

## Financial Market Contagion in the Asian Crisis

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*This paper tests for evidence of contagion between the financial markets of Thailand, Malaysia, Indonesia, Korea, and the Philippines. We find that correlations in currency and sovereign spreads increase significantly during the crisis period, whereas the equity market correlations offer mixed evidence. We construct a set of dummy variables using daily news to capture the impact of own-country and cross-border news on the markets. We show that after controlling for own-country news and other fundamentals, there is evidence of cross-border contagion in the currency and equity markets. [JEL F30, F40, G15]*

Following the collapse of the Thai baht's peg on July 2, 1997, the financial markets of East and Southeast Asia—in particular, Thailand, Malaysia, Indonesia, the Philippines, and Korea—headed in a similar, downward direction during late 1997 and early 1998. The regional markets faced increasing pressure in the aftermath of the devaluation of the baht, and this pressure was reflected in the subsequent unraveling of the managed currencies in Malaysia and Indonesia. As the crises became full-blown, intense foreign exchange and stock market turmoil spread in the entire region, culminating in the collapse of the Korean won. News of economic and political distress, particularly bank and corporate fragility, became commonplace in the affected countries, and it appeared as though anything that brought one market down put additional pressure on the other markets as well.

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What was the driving force behind this transmission of shocks from one country to the other? Was it fundamentals driven, or was it a case of irrational, herd mentality displayed by panic-stricken investors? Could the reaction of the markets simply be explained away by their historically close relationships? Finally, did some countries play a larger role in terms of cross-border impact than others? These questions provide the motivation behind this paper. We carry out three sets of analysis to tackle these issues. First, we use correlations and vector autoregressions (VARs) to see the extent of comovement in the markets during the crises. Second, we test whether the correlations in these markets increased significantly during the crises. Finally, we estimate the impact of own-country and cross-border news on selected financial markets of the region.

We use three and a half years of daily data (1995–98) from the five selected countries for our empirical analysis. We first study the correlation between the countries of their respective foreign exchange, equity, interest rate, and sovereign debt markets, examining which markets seemed more affected and postulating why this was the case. We apply a VAR methodology to estimate the impulse responses to shocks in each of the currency and stock markets. This allows us to see if there was indeed significant transmission of pressure in the respective markets, as well as how persistent those shocks were.

Then, we test if the correlations in the various markets increase significantly during the crisis period in comparison to historical, “tranquil” period levels. If there is no significant increase in the correlation, then it is likely that the pressure felt by the markets is more due to some common cause or spillover effects. The policy implication would be to focus on the source of the shock and try to tackle that first. On the other hand, if the increase in correlation is significantly and substantially higher than the historical correlations, then there is reason to suspect that market fundamentals and/or sentiments have shifted, resulting in a different set of market dynamics. In such circumstances, there is an avenue for measures to calm the markets.

Finally, we distinguish between the impact of fundamentals and possible herd behavior on stock markets and exchange rates. But our use of high-frequency daily data limits our capacity to obtain many representations of fundamentals. We remedy this by creating a set of dummy variables to take into account the significant, market-moving news for the respective countries.

The dummy variables serve a dual purpose; they are proxies of own-country fundamentals, as well as a source of contagion for other countries. We estimate the impact of these dummies, as well as other selected fundamentals, on the financial markets through country-by-country regressions. We further our study by analyzing the residuals of these regressions to see the extent of cross-border correlation after controlling for fundamentals.

In addition, we compare the correlation result of our sample countries (the “Asia-5”) against a “control” group. For this purpose, we choose five European countries that were not undergoing any sort of financial crises, and check whether the market variables of the Asian crisis countries behaved differently than their European counterparts. We make our comparisons among the crisis group and the control group, and test for significant changes in correlations within the control group.

## I. Conceptual Discussion of Contagion

The fact that the financial crises in the Asian countries occurred almost at the same time has led to the widespread use of terms like the Asian “flu,” with the implication that this is a case of contagion, where one country’s ill fate transmits to other, vulnerable countries. Use of such terminology, however, tends to obscure several pertinent issues involving simultaneous occurrence of financial crises. The term contagion itself is too broad, as there are several distinct forms of shock that can transfer across borders, each with very different policy implications.<sup>1</sup> Masson (1998) highlights the various concepts of contagion. The simultaneous movement of markets could be explained by common external factors (e.g., a rise in U.S. interest rates or the devaluation of the yen), trade linkage, or third-market competition-related spillovers, or market sentiments. While any of these factors could lead to what is perceived as contagious financial crises, it is crucial to identify which one of them is actually driving the market mayhem. One also needs to take into account whether the presence of a high degree of correlations is sufficient proof of contagion. If markets are historically cross-correlated, then a sharp change in one market will have an expected change in given magnitude in the other markets. If there is no appreciable increase in correlations during the crisis period, then the markets are simply reacting to each other, as dictated by their traditional relationship. The scenario is quite different if the correlations change substantially subsequent to the onset of the crises, in which case one can indeed make the case for contagion. In this section, we analyze the relevance of these various concepts in the context of the Asian crises.

External or “monsoonal” effects, like the rise in German interest rates in 1992 (in the context of the ERM crises) or the U.S. interest rate hike in 1994 (for the Tequila episode), have been widely held to be triggers of contagious currency crises among commonly affected countries.<sup>2</sup> It has been argued that the sustained depreciation of the Japanese yen vis-à-vis the U.S. dollar, beginning in the summer of 1995, was a significant external factor contributing to the pressure faced by Asian markets. This argument is highlighted by the fact that the five most affected countries—Thailand, Malaysia, Indonesia, Korea, and the Philippines—had substantial trade linkages with Japan and the United States (see Table 1). The yen’s depreciation led to real appreciation of the currencies that were predominantly pegged to the U.S. dollar, thus hurting the export sectors of these countries. The declining exports in turn put pressure on the currencies ahead of the 1997 crises. There are, however, several problems with this argument. As argued in Baig (1998) and Chinn (1997), notwithstanding the depreciation of the yen, the real exchange rates of the affected economies (with the exception of Thailand) did not show any clear case of overvaluation relative to their historical movements. Furthermore, there was a substantial time lag between the yen’s depreciation and the onset of the crises in Asia.

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<sup>1</sup>For further work on contagion, see Forbes and Rigobon (1998), Glick and Rose (1998), Kaminsky and Schmukler (1998), Agénor and Aizenman (1998), Valdés (1997), and Sachs, Tornell, and Velasco (1996).

<sup>2</sup>See Masson (1998).

**Table 1. Export Share of the Asia-5 in 1997**  
*(As a percentage of total exports)*

	Thailand	Malaysia	Philippines	Indonesia	Korea	United States	Japan
Thailand	—	4.6	1.2	2.0	1.8	19.8	15.0
Malaysia	3.7	—	1.3	1.5	3.2	18.3	12.4
Philippines	2.4	3.0	—	0.4	1.8	34.7	16.1
Indonesia	1.7	2.4	1.4	—	7.1	16.3	24.7
Korea	2.0	3.1	1.6	2.9	—	16.6	10.6

Source: IMF, *Direction of Trade Statistics Quarterly*.

While trade linkages between countries with geographic proximity can have an impact in explaining spillover effects (see Glick and Rose, 1998, and Eichengreen, Rose, and Wyplosz, 1996), they are not adequate to account for what happened in East Asia. The trade linkages among the five countries in discussion are not very striking (see Table 1). Consider the fact that the financial markets in the region came under severe pressure after the collapse of the Thai baht on July 2, 1997. It is difficult to reconcile the trade linkage argument with the transmission of exchange rate pressure from Thailand to other countries of the Asia-5. The export share to Thailand constituted less than 4 percent of total exports for each of the four countries in discussion, making intracountry trade an unlikely source of pressure on financial markets.

Since the Asia-5 countries exported a large portion of their goods to the United States and Japan, it is tempting to believe that some indirect trade linkage due to third-market competition was instrumental in repeated rounds of competitive devaluation. We do not find much evidence in support of this argument either. The Asia-5 countries do not share very similar third-country export profiles that would amount to severe competitiveness pressures. Going back to the Thai case, even after taking into account bilateral trade and competition in third countries, the importance of Thailand is rather small for the countries concerned.

In addition to external shocks and spillovers, there exists a strand of explanation that looks at the markets from the point of view of global investors. Calvo (1996) argues that emerging markets are susceptible to herd mentality by investors. Since it is too costly for investors to address the state of each economy, it is optimal for them to pull out of a group of related markets simultaneously when they spot signs of nervousness in just one of them. Masson (1998) argues somewhat along the same lines in his explanation of investor psychology in a multiple equilibria framework. Small triggers can be precipitating factors for investors, leading to across-the-board loss of confidence and a higher perceived risk of holding investment in a set of countries. As investors follow each other and pull their money out, the herd behavior pushes these countries to the bad equilibrium of financial distress.

