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Currency Crisis and Stock Market Integration: A Comparison of East Asian and European Experiences

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Using cointegration and variance decomposition analyses, this paper investigates the impact of the 1997 Asian currency crisis on stock market integration in East Asia, and compares this experience with Europe's experience after the ERM crisis. This paper finds that in the long and short run, East Asian stock markets became increasingly integrated with the US market after the currency crisis, confirming a popular view that the Asian crisis brought about US dominance over Asian stock markets. Long and short run relations between Asian and US markets on one hand, and between Asian markets themselves on the other hand emerged in the post-crisis period. This phenomenon, however, is limited only to Asian stock markets. In Europe, the currency crisis ended up eliminating the pre-existing long and short relation, even though it led to a temporary increase in stock market linkages during the currency crisis period. In particular, the integration of European markets with the US market turned out to be insufficient all throughout currency crisis. These contrasting behaviors of Asian and European stock markets after the currency crisis seem to result from their different experiences regarding capital liberalization, particularly foreign equity investment liberalization.

1. INTRODUCTION

It is said that the currency crisis in East Asia brought about an increase in the cross-market correlations among East Asian stocks. This result is not inconsistent with the findings of many studies that examined the impact of shocks like the 1987 US stock market crash or the currency crises on the cross-market correlation (For instance, Furstenberg and Jeon (1989), Bertero and Mayer (1990), King et al. (1994) and Meric and Meric (1997)). But the problem is that the increase in cross market correlations does not necessarily mean an increase in the financial market integration, because it can be a transitory phenomenon that could be observed only in periods of high turbulence. In fact, Forbes and Rigobon (1998) indicates that this is the case. They define contagion as a significant increase in market co-movement after a shock to one country. According to them, the traditional tests of correlation coefficient are biased because the unadjusted cross-market correlation coefficient is conditional on market volatility. Correcting for this bias, they find there was virtually no evidence of contagion during the 1997 East Asian crisis.

This means that looking at cross market correlations is not sufficient for investigating the question of stock market integration. Indeed, an increasing proportion of empirical studies on stock market linkages are now employing cointegration techniques and examining the number of common stochastic trends. (For instance, Kasa (1992), Chung and Liu (1994), and Masih & Masih (1999) on Pacific Rim county stock markets, Jochum, Kirchgassmer and Platek (1999) for Eastern European stock markets) Moreover, it seems necessary to divide the periods following the crisis into two sub-periods: crisis period, when the market is volatile, and post crisis period, when the market is stable.

This paper intends to investigate the impact of the 1997 Asian currency crisis on the stock market integration in East Asia and to compare this experience with the European experience after the ERM crisis. For this purpose, this paper conducts cointegration and

variance decomposition analyses for each of the three periods (pre-crisis, crisis, and post-crisis periods).

We find that in the long and short run, East Asian stock markets became increasingly integrated with US market after the currency crisis, confirming a popular intuitive view that the Asian crisis brought about US dominance over Asian stock markets. Long and short run relations between Asian and US markets on one hand and between Asian markets themselves on the other hand emerged. It is important, however, to note that this result is so far limited only to Asian stock markets, because contrary to the Asian case, no such result has been observed in the case of Europe. It turns out that in Europe, the currency crisis ended up eliminating the pre-existing long and short relation, even though it caused a temporary increase in stock market linkages during the currency crisis period. Jochum, Kirchgassmer and Platek (1999) provide a similar evidence in the case of Eastern European countries. According to them, currency crises contribute to eliminating the long run relations that existed in these markets.

This paper is organized in the following manner. Section 2 contains a brief overview of the data and the correlations that exist among Asian stock markets on the one hand and European stock markets on the other hand. Section 3 focuses on Asian stock markets and discusses the empirical findings on the basis of cointegration and variance decomposition outcomes. Section 4 conducts the same analysis as in Section 3 for European stocks. Finally, a conclusion appears in Section 5.

2. FIRST LOOK AT THE ASIAN AND EUROPEAN STOCK MARKET INTEGRATION

It has been noted that the 1997 Asian currency crisis has helped to increase the stock market linkages between East Asian countries and the US, and between East Asian countries themselves. Before we investigate the extent of stock market linkages among 10 countries (Nine East Asian countries and the US) before and after the currency crisis, we first present a correlation table for Asian and US stock markets both in terms of its level (log price) and its difference (return). The data for Asian stock markets are daily national stock price indexes from 4 January 1995 to 30 June 2000. These indexes include the Nikkei 225 (Japan), KOSPI (Korea), Hang Seng (Hong Kong), JCI (Indonesia), KLCI (Malaysia), PCOMP (Phillippines), STI (Singapore), TWSE (Taiwan), SET (Thailand) and Dow Jones Index (US), and come from Morgan Stanley data base and each national stock exchange. Three periods have been distinguished. The reason for this division is because the volatility of the stock market can increase during the currency period and thus increased stock market volatility can cause an increase in cross market correlations, as Forbes and Rigobon (1998) pointed out. The first period was the pre-crisis period ranging from January 4, 1995 to May 30, 1997. Financial tensions were already very high in June, 1997, even though the collapse of Thai baht started in July. During 1998, the financial turmoil continued with the financial instability in Russia adding new elements of uncertainty in the region. It seems that the effects of all these turmoils were not eliminated until March 1999. Consequently the crisis period was assumed to last from June 1, 1997 to February 26, 1999. Thereafter the post crisis followed. Subtracting the days when the stock market was not opened in any one of these 10 countries, we can then obtain 460, 338 and 319 observations for each of these sub-periods, respectively.

