualitatively change the significance of the Japanese currency variable. The yen effect, again, shows up mainly during the crisis period and does not exist in the post-crisis sample. Thus, the reported Japanese currency effect is not just a reflection of market concerns about the Japanese economy captured by the stock market variable.

[8] Dollar return data gave results similar to those reported in Table 6. In fact, the use of dollar return data does not qualitatively change the results reported in the text.

6. Concluding Remarks

The paper presents an empirical study on the interactions between the U.S. and four East Asian markets. The main empirical insights are the changes in the information structure/flow and in the role of the Japanese yen around the 1997 Asian financial crisis. The results are not contaminated by conditional heteroskedasticity because our testing procedure explicitly accounts for GARCH effects in the data. Our results document that the information structure during the crisis period is different from the non-crisis periods. The empirical evidence confirms the dominant role of the U.S. market - the U.S. index led these East Asian markets before, during, and after the crisis. The influence of these East Asian markets on the U.S., however, was mainly found during the crisis. Specifically, in the post-crisis sample these markets did not affect the U.S. market.

An interesting finding is the effect of the Japanese currency. Consistent with concerns reported in the market, the Japanese currency is found to have affected these equity markets during the crisis period. The Japanese yen effect, however, disappeared in the post-crisis sample. The Japanese yen effect does not appear spurious. The same currency effect is uncovered from both local currency and U.S. dollar return data and is detected in the presence of the Japanese stock return variable. The findings corroborate the contention that financial crises endure extreme market conditions. These extreme market conditions can lead to changes in the channel via which information is incorporated and transmitted across markets.

The results on the change in information flows have substantial implications for both academia and the investment community. The varying causation pattern warrants a detailed study on information flow and propagation mechanisms under different market conditions. The upsurge and disappearance of the Japanese yen effect is an intriguing phenomenon. The channel and transmission mechanism with which the yen exchange rate affects the East Asian economies is an interesting future research area. For practitioners, information on market interactions helps improve hedging and managing portfolios that contain foreign equities. The documented changes in the causal relationship suggest that different investment strategies should be pursued under different market conditions. Further, if changes are not allowed for, the use of long sample data may yield obscure and even erroneous information on market interactions.

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Table 1. Unit Root Test Results

PANAL A: Levels of the logarithmic stock indexes series

	Pre-Crisis		During Crisis		Post Crisis		Combined	
	Lag	ADF	Lag	ADF	Lag	ADF	Lag	ADF
HK	7	-3.0296	4	-2.9352	0	-2.8051	4	-2.2591
SG	1	-2.0625	1	-2.1503	0	-2.6153	1	-1.7609
TW	0	-1.8843	0	-2.3897	4	-1.7241	4	-0.8041
KW	1	-2.5819	1	-2.2745	0	-2.3225	1	-1.8177
U.S.	0	-2.5008	0	-2.7434	0	-2.7275	0	-1.7650

PANAL B: First-differences of the logarithmic stock indexes series

	Pre-Crisis		During Crisis		Post Crisis		Combined	
	Lag	ADF	Lag	ADF	Lag	ADF	Lag	ADF
HK	9	-8.8700	3	-13.9441	4	-7.5727	3	-20.4037
SG	9	-7.9221	0	-23.2547	0	-16.9971	0	-35.5687
TW	0	-26.5235	0	-26.7071	3	-9.4552	3	-21.8195
KW	0	-22.4551	0	-24.9709	1	-12.4212	4	-19.9654
U.S.	0	-24.7743	9	-9.0355	1	-12.6816	2	-25.5043

Notes: The augmented Dickey-Fuller unit root test results are reported. The lag parameter is given under the column "lag" and the statistics are given under "ADF." The stock indexes are HK - Hong Kong Hang Seng Index, SG - the Singapore Strait Times Index, TW - the Taiwan Weighted Index for Taiwan, KW - the Korea Composite Index, and U.S. - the U.S. Dow Jones Industrial Average Index. All data were transformed to the logarithmic form. The pre-crisis sample is from January 1995 to June 1997, the crisis sample from July 1997 to June 2000 and the post-crisis sample from July 2000 to July 2001. The "Combined" column contains results from January 1995 to July 2001. All the statistics in Panel A do not reject the unit root null hypothesis. The same null hypothesis is rejected by first log differenced data (Panel B).