The subsequent sections of this paper empirically test for the existence of possible investor herd behavior in Asia. We use two types of tests. The first verifies if there is a significant increase in correlations between the precrisis and the crisis period. Following Forbes and Rigobon (1998), we use a two-sample or heteroscedastic *t*-test for this purpose. If the correlations have increased significantly, then there are grounds for believing that the markets have moved away from the relationships dictated by traditional movements of fundamentals. On the other hand, if the correlations are not significantly different, then markets are simply reacting to shocks that are common-cause or spillover generated. The hypothesis behind this test is that the correlation between the fundamentals has not increased substantially after the crisis and, therefore, we can assign the increase in comovements to shifts in market sentiments affecting the entire region. We also apply a log-likelihood ratio test for the significance of groupwise correlations. In the second test, we check whether after controlling for own-country news and other fundamentals, there is still an impact of cross-border news on the markets. The assumption is that own-country news and the selected variables capture the essential movements in fundamentals, and that the other-country dummy coefficients capture contagion effects.

In the recent literature on the Asian crises, an alternative interpretation for the contagion was advanced, stating that the spread of the crisis to several Asian countries was the consequence of a “wake-up call” effect. Accordingly, after the collapse of the Thai baht, investors started perceiving other countries differently, interpreting the same fundamentals to be a sign of weaker economies. Since the observed fundamentals have not changed, this paper will not be able to distinguish between the herd behavior and the wake-up call effect. Therefore, one could interpret the results regarding herd behavior in the rest of the paper as possible evidence in favor of the wake-up call effect.

## II. Financial Market Correlations (Evidence and Tests)

### Currency Market Correlations

We begin our analysis by estimating correlation coefficients of the daily change in nominal exchange rates. The sample period begins from the day of the baht devaluation, July 2, 1997, and extends up to May 18, 1998. After calculating the overall correlation in the sample period, we extend our analysis by repeating the exercise for subsamples consisting of three-month windows, and rolling them till the end date. This allows us to take a deeper look at the dynamics of cross-border correlations.

The full sample (see Table 2) shows positive coefficients for all pairs, with seven of ten pairs with correlations of 0.25 or higher. Indonesia’s cross-correlations with the other countries stand out, with correlation coefficients of its daily change in exchange rates with Korea, Malaysia, Philippines, and Thailand being 0.25, 0.36, 0.26, and 0.28, respectively. The other cases of sizable correlations are Malaysia’s with the Philippines and Thailand, 0.28 and 0.35 respectively, and Thailand-Philippines (0.31). It is interesting to note that despite the mayhem associated with the Korean won’s downward plunge between October 1997 and January 1998, the full sample correlation matrix shows barely any influence of the won on regional currencies.

**Table 2. Exchange Rate Correlation**  
*(Full sample and rolling panel with three-month window)*

<b>7/1/1997 to 5/18/1998 (full sample) LR Test: 37.38**</b>				
	Indonesia	Korea	Malaysia	Philippines
Korea	0.25	—	—	—
Malaysia	0.36	0.10	—	—
Philippines	0.26	0.14	0.28	—
Thailand	0.28	0.10	0.35	0.31

  

<b>7/1/1997 to 9/30/1997 LR Test: 5.11</b>		<b>8/1/1997 to 10/31/1997 LR Test: 5.79</b>							
	Indonesia	Korea	Malaysia	Philippines					
Korea	-0.01	—	—	—	Korea	0.05	—	—	—
Malaysia	0.28	-0.10	—	—	Malaysia	0.38	-0.09	—	—
Philippines	0.08	0.10	0.27	—	Philippines	0.12	0.11	0.08	—
Thailand	0.01	-0.12	0.05	-0.22	Thailand	0.04	-0.06	0.22	-0.01

  

<b>9/1/1997 to 11/30/1997 LR Test: 11.66</b>					<b>10/1/1997 to 12/31/1997 LR Test: 18.08*</b>				
	Korea	Malaysia	Philippines	Thailand		Korea	Malaysia	Philippines	Thailand
Korea	0.02	—	—	—	Korea	0.53	—	—	—
Malaysia	0.60	0.03	—	—	Malaysia	0.31	0.05	—	—
Philippines	-0.01	0.09	0.07	—	Philippines	0.30	0.16	0.06	—
Thailand	0.03	-0.10	0.20	0.04	Thailand	0.17	0.14	0.23	0.46

  

<b>11/1/1997 to 1/31/1998 LR Test: 16.81*</b>					<b>12/1/1997 to 2/28/1998 LR Test: 25.08**</b>				
	Korea	Malaysia	Philippines	Thailand		Korea	Malaysia	Philippines	Thailand
Korea	0.28	—	—	—	Korea	0.28	—	—	—
Malaysia	0.12	0.14	—	—	Malaysia	0.31	0.11	—	—
Philippines	0.30	0.20	0.48	—	Philippines	0.39	0.23	0.40	—
Thailand	0.19	0.16	0.36	0.62	Thailand	0.39	0.21	0.58	0.75

  

<b>1/1/1998 to 3/31/1998 LR Test: 26.03**</b>					<b>2/1/1998 to 4/30/1998 LR Test: 26.34**</b>				
	Korea	Malaysia	Philippines	Thailand		Korea	Malaysia	Philippines	Thailand
Korea	0.16	—	—	—	Korea	0.09	—	—	—
Malaysia	0.35	0.22	—	—	Malaysia	0.57	0.04	—	—
Philippines	0.45	0.23	0.53	—	Philippines	0.30	0.02	0.40	—
Thailand	0.49	0.08	0.57	0.63	Thailand	0.45	-0.06	0.51	0.59

Notes: LR test attempts to reject the null that all pairwise correlations are zero. One and two asterisks imply rejection at the 10 percent and 5 percent level, respectively.

The problem with using the full sample is that it smoothes out a lot of shorter duration interactions between the markets. For instance, events in Korea and Indonesia had a substantial impact on the markets for periods of three to four months during certain phases of the crises, but those movements are diminished by the use of the full sample. The rolling correlations alleviate this problem to some extent (see Table 2). It is instructive to note that the correlation between Indonesia and Korea is barely different from zero in the first three months of the crisis. Subsequently, the correlation increases substantially from November onward, as both countries came under severe exchange rate pressure. Korea's correlation with Thailand nearly doubles from late 1997, and similar increases are seen vis-à-vis Malaysia during the first three months of 1998. The rolling correlations also reveal very high volatility in the region. The correlation coefficient between

Thailand and the Philippines goes from  $-0.22$  to  $0.75$  from July–September 1997 to December 1997–February 1998.

The results also reveal that the Indonesian and Malaysian currencies were the most consistently and highly correlated through the sample. Except for isolated sample windows and with the exception of Indonesia, the Korean currency seems to be roughly uncorrelated with the rest of the currencies. Finally, despite being the primary source of the shock that triggered the Asian crises, the Thai baht shows no sign of appreciable correlation with other currencies, with the exception of Malaysia, until the October–December 1997 window. The correlations become noticeably large in December 1997 and the first three months of 1998.

### Stock Market Correlations

The full sample panel with cross-border correlations for changes in stock indices reveals a fairly high level of comovement in the region's equity markets (see Table 3). As with the currency correlations, the Malaysian and the Indonesian markets have the highest degree of correlation. This is perhaps surprising given the fact that the countries do not export more than 1.5 percent of their total exports to each other (see Table 1), and there are significant structural and political differences between the two countries as well as differing levels of financial sector development. The two countries also display sizable positive correlations with the rest of the countries under consideration.<sup>3</sup>

In the rolling correlations, from August 1997 onward, the Malaysian and Thai stock markets demonstrate strikingly high degrees of correlation, up to  $0.70$  in the December 1997–February 1998 window. This mimics their close relationship in the foreign exchange market during the same period. Similarly high degrees of correlations are seen in the Malaysia-Philippines case. Overall, the stock market correlations (both full sample and rolling panel) are larger when compared to the respective correlations in the currency markets. For instance, the Malaysia-Thailand equity returns correlations in various windows are  $0.1$ – $0.2$  greater than the currency market correlation counterparts.