Also to compare the stock market integration in East Asia with the European integration, we present daily national stock prices for nine European countries and the US: FAZ General

(Germany), CAC40 (France), FTSE100 (UK), Madrid SE General (Spain), BEL20 (Belgium), Amsterdam AEX(EOE) (Netherlands), HEX General (Finland), Copenhagen KFX (Denmark), Athens SE General (Greece) and Dow Jones Index (US). Europe was hit by the currency crisis during 1992-93. As with East Asia, three sub-periods are distinguished. The first period ranges from January 2, 1990 to August 31, 1992, the second from September 1, 1992 to May 31, 1994, and the third period from June 1, 1994 to December 27, 1995. In fact, the first speculative attack came on September 6, 1992 and the continued turmoil forced EMS countries to adopt wide bands exchange rate system on July 1993. However, because small turbulences subsisted, we assume the crisis period lasted until the end of May 1994. The data is based on daily national stock price indexes.

Table 1. Correlation Table for Asian and US Stocks

	Level						Return					
	Pre-crisis		Crisis		Post-crisis		Pre-crisis		Crisis		Post-crisis	
	Asia	US	Asia	US	Asia	US	Asia	US	Asia	US	Asia	US
JAP	0.28	0.50	0.78	-0.49	0.55	0.45	0.14	0.06	0.20	0.18	0.35	0.07
KOR	-0.44	-0.83	0.78	-0.31	0.58	0.69	0.02	0.04	0.24	0.22	0.31	0.05
TWN	0.09	0.55	0.67	-0.38	0.43	0.34	0.11	-0.02	0.23	0.15	0.18	0.07
MAL	0.38	0.83	0.87	-0.35	0.50	0.44	0.34	0.09	0.31	0.19	0.26	0.02
SING	0.36	0.69	0.84	-0.34	0.63	0.73	0.37	0.18	0.42	0.29	0.40	0.02
PHIL	0.37	0.69	0.81	-0.02	-0.02	0.25	0.28	0.10	0.32	0.29	0.30	0.04
HK	0.33	0.98	0.84	-0.37	0.48	0.45	0.17	0.01	0.08	0.04	0.36	0.04
INDO	0.38	0.94	0.81	-0.24	0.60	0.67	0.30	0.11	0.27	0.03	0.24	0.02
THAI	-0.34	-0.79	0.85	-0.33	0.40	0.58	0.25	0.03	0.34	0.26	0.35	0.05

Note: Asian country's correlation with Asia is calculated as the average value of correlation coefficients for other 8 Asian countries.

The correlation table for Asian and US stocks reveals two important facts. First, starting with (log) prices, we find that Asian stock prices became more closely linked to each other during the currency crisis. Compared to the pre-crisis period, the correlation coefficients become higher during the crisis period, but they fall again in the post-crisis period. In contrast, the correlation coefficients of Asian stock prices with the US price turn out less close and negative during the crisis period. This implies that Asian markets, even though they were more integrated among themselves, became detached from the US market during the crisis period. Secondly, in terms of stock market returns (log price difference), we neither confirm a significant increase in correlation coefficients of returns among Asian countries during the crisis period, nor during the post-crisis period. Thus, the behavior of Asian stocks seems to remain unchanged between pre and post crisis periods.

Table 2. Correlation Table for European and US Stocks

	Level						Return					
	Pre-crisis		Crisis		Post-crisis		Pre-crisis		Crisis		Post-crisis	
	EUR	US	EUR	US	EUR	US	EUR	US	EUR	US	EUR	US
LSP	0.57	0.06	0.95	0.97	0.62	0.25	0.49	0.30	0.33	0.17	0.42	0.28
LGER	0.56	0.05	0.94	0.93	0.62	0.30	0.48	0.27	0.33	0.10	0.37	0.11
LFR	0.54	0.48	0.92	0.94	0.16	-0.35	0.52	0.35	0.39	0.24	0.39	0.30
LUK	0.22	0.83	0.90	0.91	0.52	0.95	0.41	0.37	0.36	0.26	0.42	0.38
LFIN	0.29	-0.63	0.93	0.94	0.48	0.42	0.19	0.06	0.19	0.05	0.27	0.12
LNET	0.40	0.79	0.95	0.96	0.57	0.91	0.53	0.38	0.40	0.21	0.48	0.32
LDK	0.45	-0.18	0.95	0.96	0.59	0.43	0.42	0.26	0.24	0.00	0.33	0.10
LBEL	0.57	0.18	0.95	0.94	0.67	0.55	0.50	0.30	0.35	0.16	0.43	0.27
LGR	-0.02	-0.09	0.89	0.91	0.59	0.68	0.20	0.07	0.04	0.03	0.00	-0.01

Note: European country's correlation with Europe is calculated as the average value of correlation coefficients for other 8 European countries.

