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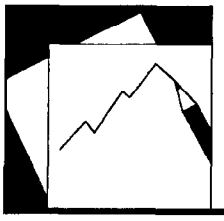

IMF Working Paper

Asian Flu or Wall Street Virus? Price and Volatility Spillovers of the Tech and Non-Tech Sectors in the United States and Asia

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Abstract

This paper, using T-GARCH models, finds that the United States has been the major source of price and volatility spillovers to stock markets in the Asian region during three different periods in the last decade: the pre-Long Term Capital Management crisis period, the "tech bubble" period, and the "stock market correction" period. Hong Kong SAR, Japan, and Singapore also were important spillover sources within the Asian region and affected United States to a lesser degree during the "stock market correction" period. There is also evidence of structural breaks in the stock price and volatility dynamics induced during the "tech bubble" period.

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I. INTRODUCTION

There is a widespread belief among the business and policymaking communities that the financial system has become an increasingly important mechanism for the transmission and amplification of local shocks to the international economy, especially in recent years. This belief is supported by the fact that cross-country correlations between financial variables – in particular, stock markets – increase during periods of market stress.[2] Several arguments have been advanced to explain why stock prices have become more correlated across countries, including the diversification of production across countries by multinationals, easy access to information through the Internet, increased equity issuance and securitization, and the growing importance of the telecommunications, media, and technology (TMT) sector.[3]

Empirical research has found that the importance of global factors in determining stock returns across countries relative to country-specific factors has increased significantly in recent years.[4] In particular, both "new" and "old" economy stocks became especially correlated during the so called tech bubble period—a synchronous rise of TMT stock prices across countries during the period between late 1998 and early 2001, followed by an abrupt correction—while economic fundamentals were not as synchronized. This made some observers to speculate that TMT stocks may have become a new channel of transmitting shocks throughout the world financial markets.

This paper attempts to shed light on the issue by analyzing whether transmission mechanisms differ in the TMT and non-TMT sectors, and whether there were structural breaks in their dynamics. It studies the transmission mechanisms of the conditional first and second moments of daily returns across stock markets in the United States and the Asia-Pacific region across three different periods. The periods under study include the period preceding the rapid increase in stock prices in the technology sector (or the "tech bubble"), the "tech bubble" period, and its aftermath or the price-correction period.[5] We are specially interested in assessing whether price changes and volatility spillovers were generated mainly

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[2] For example, King, Sentana, and Wadhwani (1994) and King and Wadhwani (1990) found that sharp changes in one stock market transmitted quickly to other stock markets during the October 1987 crash.

[3] See *Business Week*, September 11, 2000, and *The Economist*, "Rise and Fall: A Survey of Global Equity Markets," May 5, 2001.

[4] See Baca, Garbe, and Weiss (2000), and Brooks and Catao (2000).

[5] The definition of a bubble in this paper is rather loose and refers to a period characterized by a surge in equity prices. For example, the period from the fourth quarter of 1998 to the first quarter to the first quarter of 200 has been commonly referred to as the "tech bubble" period by the media. For a formal definition of bubble, which is not used here, see Flood and Garber (1982).

from the United States – the *Wall Street Virus* hypothesis – or from Asian countries – the *Asian Flu* hypothesis. The analysis is based on TGARCH models, which directly model the time-varying behavior of expected stock returns and volatility *conditioning* them on all information currently available to investors. These models can capture the asymmetric effect of negative and positive returns on the conditional variance of returns.[6]

The study finds that price change spillovers between the United States and the Asia-Pacific region are asymmetric. U.S. stock markets play an important role in determining the price dynamics in the Asian stock markets regardless of the sector analyzed. China is the only country not affected by the United States. Price spillovers from the Asia-Pacific countries have little or no effect on the U.S. stock markets, especially across TMT stocks. Only during the price correction period did spillovers from Japan, Singapore and Thailand became significant for the U.S. non-TMT stock prices. These findings support the Wall Street Virus hypothesis rather than the Asian Flu hypothesis. One explanation of these findings is that the process of price discovery in the United States is more efficient, and hence, closely monitored and followed in other countries. Another interpretation is that prices in other markets tend to mimic those of the United States, a symptom of herding behavior abroad.[7]

The results also show that at the regional level, the importance of price spillovers from Japan, Hong Kong SAR, and Singapore in determining price returns in other Asia-Pacific stock markets has increased during the price-correction period. Spillover patterns in the TMT and non-TMT sector show substantially different price dynamics with few markets exhibiting the same patterns across sectors. Finally, the relative importance of volatility spillovers compared with price change spillovers is quite small, and in many cases is not significant.

The structure of the rest of the paper is as follows. Section II reviews the related literature. Section III describes the data used in the study. Section IV explains the empirical methodology. Section V presents the results. Section VI concludes.

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[6] Bollerslev, Chou and Kroner (1992) and Bollerslev, Engle and Nelson (1994) provide two excellent surveys on the application of ARCH models in the area of financial econometrics.

[7] This behavior is exemplified by the following quotation: "Asian shares posted broad-based gains... after Wall Street posted its biggest rise in more than six weeks." (Reuters World service, August 27, 2001).

II. Related Literature

There is a substantial amount of theoretical and empirical work on documenting and understanding how stock returns and volatility are transmitted across countries.[8] On the theoretical side, a number of explanations based on the "revision of expectations" have been advanced. For example, King and Wadhawani (1990) argue that mistakes could be transmitted between two markets as domestic traders have to infer information imperfectly from foreign prices. Kodres and Pritsker (1998) suggest that the existence of feedback traders and asymmetric information could lead to the propagation of shocks through portfolio rebalancing effects. Calvo (1999), and Calvo and Mendoza (2000) argue that comovements in stock markets are caused by herd behavior among portfolio managers. The importance of information asymmetries highlighted by the studies cited above is partly supported by survey studies such as Shiller, Konya, and Tsutsui (1991). Other studies argue that technical factors such as margin calls and convergence trades could lead to increased comovements in stock markets, as in Kyle and Xiong (2001), Lagunoff and Schreft (1999), and Schinasi and Smith (2000), among others.