### Interest Rate Correlations

We look at the cross-border correlations of interest rates with some reservations. The overnight call rates used in this exercise may not be comparable given the variation in the way they are set across countries. Besides, interest rates were widely used as tools of monetary policy in all the countries in discussion; thus, the rates reflected the policy stance rather than market-determined levels. During specific periods of severe market mayhem, interest rates were raised to very high levels for a short period to tackle speculative attacks in Indonesia, Malaysia, and the Philippines, resulting in extreme outliers in the data.<sup>4</sup> As they were used as monetary policy instruments, the interest rates are not necessarily reflective of market

<sup>3</sup>With the exception of relatively small correlation between Indonesia and Korea ( $0.09$ ).

<sup>4</sup>For example, in Indonesia overnight interest rates were raised to 91 percent on August 20, 1997.

**Table 3. Stock Index Correlation**  
(Full sample and rolling panel with three-month window)

<b>7/1/1997 to 5/18/1998 (full sample) LR Test: 60.53**</b>				
	Indonesia	Korea	Malaysia	Philippines
Korea	0.09	—	—	—
Malaysia	0.45	0.26	—	—
Philippines	0.44	0.16	0.38	—
Thailand	0.38	0.23	0.39	0.27

  

<b>7/1/1997 to 9/30/1997 LR Test: 13.37</b>		<b>8/1/1997 to 10/31/1997 LR Test: 27.17**</b>							
	Indonesia	Korea	Malaysia	Philippines					
Korea	0.11	—	—	—	Korea	0.23	—	—	—
Malaysia	0.37	0.11	—	—	Malaysia	0.48	0.09	—	—
Philippines	0.43	0.06	0.23	—	Philippines	0.61	0.15	0.35	—
Thailand	0.38	-0.05	0.19	-0.03	Thailand	0.57	0.19	0.40	0.26

  

<b>9/1/1997 to 11/30/1997 LR Test: 23.85**</b>					<b>10/1/1997 to 12/31/1997 LR Test: 21.80**</b>				
Korea	0.07	—	—	—	Korea	0.05	—	—	—
Malaysia	0.52	0.24	—	—	Malaysia	0.46	0.31	—	—
Philippines	0.52	0.15	0.27	—	Philippines	0.47	0.14	0.35	—
Thailand	0.41	0.30	0.35	0.28	Thailand	0.26	0.46	0.33	0.39

  

<b>11/1/1997 to 1/31/1998 LR Test: 27.56**</b>					<b>12/1/1997 to 2/28/1998 LR Test: 29.63**</b>				
Korea	0.02	—	—	—	Korea	0.11	—	—	—
Malaysia	0.51	0.32	—	—	Malaysia	0.50	0.29	—	—
Philippines	0.51	0.18	0.40	—	Philippines	0.48	0.23	0.56	—
Thailand	0.47	0.31	0.55	0.53	Thailand	0.47	0.23	0.70	0.52

  

<b>1/1/1998 to 3/31/1998 LR Test: 36.14**</b>					<b>2/1/1998 to 4/30/1998 LR Test: 17.23**</b>				
Korea	0.13	—	—	—	Korea	0.20	—	—	—
Malaysia	0.48	0.26	—	—	Malaysia	0.09	0.41	—	—
Philippines	0.47	0.27	0.60	—	Philippines	0.03	0.27	0.46	—
Thailand	0.46	0.17	0.69	0.51	Thailand	0.18	0.26	0.51	0.36

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two asterisks imply rejection at the 5 percent level.

forces. As illustrated in Table 9 (p. 180), the interest rate correlations vary widely from pair to pair, with five of the correlations negative and the other five positive. The Indonesia-Korea, Indonesia-Thailand, and Thailand-Malaysia interest rate correlations appear to be consistent with their currency and stock market relationships. Other than these, it is hard to discern much from the results.<sup>5</sup>

### Sovereign Spread Correlations

A superior alternative to domestic interest rates in investigating the market assessment of country risk is the interest rates on foreign currency-denominated debt that is traded

<sup>5</sup>For brevity, we omit the rolling correlations for the interest rates; the results are not very instructive.



**Table 4. Sovereign Spreads Correlation**  
*(Full sample and rolling panel with three-month window)*

<b>7/1/1997 to 5/18/1998 (full sample) LR Test: 538.95**</b>				
	Indonesia	Korea	Malaysia	Philippines
Korea	0.74	—	—	—
Malaysia	0.91	0.69	—	—
Philippines	0.73	0.83	0.59	—
Thailand	0.66	0.82	0.51	0.90

  

<b>7/1/1997 to 9/30/1997 LR Test: 166.13**</b>					<b>8/1/1997 to 10/31/1997 LR Test: 211.44**</b>				
	Indonesia	Korea	Malaysia	Philippines		Indonesia	Korea	Malaysia	Philippines
Korea	0.95	—	—	—	Korea	0.95	—	—	—
Malaysia	0.60	0.60	—	—	Malaysia	0.13	0.17	—	—
Philippines	0.60	0.62	0.52	—	Philippines	0.75	0.89	0.30	—
Thailand	0.92	0.89	0.58	0.76	Thailand	0.92	0.93	0.26	0.87

  

<b>9/1/1997 to 11/30/1997 LR Test: 236.46**</b>					<b>10/1/1997 to 12/31/1997 LR Test: 136.56**</b>				
	Indonesia	Korea	Malaysia	Philippines		Indonesia	Korea	Malaysia	Philippines
Korea	0.92	—	—	—	Korea	0.89	—	—	—
Malaysia	0.50	0.66	—	—	Malaysia	0.66	0.76	—	—
Philippines	0.87	0.95	0.68	—	Philippines	0.60	0.56	0.19	—
Thailand	0.95	0.97	0.62	0.94	Thailand	0.64	0.53	0.18	0.88

  

<b>11/1/1997 to 1/31/1998 LR Test: 78.29**</b>					<b>12/1/1997 to 2/28/1998 LR Test: 58.86**</b>				
	Indonesia	Korea	Malaysia	Philippines		Indonesia	Korea	Malaysia	Philippines
Korea	0.47	—	—	—	Korea	0.09	—	—	—
Malaysia	0.81	0.71	—	—	Malaysia	0.69	0.14	—	—
Philippines	0.29	-0.06	0.15	—	Philippines	0.53	0.50	0.08	—
Thailand	0.65	0.16	0.56	0.46	Thailand	0.56	0.41	0.25	0.70

  

<b>1/1/1998 to 3/31/1998 LR Test: 80.30**</b>					<b>2/1/1998 to 4/30/1998 LR Test: 31.80**</b>				
	Indonesia	Korea	Malaysia	Philippines		Indonesia	Korea	Malaysia	Philippines
Korea	0.19	—	—	—	Korea	0.16	—	—	—
Malaysia	-0.09	-0.54	—	—	Malaysia	0.50	0.06	—	—
Philippines	0.57	0.69	-0.63	—	Philippines	0.16	0.03	-0.42	—
Thailand	0.31	0.88	-0.52	0.78	Thailand	0.42	0.16	0.85	-0.46

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two asterisks imply rejection at the 5 percent level.

in offshore markets. We obtain such rates on selected dollar-denominated debt for the five countries, and then calculate the spread by subtracting the U.S. treasury bill yield with the corresponding maturity. The resulting spreads are proxies for default risk for the respective countries.<sup>6</sup> Details about the data used to construct the spreads are available in the working paper version of this paper, Baig and Goldfajn (1998).

The cross-correlation matrix of the sovereign spreads presents striking results (see Table 4). The cross-country correlations are extremely high, ranging from 0.51 (Malaysia-Thailand) to as high as 0.91 (Indonesia-Malaysia). Previously observed high correlations between Indonesia-Malaysia continue to demonstrate similar results. Even pairs that show relatively small degrees of correlation in the

<sup>6</sup>Although in crisis periods a significant liquidity premium can get incorporated into the spreads as well.

currency and the stock markets, such as Thailand-Philippines, are marked by remarkably high coefficients (0.90 in this case). This extremely high degree of correlation between the spreads indicates that the global investors treated these five countries' financial fragility with a broad stroke by demanding high-risk premiums for all of them during the crisis. The probability of private debt default was perceived to have increased dramatically in all of these countries, and nervousness about one market transmitted readily to other markets.

The rolling correlations reveal salient aspects of the market dynamics. Beginning with the Thai crisis, the cross-border correlations among Korea, Indonesia, and Thailand go up substantially and remain uniformly strong until early 1998.<sup>7</sup> The most striking illustration of this is the September–November window, when the cross-correlations between Korea-Indonesia, Thailand-Indonesia, and Korea-Thailand are 0.92, 0.95, and 0.97, respectively. While the Philippines' stock and currency markets do not show a very high degree of correlation with these three countries, its risk premium appears to be markedly tied to their fortune. From July to December 1997, the Philippines' spreads are strongly correlated with these three countries.