Table 2. Cointegration Test Results

	Pre-Crisis		During Crisis		Post Crisis		Combined	
	C.E.(s)	L.R.	C.E.(s)	L.R.	C.E.(s)	L.R.	C.E.(s)	L.R.
U.S./HK	0	40.6611	0	11.1884	0	10.0627	0	16.1210
	1	14.2568	1	1.6758	1	2.1765	1	5.0031
U.S./SG	0	24.4054	0	8.0678	0	12.5974	0	17.1445
	1	7.2632	1	1.2358	1	1.7776	1	2.9841
U.S./TW	0	30.7747	0	11.7817	0	12.1283	0	13.4981
	1	13.2000	1	4.5866	1	4.2069	1	1.5199
U.S./KW	0	22.4716	0	8.5591	0	19.5428	0	15.6297
	1	6.4538	1	1.0620	1	4.3707	1	3.2613

Notes: The Johansen trace statistics are reported. The maximum eigenvalue statistic gives similar results. See the note to Table 1 for the definitions of notation. Cointegration is found only in the pre-crisis sample but not in the crisis or post-crisis samples.

Table 3. Causality Test Results

PANAL A: The U.S. Granger-Causes the East Asian Economies

		Prior Crisis		During Crisis	Post Crisis	Entire Period
		β_js = 0	ECT=0	β_js = 0	β_js = 0	β_js = 0
HK	LR	142.23	15.64	117.52	83.32	355.42
	p-value	0.00	0.00	0.00	0.00	0.00
SG	LR	62.13	4.78	123.34	35.60	193.27
	p-value	0.00	0.03	0.00	0.00	0.00
TW	LR	4.33	14.01	50.89	10.38	61.46
	p-value	0.11	0.00	0.00	0.00	0.00
KW	LR	0.93	6.64	53.46	37.39	52.91
	p-value	0.33	0.01	0.00	0.00	0.00

PANAL B: The East Asian Economies Granger-Cause the U.S.

		Prior Crisis		During Crisis	Post Crisis	Entire Period
		β_js = 0	ECT=0	β_js = 0	β_js = 0	β_js = 0
HK	LR	9.54	3.00	39.24	0.90	33.83
	p-value	0.02	0.08	0.00	0.64	0.00
SG	LR	3.73	1.87	19.76	2.57	23.58
	p-value	0.05	0.17	0.00	0.11	0.00
TW	LR	0.12	0.33	15.07	0.44	8.22
	p-value	0.73	0.56	0.04	0.51	0.08
KW	LR	9.50	1.29	8.78	4.11	7.40
	p-value	0.02	0.26	0.00	0.53	0.01

Notes: The table reports the causality test results based on equations (1) to (4) in the text. Likelihood ratio statistics allowing for GARCH in error terms are used to conduct the test. The "LR" row gives the likelihood ratio statistics and the "p-value" row gives the corresponding p-values. The column β_js = 0" lists the statistic that tests the joint significance of the β_js in equations (2) and (4). The column "ECT=0" lists the statistic that tests the significance of the error correction term included in regressions considered in the pre-crisis sample. Panel A contains the results of testing the hypothesis of the U.S. does not Granger-cause the individual East Asian markets. Panel B contains the results of testing the hypothesis of an East Asian market does not Granger-cause the U.S.. See the note to Table 1 for definitions of notation.