European stocks show a similar pattern to Asian stocks except for their behaviors during the currency crisis period. First, the correlation coefficients of European stocks in terms of price level turn out increasing unanimous during the currency period, but end up declining during the post-crisis period. Note, however, that during the crisis period, European stock prices move together with US stock price. Secondly, the European stocks in terms of return correlation show that there is no noticeable change in the extent of stock market integration between pre and post crisis periods. However, different behaviors are observed between European and Asian stocks again during the currency period. In fact, we find that there is a slight decrease in the correlation coefficients of stock returns not only among European markets themselves, but also between European and US markets during the crisis period.

In conclusion, the comparison of correlation tables shows that there are some temporary differences in market integration between Asian and European stocks only during the crisis period.[1] However, there is no evidence at all about different stock market behaviors in Asia and Europe after the currency crisis. A more detailed analysis will reveal that this is not the case. Indeed, we will show that the integration of Asian markets among themselves and with the US substantially increased after the currency crisis period, relying on co-integration and variance decomposition methods.

[1] Because, as we will show, stock price series are unstable with I(1), it can be meaningless even to speak about the correlation coefficients in price indexes.

3. LONG RUN RELATION AND SHORT RUN DYNAMICS OF EAST ASIAN STOCK MARKETS

3.1. Co-integration

We will first examine the long run relation between Asian stock markets and, for that purpose, proceed to the cointegration analysis. The first step is of course to establish whether the time series concerned are stationary or not. It is now very well known that only the stock returns are stable with stock price series being unstable I(1). Appendix confirms that this really is the case, based on the Augmented Dickey-Fuller (ADF) unit root test with different lag structures.

Because all stock price series are I(1), we can now conduct the Johansen cointegration test. We first test for bivariate cointegration between each pair of markets. Underlying the cointegration regression is a VAR with a lag of 3. We choose lag 3 on the basis of Akaike and SCB criteria and keep the lag length the same over all models because these information criteria have a very limited degree of variation in the optimal lag length. Table 3 provides the results of this test procedure. Next, we find that market linkages have increased significantly in the post-crisis period. Note first that the null hypothesis of no cointegration is generally accepted before and during the crisis period. Only 4 cointegations are found among 45 bilateral relations during the pre-crisis period, and only 2 cointegrations during the crisis period. Thus, there is no significant difference in the behavior of stock market between pre-crisis and crisis periods. This result suggests that, even though market volatility might increase during the crisis period, no long run equilibrium relation emerged and only the short run dynamics dominated the behavior of the Asian markets. In the post-crisis period, however, the null hypothesis of no cointegration is rejected for 21 out of 45 bilateral relations. Thus, a long run relation emerged in the post-crisis periods. In fact, if we look more closely at which pair of countries maintain the largest number of cointegration relations, the US turns out to have the largest number of cointegration relations (8 out of 9 relations). This means that practically all East Asian stock markets maintain long run relation with the US except Phillipines. After the US, Asian countries such as Singapore, Malaysia and Korea have the next largest number of cointegration relations.

Table 3. Bivariate Cointegration Tests for Asian and US Stocks

Pre-crisis period

	KOR	HK	TWN	INDO	SING	MAL	PHIL	THAI	US
JAP	6.03	5.23	7.06	3.5	6.57	6.61	6.51	4.59	5.34
KOR		10.34	15.12	8.14	8.21	10.92	8.89	9.41	8.07
HK			10.67	16.83*	8.19	7.67	9.34	9.25	24.06**
TWN				9.52	10.34	13.49	8.58	12.53	9.95
INDO					10.49	6.59	4.83	9.2	16.03*
SING						10.33	14.05	10.34	7.35
MAL							17.03*	7.59	8.53
PHIL								6.65	8.56
THAI									6.62

Crisis period

	KOR	TWN	MAL	SING	PHIL	HK	INDO	THAI	US
JAP	7.57	14.6	7.97	5.85	9.4	7.79	14.61	6.87	8.28
KOR		5.22	15.84*	22.46**	11.56	9.49	9	8.76	7.53
TWN			8.37	5.28	6.96	4.99	9.11	6.07	9.18
MAL				10.23	11.7	12.67	10.63	14.08	9.58
SING					7.25	8.09	6.97	9.29	8.75
PHIL						6.57	13.39	11.02	9.94
HK							8.51	10.84	8.3
INDO								7.65	7.2
THAI									12.45

Post-crisis period

	KOR	TWN	MAL	SING	PHIL	HK	INDO	THAI	US
JAP	18.97*	14.68	14.59	16.01*	10.71	12.81	15.47*	11.08	19.46*
KOR		17.13*	17.26*	22.02**	12.1	14.05	20.47**	13.7	25.00**
TWN			20.77**	16.30*	8.91	16.11*	14.22	10.53	19.05**
MAL				20.45**	11.41	21.49**	14.94	13.51	22.58**
SING					11.31	12.92	17.31*	12.46	25.14**
PHIL						12.22	9.49	9.39	13.71
HK							11.68	11.24	20.13**
INDO								10.35	23.16**
THAI									16.42*

Note: *(**) denotes rejection the hypothesis of no cointegration at 5%(1%) significance level.
The critical values for 5 and 1% significance level are respectively 15.41 and 20.04.