Following the correlations of Malaysia with the rest of the pack reveals that, until early 1998, they were relatively less correlated with the markets in Thailand and the Philippines, while remaining fairly well correlated with Indonesia and Korea. However, as the spreads for the other countries came down and showed some stability, Malaysia's spreads kept rising and persisted at very high levels. In the January–March window, Malaysia's spreads were negatively correlated with all the countries in the sample, ranging from  $-0.09$  with Indonesia to  $-0.63$  with the Philippines. The correlations recovered somewhat in April. It must be noted here though that the negative correlations do not necessarily reflect a comparatively worse financial state in Malaysia. During the last few months of the sample when it appears as though Thailand was recovering while Malaysia remained stuck in financial distress, the latter has consistently commanded relatively lower spreads.

## VAR Analysis

The Asian crises were marked by periods of market mayhem when currencies and stock markets in the region tumbled in waves, with declining markets pushing each other in a circular and mutually reinforcing manner. It is very difficult to isolate the magnitude of shocks that transmitted from one market to the other. To discern the patterns of currency and stock market pressure, we take advantage of the VAR methodology. The methodology is useful in this context as it recognizes the endogeneity of all the variables in the system. It also moves away from our earlier focus on contemporaneous correlations, and allows for the impact of lagged values of the variables. To keep the analysis simple, we do not estimate VARs that include overlapping markets (i.e., incorporating both exchange rates and stock

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<sup>7</sup>When compared with the correlations in June 1997, the Korea-Indonesia, Thailand-Indonesia, and Korea-Thailand correlations increase from 0.56, 0.60, and 0.22 to 0.95, 0.92, and 0.89, respectively, in the July–September window.

market returns on the right-hand side), but rather look at the interactions between the five countries one market at a time. For a given country, the sample starts from the day that country's currency peg unraveled<sup>8</sup> and ends on May 18, 1998.<sup>9</sup> We then run a five-variable VAR for the exchange rates, obtain the estimated impulse response function for the shocks originating from the given country, and then do the same for the stock market data. We choose a lag length of one day, and do not find improvement in our model by including more lags. This exercise was repeated for all five countries, giving us a total of ten impulse responses. By virtue of this, we make use of the data that span a country's financial turmoil phase, and follow the impact of one standard deviation innovation in its currency and stock market on the rest of the markets under study. The issue of ordering the variables for generating the impulse response functions turned out to be inconsequential; changing the ordering did not have any significant impact in the results.

The impulse responses show that shocks originating from Thailand's currency market have a significant impact on the markets of Malaysia, Indonesia, and the Philippines. A depreciation of the baht led to an immediate depreciation of the currencies in these countries. The impact of the shocks tends to disappear after about four days. In the stock market, Thailand's movements had a significant and corresponding reaction from all of the countries in discussion. Details on these results are available in the working paper version of this paper, Baig and Goldfajn (1998).

Of the remaining impulse response functions, Malaysia demonstrates similar results. All four countries responded to shocks in its currency and stock markets with the right sign and significance. Indonesia had the most impact on the markets of Thailand and Malaysia, whereas the evidence of its impact on the Philippines and Korea is weaker. Korea stands out in this exercise as the country that did not react to or have a significant impact on the rest of the countries. The Philippines had only a modest impact on Malaysia and Thailand.

The common element in the impulse response functions is the relatively stronger reaction by the equity markets to shocks in a given country, when compared with corresponding results in the currency markets. This is consistent with our earlier results. However, it must be noted that evidence of strong interactions between markets is not sufficient evidence of contagion. As seen in the next section, despite the higher correlations, stock market dynamics changed relatively less than the currency markets' during the Asian crises.

Tables 5 and 6 summarize the correlations and impulse response results.

### III. Testing for Significant Increase in Correlations

#### Crisis Countries

While the full sample and rolling correlations help us identify the pattern of contagion, they do not tell us whether these correlations are significantly different

<sup>8</sup>In the case of Korea, we chose the day the won began its downward fall.

<sup>9</sup>The sample start dates for Thailand, Malaysia, the Philippines, Indonesia, and Korea were July 2, July 14, July 11, August 14, and November 6, respectively. All sample end dates are May 18, 1998.

**Table 5. Correlations Summary**

Exchange Rates	Stock Markets	Interest Rates	Sovereign Spreads
From October onward, correlations between Indonesia and Korea increase substantially.	The Malaysian and the Indonesian stock markets have the highest degree of correlation among all the pairs.	With the exception of the Philippines, all the countries had positive correlations.	From July to December 1997, the Philippines' spreads are strongly correlated with Thailand, Korea, and Indonesia.
Rolling correlations reveal high volatility.	In general, correlations are greater than the currency markets'.		
Indonesia and Malaysia are consistently correlated.			
In general, the Korean won is uncorrelated with the rest of the countries (exception: Indonesia).			

**Table 6. Impulse Response Summary**  
(Response to one standard deviation innovation)

	Exchange Rates				
	Thailand	Malaysia	Philippines	Korea	Indonesia
Shocks originating from:					
Thailand	—	+	+		+
Malaysia	+	—	+		+
Philippines	+	+	—		
Korea				—	
Indonesia	+	+			—
Stock Markets					
Thailand	—	+	+	+	+
Malaysia	+	—	+		+
Philippines	+	+	—		+
Korea	+			—	
Indonesia	+	+	+		—

Note: Only significant results are reported; we omit the country responses to own shocks.

from market behavior in tranquil times. To address this issue, we apply the two-sample or heteroscedastic *t*-test. For the currency, equity price index, and interest rates, we define the crisis period as the one analyzed above, which is July 2, 1997 to May 18, 1998. For the tranquil phase, we obtain the corresponding data from

Table 7. Exchange Rates

	<b>Crisis Period (7/1/97–5/18/98)</b>		<b>LR Test: 37.38**</b>	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.25***	—	—	—
Malaysia	0.36***	0.10***	—	—
Philippines	0.26***	0.04***	0.28***	—
Thailand	0.28***	0.10***	0.35***	0.31***
	<b>Tranquil Period (1/1/95–12/31/96)</b>		<b>LR Test: 2.84</b>	
Korea	-0.03	—	—	—
Malaysia	0.008	0.05	—	—
Philippines	0.025	-0.03	-0.04	—
Thailand	0.03	-0.003	0.09	-0.05

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two and three asterisks imply rejection at the 5 percent and 1 percent level, respectively, of the null hypothesis that the crisis period is not significantly different from the tranquil period correlation.

January 1, 1995 to December 31, 1996.<sup>10</sup> We run the same cross-correlations, and then test for a significant increase in correlations during the crisis period. The results are presented in Tables 7–10. The crisis period correlations that are greater than the corresponding tranquil period correlation within a 1 percent level of significance are highlighted. Owing to data limitations, we restrict the crisis sample for sovereign spreads from April 11, 1997 to June 30, 1997. While this is a considerably shorter period than the other cases, we believe that it nevertheless captures the market dynamics prior to the crisis.

The tranquil period correlations for the exchange rates in every single pair are barely different from zero. This observation must, however, be seen in the context of the practice of managed exchange rates prior to the crises in all the countries in discussion. In light of the fact that most of the currencies moved very little during the tranquil period, it is hardly surprising that the correlations in the crisis period are significantly greater than every single pairwise correlation in the tranquil period (see Table 7).

The stock market tests, however, paint a different picture. In six out of the ten pairs, the stock market correlations are positive and large. Among the striking correlations, Indonesia-Malaysia, Indonesia-Thailand, and Malaysia-Thailand are most notable, with coefficients of 0.37, 0.32, and 0.41, respectively. Despite historically high levels of correlation, we find evidence that in the cases of Indonesia-Malaysia and Indonesia-Thailand, the correlations were significantly higher in the crisis period (see Table 8). The Philippines showed large correlations with all the countries (except Korea) during both the tranquil and crisis periods, and none of these results

<sup>10</sup>To get a comparative idea about the behavior of the variables during the crisis and tranquil phase, see Baig and Goldfajn (1998).

Table 8. Stock Market Returns

	Crisis Period (7/1/97–5/18/98)		LR Test: 60.53**	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.09***	—	—	—
Malaysia	0.45***	0.26***	—	—
Philippines	0.44	0.16***	0.38	—
Thailand	0.38***	0.23***	0.39	0.27
	Tranquil Period (1/1/95–12/31/96)		LR Test: 111.46**	
	Indonesia	Korea	Malaysia	Philippines
Korea	-0.03	—	—	—
Malaysia	0.37	0.06	—	—
Philippines	0.46	0.02	0.41	—
Thailand	0.32	0.005	0.41	0.30

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two and three asterisks imply rejection at the 5 percent and 1 percent level, respectively, of the null hypothesis that the crisis period is not significantly different from the tranquil period correlation.