Table 4. The Japanese Currency Effect

PANAL A: The U.S. Granger-Causes the East Asian Economies

		Prior Crisis			During Crisis		Post Crisis		Entire Period	
		β_js = 0	γ_js = 0	ECT=0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0
HK	LR	138.72	7.47	15.20	129.28	16.42	84.20	0.96	353.71	0.09
	p-value	0.00	0.01	0.00	0.00	0.00	0.00	0.33	0.00	0.76
SG	LR	59.86	2.31	4.82	129.89	9.05	34.94	0.01	192.08	0.06
	p-value	0.00	0.13	0.03	0.00	0.01	0.00	0.90	0.00	0.81
TW	LR	4.45	6.14	14.11	55.83	12.70	8.19	2.77	63.16	3.41
	p-value	0.11	0.05	0.00	0.00	0.00	0.00	0.10	0.00	0.06
KW	LR	0.91	0.01	6.65	63.14	31.24	37.41	0.10	56.46	13.80
	p-value	0.34	0.92	0.01	0.00	0.00	0.00	0.75	0.00	0.00

PANAL B: The East Asian Economies Granger-Cause the U.S.

		Prior Crisis			During Crisis		Post Crisis		Entire Period	
		β_js = 0	γ_js = 0	ECT=0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0
HK	LR	10.90	4.30	2.90	40.88	3.53	1.19	2.94	36.23	20.51
	p-value	0.01	0.04	0.09	0.00	0.06	0.55	0.40	0.00	0.00
SG	LR	4.39	3.62	1.81	19.91	3.39	2.34	2.71	25.08	20.12
	p-value	0.04	0.06	0.18	0.00	0.07	0.13	0.44	0.00	0.00
TW	LR	0.21	2.89	0.17	22.47	5.35	0.03	2.81	8.70	19.71
	p-value	0.65	0.09	0.68	0.00	0.07	0.87	0.42	0.07	0.00
KW	LR	9.08	2.67	1.12	8.63	3.25	4.61	4.31	8.25	19.32
	p-value	0.03	0.10	0.29	0.00	0.07	0.47	0.23	0.00	0.00

Notes: The table reports the test for the Japanese currency effect based on equations (5) and (6) in the text. The column "γ_js = 0" gives the likelihood ratio statistic that tests the joint significance of the γ_js = 0 in equations (5) and (6). See the notes to the previous Tables for additional definitions of notation.

Table 5. The Japanese Currency Effect - Dollar Return Data

PANAL A: The U.S. Granger-Causes the East Asian Economies

		Prior Crisis			During Crisis		Post Crisis		Entire Period	
		β_js = 0	γ_js = 0	ECT=0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0
HK	LR	135.73	13.02	15.15	129.36	16.98	84.35	0.97	353.56	0.04
	p-value	0.00	0.01	0.00	0.00	0.00	0.00	0.32	0.00	0.84
SG	LR	43.21	11.53	3.14	108.85	2.45	31.74	0.13	170.63	0.67
	p-value	0.00	0.02	0.08	0.00	0.12	0.00	0.72	0.00	0.41
TW	LR	4.13	3.33	11.91	53.92	27.71	8.84	4.48	57.35	12.44
	p-value	0.13	0.19	0.00	0.00	0.00	0.00	0.03	0.00	0.00
KW	LR	1.14	3.28	2.81	75.29	42.80	29.98	0.39	58.31	19.27
	p-value	0.57	0.19	0.09	0.00	0.00	0.00	0.53	0.00	0.00

PANAL B: The East Asian Economies Granger-Cause the U.S.

		Prior Crisis			During Crisis		Post Crisis		Entire Period	
		β_js = 0	γ_js = 0	ECT=0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0	β_js = 0	γ_js = 0
HK	LR	10.74	4.25	2.89	41.14	3.49	1.17	2.93	35.81	20.40
	p-value	0.01	0.04	0.09	0.00	0.06	0.56	0.40	0.00	0.00
SG	LR	12.97	2.49	1.45	16.47	3.75	2.57	3.29	28.52	16.51
	p-value	0.07	0.11	0.23	0.00	0.05	0.11	0.35	0.00	0.01
TW	LR	0.16	2.88	0.10	23.85	14.49	0.00	2.85	6.71	19.39
	p-value	0.69	0.09	0.76	0.00	0.00	0.95	0.41	0.03	0.00
KW	LR	22.71	2.80	1.62	8.43	6.43	2.44	3.91	7.80	19.03
	p-value	0.02	0.09	0.20	0.00	0.00	0.12	0.27	0.01	0.00

Notes: The table reports the test for the Japanese currency effect based on equations (7) and (8) in the text. The column "γ_js = 0" gives the likelihood ratio statistic that tests the joint significance of the γ_js = 0 in equations (7) and (8). Dollar return data are used to generate the statistics. See the notes to the previous Tables for additional definitions of notation.