Next, we test for multivariate cointegration for all three periods. Table 4 suggests that there is at most a single cointegrating vector or analogously nine independent common stochastic trends within 10 variable system regardless of the period concerned.[2] Thus, in contrast to bivariate cointegration analysis, multivariate cointegration method seems to suggest that the Asian crisis did not affect the stock market behavior significantly.

Table 4. Multivariate Cointegration Test for Asian and US Stocks

Hypothesis	Critical Value		Likelihood Ratio		
No. of CE(s)	5 Percent	1 Percent	Pre-crisis	Crisis	Post-crisis
None	233.13	247.18	233.954*	248.139**	255.105**
At most 1	192.89	205.95	180.280	185.951	178.945
At most 2	156	168.36	128.186	139.014	125.999
At most 3	124.24	133.57	92.315	95.132	89.943
At most 4	94.15	103.18	65.305	69.106	61.214
At most 5	68.52	76.07	44.286	44.302	36.654
At most 6	47.21	54.46	28.230	24.110	22.932
At most 7	29.68	35.65	15.385	10.551	13.637
At most 8	15.41	20.04	6.008	4.262	5.493
At most 9	3.76	6.65	2.197	0.540	1.534

Note: *(**) denotes rejection of hypothesis at 5%(1%) significance level

3.2. Variance Decomposition.

Because Table 4 suggests that there is at most one cointegration relation, we now conduct variance decomposition analysis on the basis of the vector error correction method (VECM) and examine the short run dynamic property of Asian and US stock markets.[3] Table 5 shows the variance decompositions from one standard deviation shocks to each market over a 5 day time horizon. Since the results of the variance decomposition are not independent of the ordering chosen for the variables, we follow the trading times of the stock markets, putting Japan in first place and US in last place.[4]

[2] Masih and Masih(1997) find similar results for 6 OECD stock markets.
[3] Indeed the VECM is estimated using a lag structure of 3 for all (log) stock price differences.
[4] Changes in the ordering of stock markets do not change the main conclusions of this section. Especially putting US market (previous day) on first place leaves the conclusion intact.

Table 5. Variance Decomposition for Asian and US Stocks (5-Day Time Horizon)

Pre-crisis period

	JAP	KOR	TWN	MAL	SING	PHIL	HK	INDO	THAI	US
JAP	88.42	1.18	1.25	0.09	0.08	0.84	1.98	0.20	0.32	5.64
KOR	0.52	97.34	1.08	0.05	0.13	0.16	0.07	0.57	0.01	0.07
TWN	0.30	2.55	94.09	0.12	1.50	0.31	0.54	0.09	0.01	0.50
MAL	4.54	0.02	1.37	88.69	0.53	0.06	0.17	0.10	0.22	4.32
SING	8.64	0.20	1.07	28.87	56.18	0.18	0.20	1.34	0.42	2.91
PHIL	1.51	0.26	1.03	25.05	6.10	60.71	1.14	0.49	0.77	2.95
HK	2.97	0.75	0.45	23.08	8.52	0.19	59.71	0.30	0.05	3.97
INDO	3.00	0.06	0.86	24.24	10.19	6.99	0.19	51.40	0.63	2.44
THAI	1.48	0.11	0.47	12.56	7.99	1.12	2.25	0.21	72.11	1.69
US	6.20	0.34	0.25	0.48	3.89	0.12	0.13	0.97	0.70	86.93

Crisis period

	JAP	KOR	TWN	MAL	SING	PHIL	HK	INDO	THAI	US
JAP	92.16	0.42	0.25	0.05	0.38	1.45	0.51	0.56	0.61	3.62
KOR	2.70	93.34	0.35	0.02	0.63	0.03	0.91	0.05	1.60	0.37
TWN	1.32	1.24	90.74	1.44	0.08	0.88	0.29	0.14	0.04	3.83
MAL	6.28	8.66	2.27	71.33	0.01	3.99	0.47	3.90	2.83	0.25
SING	2.98	4.52	8.04	16.88	56.45	3.11	1.34	1.97	1.02	3.69
PHIL	2.01	4.16	4.76	11.64	17.61	48.61	0.72	5.85	0.81	3.83
HK	1.60	6.94	3.13	8.71	16.26	3.51	53.48	1.20	0.03	5.14
INDO	4.07	8.46	1.08	0.69	1.98	3.02	2.70	71.58	3.86	2.56
THAI	4.19	13.78	7.00	6.02	9.95	0.41	1.68	6.34	48.81	1.83
US	1.32	2.10	1.08	1.37	4.47	3.71	0.04	0.93	1.65	83.34