Table 9. Interest Rates

	Crisis Period (7/1/97–5/18/98)		LR Test: 64.60**	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.41***	—	—	—
Malaysia	0.07***	0.43***	—	—
Philippines	-0.17	-0.32	-0.06	—
Thailand	0.37***	0.42***	0.27***	-0.25
	Tranquil Period (1/1/95–12/31/96)		LR Test: 54.95**	
	Indonesia	Korea	Malaysia	Philippines
Korea	-0.14	—	—	—
Malaysia	-0.14	-0.10	—	—
Philippines	0.05	-0.12	0.06	—
Thailand	-0.07	0.370	-0.22	0.13

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two and three asterisks imply rejection at the 5 percent and 1 percent level, respectively, of the null hypothesis that the crisis period is not significantly different from the tranquil period correlation.

increase significantly in the latter period. Overall, the evidence for contagion in the stock markets is mixed at best, as the analysis of the tranquil period demonstrated that there was substantial historical comovement in many of the markets.

In the case of the interest rates, with the exception of Korea-Thailand (0.37), there are no cases of noticeable correlations in the tranquil phase (see Table 9). In six out of ten cases, cross-border correlations are significantly greater in the crisis period.

Table 10. Sovereign Spreads

<b>Crisis Period (7/1/97–5/19/98)</b>		<b>LR Test: 538.37**</b>		
	Indonesia	Korea	Malaysia	Philippines
Korea	0.74***	—	—	—
Malaysia	0.91***	0.69***	—	—
Philippines	0.73***	0.83***	0.59***	—
Thailand	0.66***	0.82***	0.51***	0.90***
<b>Tranquil Period (4/11/97–6/30/97)</b>		<b>LR Test: 24.37**</b>		
Korea	0.12	—	—	—
Malaysia	0.47	–0.28	—	—
Philippines	–0.11	–0.32	0.27	—
Thailand	0.18	–0.21	0.48	–0.08

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two and three asterisks imply rejection at the 5 percent and 1 percent level, respectively, of the null hypothesis that the crisis period is not significantly different from the tranquil period correlation.

The tranquil period correlation matrix for the sovereign spreads, despite being limited by the sample size, is instructive (see Table 10). While Indonesia-Malaysia (0.47) and Thailand-Malaysia (0.48) are the only two countries with large correlations in the tranquil phase, all of the pairwise correlations increased significantly and substantially in the crisis phase. Thus, the choice of dividing the samples from the day of the baht devaluation is deemed sensible, as it captures the breaking point in market behavior in all the different variables studied in this section.

In sum, the analysis of the Asia-5 demonstrates that there was a clear case of increased correlations in the currency markets. This result comes with the caveat that the currencies' movements were minimal prior to the crises due to the existence of pegs. The evidence is not very clear in the case of the equity markets and the domestic call rates. The spreads on dollar-denominated debt, representing default risk, display the most striking degree of correlations and evidence of contagion.

### Control Group

In addition to looking at evidence of changes in correlation within the crisis group, we also use a control group of five European countries (United Kingdom, Germany, France, Spain, and Italy). The goal was to see whether the data of the Asia-5 during the crisis period exhibited significantly different behavior than data originating from noncrisis countries during the same period. We concentrate on sovereign spread correlations since these are the strongest results found for the Asia-5 case. The equity and domestic interest rate correlations have less clear results and the currency markets have the problem that in tranquil times currencies were pegged in the Asia-5.

Table 11. Sovereign Spreads (Control Group)

<b>Crisis Period (7/1/97–5/29/98)</b>		<b>LR Test: 774.57**</b>		
	England	France	Germany	Italy
England	—	—	—	—
France	0.13	—	—	—
Germany	0.49	0.91	—	—
Italy	0.90***	0.18	0.54***	—
Spain	0.90***	0.33***	0.66***	0.95
<b>Tranquil Period (7/1/97–5/29/98)</b>		<b>LR Test: 260.06**</b>		
England	—	—	—	—
France	0.43	—	—	—
Germany	0.51	0.94	—	—
Italy	0.60	0.05	0.08	—
Spain	0.62	0.07	0.21	0.88

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two and three asterisks imply rejection at the 5 percent and 1 percent level, respectively, of the null hypothesis that the crisis period is not significantly different from the tranquil period correlation. Details about the sovereign spreads data used for the control group are available from the authors.

The use of sovereign spreads for European developed countries requires explanation. First, we calculated the spreads for the European countries using the same methodology as for the Asia-5 (by taking the difference between yields on sovereign debt and U.S. treasury bill yields of comparable maturity and coupon) to make the comparison uniform. Second, controlling for movements in U.S. interest rates allows us to look at the relative risk of holding such bonds. While the spreads used here include a currency risk portion, within the context of the ERM currency, risk may not be significant during this period. In any case, as shown below, correlations did not change significantly after the Asian crisis.

The sovereign spreads correlations for the control group do not show across-the-board increases in correlation between the defined crisis and tranquil period (see Table 11). Only five pairwise correlations are significantly higher, and of these just two pairs demonstrate jumps in correlations comparable to the Asia-5 case. Since we saw sharp and significant increases in almost all pairwise correlations in the Asia-5 case, the sovereign debt market continued to provide us with the strongest evidence of contagion in the crisis countries.

The results for the equity markets for the control group are less clear.<sup>11</sup> They show that the equity market correlations rose between 1995–96 (tranquil period for the Asia-5) and 1997–98 (Asian crisis). This is in contrast to the Asia-5 equity market results, where the evidence of increase in correlations is mixed at best. Thus, we cannot assert that equity market in the Asia-5 displayed significantly different behavior during the crisis period.

<sup>11</sup>The correlation results for the equity markets are available from the authors upon request.



## IV. Incorporating Dummy Variables

### Dummy Variables

One can define contagion as comovements in financial variables in excess of those that can be explained by comovements of fundamentals. Under this definition, to identify contagion, it is essential to distinguish between fundamentals- and non-fundamentals-driven comovements. Empirically, if after controlling for fundamentals one finds significant comovement among the markets of two countries, then the remaining unexplained correlation may be attributed to contagion (for example, panic or investor sentiment shift).

Significant empirical difficulties exist when implementing this methodology of identifying contagion. Given that most fundamentals are measured infrequently, at least in comparison with the frequency of financial data available, one has to be sure that comprehensive and reliable data are available that represent movements in fundamentals. In general, and in the Asia-5 case in particular, there are no high-frequency variables (e.g., daily data) that can approximate fundamentals in each country. In the absence of such data, one approach is to create a set of daily variables constructed from news reported by the press that could proxy for movements in fundamentals. This approach follows Ganapolsky and Schumkler (1998) and Kaminsky and Schumkler (1998), who attempt to estimate the impact of various news events on market movements. These articles map daily news of a country into a set of dummy variables to quantify the impact of policy announcements and other news on financial markets. We followed this literature and created two series of dummy variables—good and bad news—for each country.

The mapping of fundamentals to news and then to a couple of dummy variables involves an inevitable degree of subjectivity. However, to ensure a rigorous and replicable procedure, we provide below a set of guidelines that we followed. The dummy variables were created by following a strict filtering process.

1. We began by collecting daily financial news for each of the Asia-5 countries. Our sources were the Reuters daily wire and the Bloomberg update. The goal was to separate news that truly represented fundamentals from news that was mostly noise, or an attempt of the news writer to somehow explain the movement in the market in the absence of any major events. We broke down the raw news for each country.
2. For each country, the news was separated into unambiguous “good” and “bad” news categories. Distinction between good and bad news was made by using simple guidelines—credible attempts to restructure the economy were deemed good, whereas any news that represented further deterioration of the financial or real sector was designated as bad. At this point, we had ten lists of raw good and bad news for the five countries under study ready to be filtered. The filtering was done by the following criteria.
3. For *good news*, we ignored the given explanations of why the market did better and instead focused on news that met any of the following criteria:
  - successful formation of bailout arrangements;
  - announcement of a rescue package by international organizations;

- better-than-expected economic news (GDP growth better, inflation lower, etc.); or
  - specific measures to stabilize the markets.
4. For *bad news*, we used news that met any of the following criteria:
    - collapse of the currency regime or of long-standing financial arrangements;
    - breakdown in negotiation with multilateral agencies;
    - large-scale bankruptcy or firm closure;
    - credit rating downgrade;
    - worse than expected announcements about debt exposure, inflation, growth, confusing policy moves;
    - threats or announcement of capital controls imposition;
    - resignation or firing of high-profile officials; or
    - civil unrest.
  5. Using the good and bad news series for each country, we constructed two series of dummy variables. On the dates that there was good (bad) news we placed a number one on the good (bad) news dummy series. Otherwise, we placed a zero on that date.
  6. We avoided typical biases in the presentation of news by the agencies. We ignored typical market commentary statements like “there was widespread pessimism among the traders today.” We also avoided focusing on the actual movement in the financial markets for a given day. We simply included news that fell into any of the above categories instead of finding good news on days the markets went down and vice versa.
  7. News that came out at the end of a business day was dated the following day.
  8. The news was checked across the different sources to verify date and content.