Table 6. Tests for the Japanese Currency Effect in the presence of Japanese Stock Returns

PANAL A: The U.S. Granger-Causes the East Asian Economies

		Prior Crisis				During Crisis			Post Crisis			Entire Period		
		β_js = 0	γ_js = 0	ϕ_js = 0	ECT=0	β_js = 0	γ_js = 0	ϕ_js = 0	β_js = 0	γ_js = 0	ϕ_js = 0	β_js = 0	γ_js = 0	ϕ_js = 0
HK	LR	137.47	8.60	1.92	16.17	132.93	18.45	5.65	86.09	0.76	2.98	356.17	0.11	3.06
	p-value	0.00	0.00	0.17	0.00	0.00	0.00	0.02	0.00	0.38	0.23	0.00	0.74	0.22
SG	LR	60.97	1.75	1.76	4.68	130.86	9.44	1.05	35.03	0.01	0.11	191.60	0.08	0.62
	p-value	0.00	0.19	0.19	0.03	0.00	0.01	0.30	0.00	0.94	0.74	0.00	0.78	0.43
TW	LR	4.30	6.16	0.01	14.08	43.26	10.26	7.53	8.03	2.10	1.73	60.06	2.87	6.58
	p-value	0.12	0.05	0.91	0.00	0.00	0.00	0.01	0.00	0.15	0.19	0.00	0.09	0.01
KW	LR	0.83	0.01	1.36	7.08	62.29	30.81	0.04	37.85	0.27	0.82	55.84	7.96	0.20
	p-value	0.36	0.94	0.24	0.01	0.00	0.00	0.83	0.00	0.61	0.36	0.00	0.02	0.65

PANAL B: FOCAL ECONOMIES Granger-CAU.S.E THE U.S.

		Prior Crisis				During Crisis			Post Crisis			Entire Period		
		β_js = 0	γ_js = 0	ϕ_js = 0	ECT=0	β_js = 0	γ_js = 0	ϕ_js = 0	β_js = 0	γ_js = 0	ϕ_js = 0	β_js = 0	γ_js = 0	ϕ_js = 0
HK	LR	12.27	5.33	3.45	3.26	35.39	3.37	1.11	0.31	3.06	1.11	31.88	20.53	0.32
	p-value	0.01	0.02	0.18	0.07	0.00	0.07	0.29	0.86	0.38	0.29	0.00	0.00	0.57
SG	LR	4.39	3.45	0.06	1.83	15.82	3.93	3.63	1.21	2.86	0.87	21.77	20.17	1.36
	p-value	0.04	0.06	0.80	0.18	0.00	0.05	0.06	0.27	0.41	0.35	0.00	0.00	0.24
TW	LR	0.10	3.61	1.96	0.24	20.83	6.81	7.02	0.07	2.94	2.03	8.00	19.81	3.98
	p-value	0.75	0.06	0.37	0.62	0.00	0.03	0.01	0.80	0.40	0.15	0.09	0.00	0.05
KW	LR	8.58	3.32	1.79	1.33	7.72	3.68	8.59	4.72	4.66	2.00	7.01	19.48	3.43
	p-value	0.04	0.07	0.41	0.25	0.01	0.06	0.01	0.45	0.20	0.16	0.01	0.00	0.06

Notes: The table reports the test for the Japanese currency effect in the presence of returns on Nikkei 225 index; see equations (9) and (10) in the text. The column "ϕ_js = 0" gives the likelihood ratio statistic that tests the joint significance of the Japanese stock variable (i.e. γ_js = 0) in equations (9) and (10). See the notes to the previous Tables for the additional definitions of notation.