Post-crisis period

	JAP	KOR	TWN	MAL	SING	PHIL	HK	INDO	THAI	US
JAP	70.58	0.20	0.43	3.57	0.44	0.54	3.07	0.86	1.54	18.75
KOR	5.71	72.87	0.01	2.33	2.39	0.80	0.48	0.38	0.42	14.61
TWN	7.95	0.16	82.00	1.68	0.08	0.21	0.86	0.85	0.14	6.07
MAL	3.97	0.46	5.10	69.95	1.98	0.03	0.34	1.23	2.12	14.82
SING	3.51	5.62	0.21	0.86	65.04	0.46	0.88	0.10	0.25	23.07
PHIL	1.54	3.84	0.96	2.15	4.44	71.86	0.12	0.27	0.35	14.46
HK	6.45	6.32	0.44	0.26	16.93	4.06	48.97	1.14	0.78	14.65
INDO	3.82	1.58	0.12	2.72	14.04	1.83	0.84	70.05	1.61	3.40
THAI	4.02	3.44	0.76	0.67	9.57	6.55	6.30	1.86	53.24	13.58
US	0.27	0.22	0.34	1.12	0.21	3.75	0.03	0.52	0.74	92.80

Table 5 allows us to gauge to what extent shocks to one Asian market are explained by other markets of the system. Looking at the pre-crisis period, we find that in each market, most of the variations are explained by its own shocks, and that neighboring countries account for only a very slight proportion of variation. This trend does not change much during the crisis period. It turns out, however, that variation of Asian markets is to a very remarkable degree affected by neighboring countries and the US during the post-crisis period. Especially, the role of the US in explaining the stock market variance of Asian stocks is pronounced during the post-crisis period. For instance, in the post-crisis period, the US stock markets turns out to explain very often more than 10% of the variance of most of regional stocks in a 5 day horizon, whereas in the pre-crisis and crisis periods, the US explains normally less than 5% of the variance. This means that even in the short run, the US came to exercise a dominating role in the post-crisis era.

Given the increasing dominance of the US stock market in the short run dynamics of Asian stocks, we now ask about the causal chain between Asian and US stocks in each of three periods concerned. In general, the Granger test is used for this purpose. But in our case, the standard Granger test cannot be applied due to the existence of lagged error correction term (ECT). Indeed, in a VECM, lagged error correction term representing long term equilibrium enters into the estimation equation, together with differenced variables, which reflect short run relationships. Thus, through error correction term, the VECM opens up an additional channel for Granger-causality. Masih and Masih (1999) test the Granger-causality in such a vector error correction model. Employing the same technique as Masih and Masih, we test for each of the 9 Asian stocks econometric exogeneity of US stock (expressed in log price difference or in stock return) and statistical significance of lagged error correction term.

Table 6. Temporal Causality between Asian and US Stocks

	Pre-crisis period		Crisis period		Post-crisis period	
	Lagged DUS	Lagged ECT	Lagged DUS	Lagged ECT	Lagged DUS	Lagged ECT
DJAP	5.809**	22.134**	7.393**	3.518	13.683**	13.984**
DKOR	0.398	1.113	1.007	1.454	10.563**	2.204
DTWN	0.028	4.061*	6.403**	8.043**	4.559**	0.701
DMAL	5.944**	0.593	1.546	12.767**	5.402**	29.829**
DSING	11.132**	1.035	12.330**	11.381**	17.089**	14.651**
DPHIL	2.366	6.176*	6.748**	0.328	10.428**	11.020**
DHK	1.875	2.488	5.003**	0.549	15.162**	0.038
DIND	8.393**	3.435	5.865**	19.487**	3.796*	0.003
DTHAI	2.017	4.822*	3.719*	0.320	4.512**	11.826**

Note: Figures in the above table are F statistics testing the null hypothesis that lagged US or lagged ECT are statistically insignificant. *(**) denotes rejection of these hypotheses at 5%(1%) significance level

Table 6 suggests that the extent that the US stock market Granger causes the movement of East Asian stock markets is reinforced after the currency crisis. Before the crisis, US stock

market returns Granger-causes 4 out of the 9 Asian stock markets. Lagged US stock return turns out significant in explaining the stock returns in Japan, Malaysia, Singapore, and Indonesia. However, after the crisis, it turns out that the US market is exogenous for all 9 Asian markets. In addition, Table 6 shows that US stock market is affecting Asian stock markets through the long run relationship represented by the lagged error correction term in some Asian markets.

4. COMPARISON OF EAST ASIAN AND EUROPEAN STOCK MARKET INTEGRATION

To have a clearer understanding of East Asian stock market integration, we finally compare East Asia's example with Europe's experience. Europe had a currency attack during 1992-93, as Asia did during 1997. Because all European stock price series are I(1) as with Asian stock prices, we can proceed to the same co-integration test and variance decomposition as in Section III.