It is important to realize that although some of these pieces of “news” were in some degree expected by the market and, therefore, already factored in the financial variable prices, there always remains some uncertainty that is realized the day the announcement effectively occurs. For example, days when bailout packages are announced or central bank statements are released are well known in advance, but the market nevertheless reacts to them, revealing that there was some degree of uncertainty about whether these announcements were to occur. We therefore included “news” that was partially anticipated. The entire chronology of the selected news is available in Baig and Goldfajn (1998).

The exercise that follows first regresses the financial variables of the countries on their own news and other selected fundamentals and evaluates the correlation of the residuals. The idea is that own news is a proxy for changes in fundamentals, whereas a change in the fortune of another country is a potential source of contagion. Second, we regress for each country its financial variable against all ten dummies (two for each of the five countries) on the right-hand side to evaluate the impact of cross-border news.

## Impact of Own News and Other Fundamentals

In this subsection, we present the results of the impact of own-country news and other fundamentals on the financial markets. In addition to the own-country dummies, we

add two more variables on the right-hand side: the daily stock market return in the S&P 500 and the yen-dollar exchange rate. These two variables are included as additional proxies of fundamentals. The yen-dollar rate also accounts for the monsoonal effect.

Table 12 presents the results of the exchange rate regressions. The results are strong across the board. Own-country bad news had strong downward impact on the exchange rates in all the countries in discussion. Perhaps more interestingly, with the exception of Korea and the Philippines, the other three countries' exchange rates reacted favorably and significantly to good news events. The exchange rate reaction to negative news was 1.7 percent for Malaysia and 2 percent for Thailand. Indonesia's exchange rate, marked by extraordinary volatility even by the standards of the regional mayhem, reacted with greater magnitude in both directions. The bad news dummy coefficient is 0.044, while the good news coefficient estimate is  $-0.059$ . The U.S. stock market had a favorable impact on the currencies of Thailand and Malaysia. The estimates of the impact of the yen-dollar exchange rate are quite strong. Except for Indonesia, each of the four other countries' exchange rates faced pressure whenever the yen depreciated. This is hardly surprising, given their large trade shares with Japan. A 1 percentage point depreciation of the yen brought a 0.35–0.82 percent depreciation of the currencies.

The residuals from these regressions, having controlled for fundamentals, represent another measure of contagion. In Table 13 we present the residual correlations. The results appear to have diminished somewhat from the original correlations observed in Table 2. However, the LR test reveals statistically significant groupwise correlation of the residuals. Thus, despite controlling for fundamentals, the correlations between the currencies remain substantial and significant. Contagion effects persist well above and beyond the identified fundamentals. The evidence also proves that the financial markets correlations are not principally driven by some big news events.

The regression results with the stock prices are also strong (see Table 14). Except for the Philippines, all the other stock markets react significantly, with the right sign, to bad and good news events. In Thailand, Korea, and Indonesia, reactions to bad news were of a greater magnitude than those to good news. All five stock markets in the sample were strongly correlated the U.S. stock market. The yen-dollar rate, on the other hand, was significant only for Korea. The negative coefficient associated with the yen implies that a percentage depreciation of the Japanese currency led to a 0.6 percent decline in the Korean stock market. This result is reinforced by the yen's persistent decline during the entirety of the Asian crises, which put inordinate pressure on the Korean exports industry. After controlling for these variables, the residual correlations (see Table 15) remain relatively high and statistically significant. Once again, own-country news and selected fundamentals do not account adequately for the correlations observed among the regional stock markets.

We extend our analysis to domestic interest rates and sovereign spreads (see Tables 16 to 19). In these regressions, the news dummies do not reveal any consistent patterns. Very few of the regressors are significant, and they often have counterintuitive signs. The regressions fail to explain much of the movements in

**Table 12. Regression Results with Own-Country Dummy and Other Fundamentals**

*(Dependent variable: change in nominal exchange rate)*

	Thailand	Malaysia	Korea	Indonesia	Philippines
Constant	0.001 (0.40)	0.002 (1.08)	0.001 (0.23)	0.004 (0.83)	0.002 (1.17)
Bad news	0.020 (4.13)**	0.017 (3.75)**	0.021 (2.57)**	0.044 (3.71)**	0.043 (3.34)**
Good news	-0.022 (3.37)**	-0.016 (2.40)**	0.001 (0.04)	-0.059 (4.28)**	-0.014 (1.05)
U.S. stock index	-0.248 (2.16)**	-0.226 (1.88)*	-0.238 (1.35)	-0.494 (1.50)	-0.012 (0.11)
Yen/dollar rate	0.375 (2.13)**	0.828 (4.56)**	0.583 (2.26)**	0.657 (1.29)	0.35 (1.95)**
Adjusted $R^2$	0.17	0.21	0.06	0.17	0.07
Number of observations	180	163	162	183	183

Notes: Absolute values of  $t$ -statistics in parentheses. One and two asterisks imply significance at the 10 and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.

**Table 13. Residuals Correlation**

*(from regressions in Table 12)*

	Sample: 7/2/97–5/18/98		LR Test: 16.08*	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.21	—	—	—
Malaysia	0.21	0.11	—	—
Philippines	0.18	0.14	0.20	—
Thailand	0.16	0.12	0.21	0.23

Notes: LR test attempts to reject the null that all pairwise correlations are zero. One asterisk implies rejection at the 10 percent level.

interest rates or spreads. The residual correlations are virtually identical to the raw correlations. The results for the interest rates can be reconciled with our earlier argument that the interest rates used in this exercise are not reflective of market forces. Therefore, we do not expect them to react like other market variables, such as the exchange rate or stock market index. The lack of a consistent result on the sovereign spreads, on the other hand, seems to indicate that the debt market is not driven by fundamentals. This argument is supported by the fact that the raw correlations between the spreads, observed in the previous sections, were very high. This high degree of correlation indicates that the sovereign debt market is more prone to be driven by contagion factors along the lines of Masson (1998). The

**Table 14. Regression Results with Own-Country Dummy and Other Fundamentals**

*(Dependent variable: change in stock market index)*

	Thailand	Malaysia	Korea	Indonesia	Philippines
Constant	-0.001 (0.47)	-0.004 (1.81)*	-0.003 (1.13)	-0.0004 (1.60)	-0.003 (1.45)
Bad news	-0.025 (3.36)**	-0.023 (3.51)**	-0.026 (3.02)**	-0.013 (1.90)*	-0.018 (1.01)
Good news	0.021 (2.21)**	0.053 (5.34)**	0.018 (2.23)**	0.014 (1.81)*	0.013 (0.73)
U.S. stock index	0.493 (2.86)**	0.629 (3.62)**	0.456 (2.37)**	0.725 (3.87)**	0.58 (3.50)**
Yen/dollar rate	-0.208 (0.79)	-0.319 (1.23)	-0.67 (2.36)**	-0.163 (0.56)	0.04 (0.14)
Adjusted $R^2$	0.11	0.26	0.14	0.11	0.06
Number of observations	170	170	172	174	179

Notes: Absolute values of  $t$ -statistics are in parentheses. One and two asterisks imply significance at the 10 percent and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.

**Table 15. Residuals Correlation**

*(from regressions in Table 14)*

	Sample: 7/2/97–5/18/98		LR Test: 34.97**	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.15	—	—	—
Malaysia	0.33	0.21	—	—
Philippines	0.40	0.16	0.27	—
Thailand	0.35	0.17	0.30	0.15

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two asterisks imply rejection at the 5 percent level.

comovements of the spreads are well above anything that can be accounted through changing fundamentals and are possibly due to investor herd behavior.