4.1. Co-integration

First of all, Table 7 presents the bivariate cointegration results for each pair of European and US markets.

Table 7. Bivariate Cointegration Tests for European and US Stocks

Pre-crisis period

	GER	FR	UK	FIN	NET	DK	BEL	GR	US
SPAIN	9.49	5.12	4.17	9.08	3.48	12.37	9.79	14.34	3.86
GER		10.67	7.77	5.47	5.41	3.95	22.35**	18.02*	4.45
FR			6.85	4.64	6.64	3.91	19.66*	15.83*	4.19
UK				8.34	10.85	3.16	9.37	11.39	5.35
FIN					4.56	6.73	6.67	13.41	8.00
NET						2.94	7.07	9.61	9.06
DK							5.82	9.91	6.13
BEL								18.10*	8.63
GR									8.74

Crisis period

	GER	FR	UK	FIN	NET	DK	BEL	GR	US
SPAIN	8.26	12.96	17.24*	20.48**	10.83	29.98**	12.08	10.48	25.76**
GER		12.76	16.16*	13.11	18.38*	11.15	15.17	7.92	12.62
FR			20.34**	16.68*	20.54**	23.11**	11.05	19.39*	16.65*
UK				19.80*	20.53**	25.41**	12.49	22.38**	21.54**
FIN					10.32	17.14*	14.20	12.39	16.54*
NET						12.16	15.44*	13.05	14.82
DK							12.43	12.76	26.75**
BEL								13.64	12.81
GR									13.39

Post-crisis period

	GER	FR	UK	FIN	NET	DK	BEL	GR	US
SPAIN	25.56**	14.38	11.44	8.36	9.36	16.29*	19.06*	13.24	11.57
GER		23.94**	10.67	11.50	10.54	15.99*	19.59*	16.89*	9.15
FR			9.84	17.81*	19.17*	10.50	9.29	16.15*	9.99
UK				3.36	12.56	6.76	11.59	13.55	10.52
FIN					3.95	5.36	3.96	12.29	4.84
NET						5.72	8.79	12.96	6.55
DK							11.33	11.88	7.15
BEL								14.86	8.72
GR									9.64

Note: *(**) denotes rejection the hypothesis of no cointegration at 5%(1%) significance level.
The critical values for 5 and 1% significance level are respectively 15.41 and 20.04.

Contrary to the Asian case, the number of bivariate cointegration relations did increase substantially during the crisis period. For instance, France and UK saw their stock market integration with their neighbors highly increase during the crisis period. Consequently, the number of cointegrated bilateral relations increased from 5 during the pre-crisis period up to 21 during the crisis period. Thus, ERM crisis contributed to creating some long run relationship between European countries during the crisis period. This effect is, however, transitory, because the number of cointegrated bilateral relations fell back to 10 during the post-crisis period. Consequently there seem no apparent changes in the degree of stock market integration in Europe between pre and post-crisis periods.

If we now look at the multivariate cointegration test, there is a slight increase in the number of cointegrated vectors during the crisis period, similar to the bivariate cointegration test. This suggests that temporarily there might be an increase in the degree of integration among European and US stocks.

Table 8. Multivariate Cointegration Test for European and US Stocks

Hypothesis	Critical Values		Likelihood Ratio		
No. of CE(s)	5 Percent	1 Percent	Pre-crisis	Crisis	Post-crisis
None	233.13	247.18	270.948**	267.212**	243.057*
At most 1	192.89	205.95	202.204*	208.865**	174.276
At most 2	156	168.36	147.368	158.394*	132.621
At most 3	124.24	133.57	104.837	122.459	94.658
At most 4	94.15	103.18	76.095	88.657	63.106
At most 5	68.52	76.07	49.911	59.946	41.110
At most 6	47.21	54.46	31.274	34.356	26.321
At most 7	29.68	35.65	15.929	20.410	14.276
At most 8	15.41	20.04	6.328	8.020	4.273
At most 9	3.76	6.65	1.447	3.307	0.068

Note: *(**) denotes rejection of the hypothesis at 5%(1%) significance level

4.2. Variance Decomposition

Table 9 provides variation decomposition results.[5] We find that different from the Asian case, European markets were to a substantial degree affected by their neighboring countries before the ERM crisis and the role of the US in explaining the shocks in European stock markets remained limited throughout all periods. This suggests that there is no short term change in stock market behaviors following the currency crisis.

Table 9. Variance Decomposition for European and US Stocks (5-Day Time Horizon)

Pre-crisis period

	SPAIN	GER	FR	UK	FIN	NET	DK	BEL	GR	US
SPAIN	89.66	0.31	3.25	0.13	0.35	0.09	0.02	0.35	0.04	5.80
GER	29.50	57.96	5.46	0.36	0.09	0.03	0.88	0.04	0.39	5.30
FR	23.37	6.24	64.01	0.65	0.10	0.22	0.01	0.18	0.02	5.22
UK	14.06	1.24	14.58	58.86	0.63	1.72	0.22	0.24	0.23	8.20
FIN	6.29	1.13	4.03	1.24	84.78	0.12	0.72	0.01	0.34	1.34
NET	23.63	8.40	24.48	2.33	0.20	29.21	0.14	0.05	0.16	11.39
DK	17.95	5.15	9.16	3.30	0.24	1.12	59.12	0.13	0.71	3.12
BEL	25.07	6.00	17.84	0.12	2.06	3.40	2.62	37.21	0.29	5.39
GR	8.99	0.87	1.04	0.05	0.23	0.13	0.79	0.66	84.44	2.80
US	10.66	0.62	8.80	2.63	0.61	0.81	1.54	0.12	0.35	73.86

Crisis period

	SPAIN	GER	FR	UK	FIN	NET	DK	BEL	GR	US
SPAIN	91.27	0.54	0.32	0.27	0.20	0.22	0.07	0.04	0.53	6.54
GER	24.06	59.52	7.96	0.33	2.02	1.00	0.03	0.53	0.75	3.80
FR	25.57	3.43	60.89	0.24	0.08	0.40	2.86	1.59	1.25	3.69
UK	17.05	0.85	9.83	68.76	0.07	0.08	0.83	0.26	0.12	2.15
FIN	6.16	0.52	2.26	0.86	87.50	0.05	0.97	0.03	0.26	1.37
NET	24.51	7.37	10.60	6.80	0.62	42.50	0.89	0.74	0.85	5.12
DK	15.36	1.48	2.67	3.18	2.60	0.54	72.59	0.61	0.09	0.88
BEL	19.71	6.83	7.46	2.70	0.30	2.72	1.15	55.86	0.66	2.61
GR	0.24	0.22	2.75	0.66	0.17	0.29	0.95	0.06	93.91	0.75
US	11.09	1.98	4.27	0.73	0.20	0.06	2.04	0.95	0.69	77.99

[5] The VECM is estimated with the help of Table 8.

Post-crisis period

	SPAIN	GER	FR	UK	FIN	NET	DK	BEL	GR	US
SPAIN	93.08	0.82	1.54	0.20	0.98	0.03	0.69	0.32	0.55	1.79
GER	25.72	57.22	5.69	1.26	1.51	0.94	0.07	0.03	0.43	7.13
FR	28.73	3.56	63.59	0.04	0.07	0.25	0.28	0.31	0.51	2.64
UK	22.66	9.25	10.34	51.00	0.27	0.10	0.07	0.46	0.10	5.74
FIN	7.71	5.42	1.56	1.17	78.75	0.25	0.26	0.01	0.46	4.41
NET	34.77	12.89	7.24	7.24	2.23	28.90	0.33	0.32	0.29	5.78
DK	16.73	7.36	3.27	1.78	2.90	2.89	62.22	0.02	0.42	2.41
BEL	22.27	9.61	13.35	5.60	2.74	5.13	0.28	37.33	0.24	3.45
GR	0.07	2.87	0.26	0.19	1.72	0.71	0.13	0.38	93.44	0.23
US	8.16	0.18	3.74	5.85	0.60	0.91	0.56	0.25	0.03	79.71

If we look at the causal relationship between European and US markets, then it should be noted that even before the crisis, European stock markets are well linked with the US market, but not dominated by the US stock market. Most of lagged US stock returns are as significant in the pre-crisis period as in the post-crisis period. However, lagged error correction term representing the long term behavior turns out insignificant in explaining the short term movement of European stocks during the post-crisis period, which reflects the disappearance of long term bilateral cointegration relations between European and US stocks in the post-crisis period.

Table 10. Temporal Causality Between European and US Stocks

	Pre-crisis period		Crisis period		Post-crisis period	
	Lagged DUS	Lagged ECTs	Lagged DUS	Lagged ECTs	Lagged DUS	Lagged ECTs
DSPAIN	14.59**	5.23**	1.89	6.33**	8.27**	17.88**
DGER	14.02**	5.18**	12.70**	2.23	33.97**	0.79
DFR	12.78**	3.71*	2.88*	6.49**	7.83**	0.53
DUK	18.37**	11.01**	2.49	6.82**	13.52**	0.12
DFIN	1.67	7.91**	6.26**	1.78	11.59**	1.12
DNET	17.63**	14.96**	7.41**	3.55*	20.69**	7.31
DDK	8.92**	1.04	2.55	2.98*	14.61**	0.13
DBEL	10.07**	15.31**	3.70*	3.51*	15.57**	5.39*
DGR	2.12	3.73*	1.16	0.07	0.11	31.36**

Note: Figures in the above table are F statistics testing the null hypothesis that lagged US or lagged ECT are statistically insignificant. *(**) denotes rejection of these hypotheses at 5%(1%) significance level

It seems that the impact of ERM crisis on the stock market integration in Europe is limited. Some long run relationships appeared during the crisis period but soon disappeared.