### Impact of Cross-Border News

Tables 20 through 23 present the results of regressions with the complete set of news dummies on the right-hand side. These regressions were done to quantify the

**Table 16. Regression Results with Own-Country Dummy and Other Fundamentals**

*(Dependent variable: interest rates)*

	Thailand	Malaysia	Korea	Indonesia	Philippines
Constant	17.91 (73.42)**	8.77 (33.91)**	17.33 (40.01)**	33.26 (23.43)**	17.07 (19.98)
Bad news	-1.18 (1.37)	-0.078 (0.10)	2.55 (1.52)	0.774 (0.20)	5.13 (0.63)
Good news	-2.46 (2.13)**	-0.218 (0.17)	4.91 (3.36)**	7.24 (1.57)*	3.05 (0.37)
U.S. stock index	24.25 (1.21)	13.87 (0.65)	-2.05 (0.05)	14.19 (0.12)	122.17 (1.63)
Yen/dollar rate	-8.21 (0.26)	27.28 (0.85)	-21.85 (0.41)	119.68 (0.71)	59.06 (0.52)
Adjusted $R^2$	0.04	0.01	0.05	0.01	0.02
Number of observations	172	177	179	180	182

Notes: Absolute values of  $t$ -statistics in parentheses. One and two asterisks imply significance at 10 and 5 percent levels, respectively. Except for the dummies, all variables are in log first differences.

**Table 17. Residuals Correlation**

*(from regressions in Table 16)*

	Sample: 7/2/97–5/18/98		LR Test: 48.42**	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.37	—	—	—
Malaysia	0.02	0.36	—	—
Philippines	-0.17	-0.29	-0.02	—
Thailand	0.38	0.41	0.26	-0.27

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two asterisks imply rejection at the 5 percent level.

impact of cross-border news on the markets. In addition to the news dummies of the Asia-5, we also include good news and bad news dummies of Japan. This inclusion is interesting given the strong trade linkage and financial ties that Japan has with the countries in discussion. Additionally, during the sample period a large number of news events took place in Japan that had far-reaching implications for the regional markets. The U.S. stock market makes up the last independent variable in this exercise.

The regressions yield interesting results. In addition to own-country dummies being significant, the bad news dummy from Indonesia is significant in the currency market regressions of Thailand, Malaysia, Philippines, and Korea with the expected signs. The evidence reveals that even after controlling for fundamentals,

**Table 18. Regression Results with Own-Country Dummy and Other Fundamentals**

*(Dependent variable: sovereign spreads, in basis points)*

	Thailand	Malaysia	Korea	Indonesia	Philippines
Constant	265.41 (28.37)**	114.62 (15.72)**	235.67 (22.82)	349.15 (18.35)	311.56 (58.09)**
Bad news	-14.69 (0.44)	-12.37 (0.53)	116.93 (3.01)**	93.01 (1.71)*	-15.74 (0.31)
Good news	-47.07 (1.08)	28.02 (0.79)	122.71 (3.56)**	254.43 (4.02)**	-45.76 (0.89)
U.S. stock index	-171.48 (0.22)	278.82 (0.47)	-850.83 (1.01)	37.27 (0.02)	-41.68 (0.09)
Yen/dollar rate	-1183.05 (1.01)	-356.17 (0.39)	-209.29 (0.16)	-1483.74 (0.65)	322.48 (0.46)
Adjusted $R^2$	0.01	0.01	0.08	0.07	0.02
Number of observations	188	184	188	188	188

Notes: Absolute values of  $t$ -statistics are in parentheses. One and two asterisks imply significance at the 10 and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.

**Table 19. Residuals Correlation**

*(from regressions in Table 18)*

	Sample: 7/2/97–5/18/98		LR Test: 415.56**	
	Indonesia	Korea	Malaysia	Philippines
Korea	0.75	—	—	—
Malaysia	0.87	0.67	—	—
Philippines	0.69	0.82	0.58	—
Thailand	0.62	0.80	0.49	0.90

Notes: LR test attempts to reject the null that all pairwise correlations are zero. Two asterisks imply rejection at the 5 percent level.

these markets were significantly affected by bad news coming out of Indonesia. Thailand and Malaysia also reacted favorably to good news coming out of Indonesia. Furthermore, good news from Thailand led to favorable market reaction in Indonesia, and good news from Malaysia helped the Thai baht. In the case of the Philippines, good news from Thailand and bad news from Malaysia had a significant impact. Finally, both the good and bad news dummies for Japan were significant in the Korea regression. The result reinforces our earlier findings, and provides evidence of the immediate impact of Japanese news on the Korean market.

The results from the stock markets are slightly weaker. Malaysia and Indonesia reacted significantly to each other's news, whereas good news originating from

**Table 20. Regression Results Using Across-the-Board Dummy Variables**  
*(Dependent variable: change in exchange rate)*

		Thailand	Korea	Philippines	Malaysia	Indonesia
	Constant	0.001 (0.57)	-0.002 (0.85)	0.002 (1.02)	0.003 (1.34)	0.005 (0.94)
Thailand	Bad news	0.022 (4.58)**	0.004 (0.58)	-0.003 (0.64)	0.011 (1.75)*	-0.013 (0.91)
	Good news	-0.017 (2.67)**	-0.009 (0.87)	-0.016 (2.43)**	-0.009 (1.13)	-0.031 (1.64)*
Korea	Bad news	-0.005 (0.90)	0.041 (4.87)**	0.001 (0.25)	-0.008 (1.42)	-0.006 (0.43)
	Good news	-0.006 (1.22)	-0.004 (0.61)	-0.007 (1.65)*	-0.003 (0.50)	-0.009 (0.68)
Philippines	Bad news	0.028 (2.27)**	0.003 (0.01)	0.041 (3.32)**	-0.004 (0.20)	-0.017 (0.47)
	Good news	-0.009 (0.67)	-0.041 (1.42)	-0.004 (0.28)	-0.005 (0.20)	-0.069 (1.82)*
Malaysia	Bad news	-0.001 (0.24)	-0.007 (0.95)	0.011 (2.16)**	0.015 (2.98)**	0.017 (1.27)
	Good news	-0.008 (2.34)**	0.011 (1.02)	0.0002 (0.34)	-0.017 (2.33)**	-0.012 (0.65)
Indonesia	Bad news	0.008 (2.35)**	0.012 (2.17)**	0.008 (2.16)**	0.006 (4.10)**	0.042 (4.10)**
	Good news	-0.012 (2.54)**	-0.003 (0.47)	-0.007 (1.51)	-0.010 (1.60)	-0.046 (3.45)**
Japan	Bad news	0.001 (0.15)	0.015 (2.66)**	-0.003 (0.75)	-0.001 (0.19)	0.006 (0.59)
	Good news	-0.002 (0.28)	-0.021 (2.55)**	-0.001 (0.08)	-0.002 (0.26)	0.014 (0.78)
Change in U.S. stock index		-0.231 (2.13)**	-0.285 (1.67)*	0.023 (0.21)	-0.244 (1.90)*	-0.62 (1.98)**
Adjusted $R^2$		0.21	0.17	0.13	0.12	0.17
Number of observations		202	181	207	185	207

Notes: Absolute values of  $t$ -statistics are in parentheses. One and two asterisks denote significance at the 10 and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.



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**Table 21. Regression Results Using Across-the-Board Dummy Variables**  
*(Dependent variable: change in stock market index)*

		Thailand	Korea	Philippines	Malaysia	Indonesia
	Constant	0.002 (0.08)	-0.003 (0.91)	-0.001 (0.40)	-0.004 (1.43)	-0.005 (1.78)*
Thailand	Bad news	-0.025 (3.21)**	-0.008 (0.85)	-0.008 (1.10)	-0.001 (0.19)	-0.005 (0.63)
	Good news	0.023 (2.36)**	-0.006 (0.48)	0.022 (2.28)**	-0.001 (0.09)	0.004 (0.31)
Korea	Bad news	-0.009 (1.18)	-0.025 (2.68)**	0.006 (0.90)	-0.011 (1.35)	-0.001 (0.15)
	Good news	0.001 (0.19)	0.025 (2.93)**	-0.003 (0.42)	0.002 (0.28)	0.006 (0.85)
Philippines	Bad news	0.014 (0.74)	0.054 (2.49)**	-0.019 (1.07)	-0.014 (0.73)	-0.024 (1.21)
	Good news	-0.022 (1.14)	0.008 (0.23)	-0.002 (0.12)	0.023 (0.76)	-0.031 (0.94)
Malaysia	Bad news	-0.006 (0.87)	0.005 (0.01)	-0.017 (2.73)**	-0.019 (2.71)**	-0.005 (0.73)
	Good news	0.006 (0.59)	-0.014 (1.23)	0.010 (1.13)	0.051 (5.35)**	0.029 (2.78)**
Indonesia	Bad news	-0.001 (0.60)	-0.006 (0.86)	-0.002 (0.34)	-0.010 (1.86)*	-0.021 (3.33)**
	Good news	0.004 (0.53)	0.004 (0.47)	-0.002 (0.31)	0.014 (1.87)*	0.012 (1.53)
Japan	Bad news	-0.002 (0.33)	-0.001 (0.08)	-0.003 (0.63)	-0.001 (0.09)	0.005 (0.82)
	Good news	0.001 (0.07)	-0.006 (0.62)	0.004 (0.47)	0.007 (0.79)	0.019 (2.06)**
	Change in U.S. stock index	0.524 (3.17)**	0.546 (2.72)**	0.643 (4.16)**	0.596 (3.54)**	0.591 (3.27)**
	Adjusted $R^2$	0.10	0.10	0.11	0.24	0.16
	Number of observations	187	190	201	192	196

Notes: Absolute values of  $t$ -statistics are in parentheses. One and two asterisks denote significance at the 10 and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.