Why, in the case of Asia, was there a close linkage with US stocks after the currency

crisis whereas, in the case of Europe, this relationship was absent? One of the possible explanations may be found with capital liberalization, particularly foreign equity investment liberalization. In the case of Europe, due to the completion of the Single Market program, all countries had already completely liberalized capital flows before ERM crisis took place in 1993. The crisis worked only as a disruptive factor for already well integrated European markets. However, in many of Asian countries, the control on foreign equity investments was loosened, especially after the breakout of the currency crisis in 1997. For instance, in Japan, the prior notice requirement for portfolio investments by foreigners was abolished in March 31, 1998. In Indonesia, from September 4, 1997, foreign investors were allowed to purchase without limit stocks of non-bank financial firms in the Indonesian capital market. In Korea, the easing of capital market control was most apparent because the limit on foreign ownership of Korean equities was completely abolished during the currency crisis period. In fact, when the currency crisis took place in 1997, the Korean government, having no choice but to accept the IMF program, suddenly expanded the equity investment ceiling up to 55% and completely eliminated it in May 1998. As a consequence, the share of Korean shares owned by foreign investors sharply increased and stock market prices were dominated by foreign investors. It should be noted that the liberalization of foreign equity investment can lead to the strengthening of Asian stock market integration with US market, simultaneously increasing and decreasing the demand for Asian stocks.

5. SUMMARY AND CONCLUSION

This paper examines the impacts of currency crises on the patterns of linkages among national stock markets, and for this purpose, compares the behavior of Asian stock market after the 1997 Asian currency crisis with the behavior of European stock markets after the 1992-93 ERM crisis. This paper methodologically distinguishes the periods after currency crisis between crisis and post-crisis periods and conducts a cointegration analysis for long term relations between stock markets, using level variables (log stock price index), and a VECM for short term stock market behaviors, using difference variables (stock returns).

This analysis tends to indicate that the currency crises in Asia and Europe had a contrasting effect on Asian and European markets. In the case of Asia, a market integration emerges after the elapse of a currency crisis, whereas in the case of Europe, there appears to be a temporary increase in stock market linkage only during the crisis period. Moreover, it turns out that the integration of Asian markets with US market increases significantly after the Asian currency crisis both in the long and short run, whereas the relation of European markets with US market remains very limited throughout the ERM crisis.

These contrasting behaviors of Asian and European stock markets after a crisis seem to result from their different experiences regarding capital liberalization, particularly foreign equity investment liberalization. In the case of Europe, due to the completion of the Single Market program, all countries were able to completely liberalize capital flows before the onset of ERM crisis. The crisis worked only as a disruptive factor for already quite well integrated European markets. However, in many Asian countries, the control on foreign equity investments was loosened, especially after the breakout of the currency crisis in 1997. This explains the emergence of the long and short run close relation between Asian and US markets after the currency crisis.

APPENDIX

		Prices			Returns	
	ADF(3)	ADF(5)	ADF(10)	ADF(3)	ADF(5)	ADF(10)
04/1/1995-30/6/2000						
JAP	-1.96	-2.02	-2.05	-18.10*	-13.54*	-9.25*
KOR	-1.45	-1.41	-1.43	-17.79*	-14.19*	-9.86*
TWN	-1.46	-1.37	-1.54	-16.87*	-13.75*	-9.79*
MAL	-1.29	-1.25	-1.26	-17.21*	-14.61*	-9.58*
SING	-1.36	-1.32	-1.30	-17.94*	-15.03*	-9.93*
PHIL	-1.11	-1.09	-1.21	-16.65*	-13.58*	-9.23*
HK	-1.88	-1.89	-2.12	-16.90*	-14.35*	-9.40*
INDO	-2.07	-2.06	-2.31	-16.90*	-14.36*	-9.19*
THAI	-1.08	-1.05	-0.98	-16.60*	-13.37*	-9.11*
US	-2.05	-2.05	-2.11	-17.83*	-14.82*	-10.15*
02/1/1990-30/12/1995						
SPAIN	-1.62	-1.61	-1.65	-18.48*	-15.62*	-11.08*
GER	-1.72	-1.80	-1.66	-18.71*	-16.54*	-11.93*
FR	-2.61	-2.63	-2.54	-19.00*	-16.27*	-11.80*
UK	-0.43	-0.49	-0.52	-18.24*	-15.81*	-11.71*
FIN	-0.72	-0.84	-0.95	-16.46*	-14.32*	-9.60*
NET	0.31	0.20	-0.01	-18.85*	-15.61*	-10.82*
DK	-1.83	-1.86	-1.87	-19.31*	-16.50*	-11.29*
BEL	-1.07	-1.19	-1.30	-17.84*	-14.65*	-10.27*
GR	-3.21	-3.08	-3.27	-17.91*	-14.70*	-9.68*
US	0.37	0.35	0.44	-20.31*	-17.03*	-12.51*

Note: * means that the hypothesis of a unit root can be rejected at 1% significance level, 1% critical value being –3.439.

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