**Table 22. Regression Results Using Across-the-Board Dummy Variables**  
*(Dependent variable: interest rates)*

		Thailand	Korea	Philippines	Malaysia	Indonesia
	Constant	17.25 (60.40)**	16.950 (32.81)**	18.82 (16.99)**	8.32 (29.93)**	33.72 (20.47)**
Thailand	Bad news	-1.340 (1.58)	-2.33 (1.51)	-2.94 (0.91)	-1.28 (1.59)	-4.48 (0.94)
	Good news	-2.18 (1.96)**	-2.11 (1.03)	4.89 (1.13)	-1.32 (1.11)	4.31 (0.66)
Korea	Bad news	0.47 (0.53)	2.83 (1.73)*	-2.25 (0.67)	0.87 (1.03)	-4.35 (0.87)
	Good news	1.58 (1.99)**	4.73 (3.35)**	-5.04 (1.58)	1.41 (0.83*)	1.55 (0.35)
Philippines	Bad news	1.28 (0.62)	-1.49 (0.22)	5.27 (0.64)	9.61 (4.74)**	-11.99 (1.01)
	Good news	0.606 (0.21)	0.75 (0.12)	0.66 (0.07)	1.57 (0.48)	5.41 (0.28)
Malaysia	Bad news	1.81 (2.32)**	-0.16 (0.11)	-2.04 (0.67)	0.14 (0.19)	3.14 (0.71)
	Good news	2.34 (2.11)**	0.69 (0.36)	-5.64 (1.34)	-0.14 (0.13)	2.82 (0.43)
Indonesia	Bad news	1.08 (2.72)*	2.22 (2.01)**	-3.14 (1.32)	1.21 (2.04)**	2.37 (0.68)
	Good news	1.27 (1.64)*	5.21 (3.62)**	-1.56 (0.51)	1.46 (1.89)*	6.31 (1.38)
Japan	Bad news	-0.07 (0.11)	-0.24 (0.21)	0.88 (0.37)	-0.51 (0.85)	-2.97 (0.85)
	Good news	1.06 (1.07)	0.07 (0.04)	-4.72 (1.24)	-0.16 (0.17)	5.09 (0.91)
	Change in U.S. stock index	11.68 (0.63)	1.03 (0.03)	125.69 (1.72)*	19.58 (1.08)	25.38 (0.23)
	Adjusted $R^2$	0.11	0.11	0.12	0.09	0.10
	Number of observations	214	214	214	210	214

Notes: Absolute values of  $t$ -statistics are in parentheses. One and two asterisks denote significance at the 10 and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.

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**Table 23. Regression Results Using Across-the-Board Dummy Variables**  
*(Dependent variable: sovereign spreads)*

		Thailand	Korea	Philippines	Malaysia	Indonesia
	Constant	246.62 (23.25)**	240.510 (18.76)**	302.93 (48.14)**	109.83 (13.39)**	352.81 (16.83)
Thailand	Bad news	-32.580 (1.01)	-46.91 (1.28)	-33.58 (1.76)*	-44.78 (1.83*)	-70.59 (1.11)
	Good news	-61.29 (1.44)	-89.78 (1.75)*	-51.72 (2.05)**	-49.13 (1.41)	-99.54 (1.18)
Korea	Bad news	98.76 (2.99)**	142.23 (3.56)**	66.46 (3.39)**	-1.9 (0.08)	19.47 (0.31)
	Good news	107.22 (3.62)**	110.83 (3.10)**	59.68 (3.40)**	51.45 (2.28)**	162.05 (2.77)**
Philippines	Bad news	-26.73 (0.33)	32.03 (0.33)	-18.36 (0.68)	-82.99 (1.34)	-141.05 (0.88)
	Good news	-91.830 (1.08)	-110.33 (1.07)	-69.4 (1.38)	8.05 (0.12)	-119.17 (0.71)
Malaysia	Bad news	-45.58 (1.53)	-28.28 (0.78)	-18.95 (1.07)	3.66 (0.16)	-22.24 (0.38)
	Good news	0.980 (0.02)	-5.68 (0.11)	5.94 (0.24)	17.14 (0.54)	43.24 (0.53)
Indonesia	Bad news	42.54 (1.82)*	52.23 (1.85)*	20.94 (1.51)	34.43 (1.93)*	84.06 (1.82)*
	Good news	82.22 (2.71)*	95.27 (2.61)**	49.44 (2.75)**	89.06 (3.85)**	251.67 (4.21)**
Japan	Bad news	7.15 (0.30)	-10.15 (0.36)	1.4 (0.11)	17.65 (0.98)	-51.65 (1.11)
	Good news	10.75 (0.29)	-15.19 (0.33)	3.75 (0.17)	26.35 (0.92)	-44.41 (0.60)
Change in U.S. stock index		-120.75 (0.17)	-410.12 (0.48)	77.71 (0.19)	223.24 (0.41)	-189.65 (0.14)
Adjusted $R^2$		0.11	0.11	0.12	0.09	0.10
Number of observations		214	214	214	210	214

Notes: Absolute values of  $t$ -statistics are in parentheses. One and two asterisks denote significance at the 10 and 5 percent level, respectively. Except for the dummies, all variables are in log first differences.

Japan affected the stock market in Indonesia. Good news about Thailand had a significant and positive impact on the market of the Philippines. As seen in the earlier regressions, the U.S. stock market had a significant impact on the regional stock markets. On the other hand, the results from the interest rate and sovereign spreads regressions are again very weak. The findings reconfirm our previous argument.<sup>12</sup>

We do not presume that the news dummies capture all the movements of the fundamental for a given country. Nor do we claim that the news comprises purely exogenous shocks. However, given the lack of variables with daily frequency, they are a valuable source of information about a country's fundamental changes.

## V. Conclusion

The results obtained in this paper suggest discernible patterns of contagion during the East Asian crises. Comparing correlations in tranquil versus crisis periods, we present evidence in favor of substantial contagion in the foreign debt markets, whereas the evidence on stock market contagion is more tentative. In addition, using dummies constructed from daily news, we showed that after controlling for own-country news and a few other fundamentals, the cross-country correlations in the currency and equity markets remain large and significant.

The Asian crises suggest that during a period of financial market instability, market participants tend to move together across a range of countries. Shocks originating from one market readily get transmitted to other markets, thus becoming a source of substantial instability. The evidence of contagion in the foreign debt markets reinforces the view that there was an element of financial panic at the onset of the Asian crises, given the fact that correlations increased substantially during the crises in contrast to the relative stability of the correlation coefficients in the control group.

Despite the inherent constraints associated with high-frequency data, it is crucial to develop methodologies to understand the short-term movements in financial market variables. The policy implications associated with fundamentals-driven and contagion-driven movements are quite different. In the first case, policymakers cannot expect the markets to recover unless measures are taken to improve fundamentals. On the other hand, if markets are declining owing to panic-driven herd behavior, then credible policy actions to soothe the market sentiments ought to be the priority. Correct differentiation between these causes is a key to tackling financial market contagion.

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<sup>12</sup>As a logical extension of our work, we analyze the residual correlations of these cross-country dummy regressions. It is difficult to ascertain the informational content of these residuals. Having controlled for fundamentals and news from other countries, we have accounted for all tangible sources of market factors with daily frequency. The residuals of these regressions may contain unobserved movements of fundamentals, or pure contagion effects, or both. Given the unclear implication of the results, we omit them from this paper. It is worth noting that the exchange rate residual correlations diminish significantly relative to the correlations of own-country dummy regression residuals, whereas the stock market residuals remain fairly strong.

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