Among empirical studies, the simplest way to evaluate the interrelation of stock returns across different markets is to compare simple correlations in different periods. Examples of this approach are numerous, as exemplified by Hilliard (1979), Eun and Shim (1989), Roll (1988, 1989), Bertero and Mayer (1990), Baig and Goldfjan (1999), and Kumar, Chan-Lau, Richards, and Sloek (2001).[9] This approach, however, has been questioned by Boyer, Gibson and Loretan (1999), Rigobón and Forbes (1998), and Rigobón (2000), among others. These authors point out that even if the data is generated from the same multivariate normal distribution, the sample correlation obtained from a high volatility subsample would be higher than that corresponding to a low volatility subsample. The use of simple correlations, then, would lead to identify structural breaks in the transmission mechanism which are nonexistent.

Other studies have preferred a different empirical approach based on ARCH models and their variants. This approach is supported by the fact that stock price volatility is time-varying and that high volatility episodes are usually characterized by a high correlation of stock market returns. Among these studies, our work is closely related to that of Hamao, Masulis, and Ng (1990). These authors studied price changes and volatility spillovers across the New York, Tokyo, and London stock markets using various univariate GARCH models. They found volatility spillovers only in the period following the October 1987 crash and

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[8] De Bandt and Hartmann (2000) provide a useful survey of the literature, emphasizing the relationship between increased stock market correlation and systemic risk. Jarrow (1998) provides a selected survey of multivariate GARCH models.

[9] The correlations can be obtained either as sample correlations, using simple OLS regressions, or using the exponential smoothing method popularized by RiskMetrics.

identified an asymmetry, since Tokyo was affected by London and New York but did not have any effect on the latter two stock markets. Lin, Engle, and Ito (1994) used a signal extraction model with GARCH processes to analyze spillovers between Tokyo and New York. Once the close-to-close returns were decomposed into daytime and overnight returns, spillovers from Tokyo to New York were detected.

The use of the ARCH methodology to study stock market interdependences has not been limited to univariate models. Booth, Martikainen, and Tse (1997) analyzed the price and volatility spillovers across Scandinavian stock markets using a multivariate EGARCH model and found that Sweden was a major spillover source. Theodossiou, Kahya, Koutmos, and Christophi (1997) estimated a multivariate GARCH model using weekly stock market data to analyze returns spillover in the United States, Japan, and the United Kingdom during the October 1987 stock market crash. In contrast to Hamao, et al., they found that spillovers from Japan to the United Kingdom were significant.

III. DATA

The analysis in this paper uses daily close-of-day (business days) stock market prices in the United States and a number of markets of the Asia-Pacific region including Australia, China, Hong Kong SAR, India, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, Taiwan Province of China and Thailand. Stock market prices correspond to the proprietary indices compiled by Primark DataStream for two sectors: the Telecommunications, Media, and Technology (TMT) sector and the Total Stock Market Excluding the TMT (TXT) sector or non-TMT sector.

The selection of Primark Datastrream TMT and TXT indices is guided by the following considerations. First, the sectoral indices are constructed using the same methodology, which enhances the consistency of the results. Second, these indices are available as fixed-history indices. They are not recalculated historically when constituents change, which enables the effects of dead stocks to be seen on the index. This feature is especially important because the analysis of this paper is concerned with evaluating the aggregate impact of one equity market on the other. Finally, these data are available for a wide range of countries. With the exception of China and India, data is available for every country since January 2, 1990. All indices are expressed in local currency units since the goal of the paper is to analyze the transmission of stock market shocks across countries. Moreover, the use of local currency denominated indices helps to disentangle stock price effects from exchange rate effects.[10]

Data limitations force us to use close-to-close price returns that are calculated as changes in log closing prices, $R_t = lnP_t - ln\ P_{t-1}$. Although the use of close-to-close returns

[10] Hamao, et. al. (1990) report that currency denomination of stock prices would not change results substantially.

may induce spurious cross-autocorrelation between stock markets because of asynchronous trading. However, results by Hamao et. al. (1990) show that correcting for this situation using open-to-close returns, not susceptible to the spurious cross-autocorrelation problem, do not change results significantly.

IV. Empirical Methodology

Generalized Autoregressive Conditional Heterokedastic (GARCH) models are used to analyze stock return and volatility spillovers across the different stock markets described in the previous section.[11] In particular, after some experimentation with model specifications using likelihood ratio (LR) statistics, the MA(1)-TGARCH(1,1) model was chosen because it provided a parsimonious specification that fitted the stock return series for all countries analyzed well.[12] The choice of an asymmetric GARCH specification, TGARCH, was motivated by the apparent asymmetry in conditional volatility responses to negative and positive shocks, present in the stock return data.[13] The MA(1) term was included to capture serial correlation present in stock index returns, following Bollerslev (1987) and French, Schwert, and Stambaugh (1987).[14] While using a single model to fit all stock markets significantly facilitates cross-country comparisons, the results are generally robust to different model specifications that fitted domestic stock return data well.

The following TGARCH(1,1)-MA(1) model was used to test for spillovers in conditional mean and volatility across national stock markets:

$$R_t = \text{constant} + \alpha R_{t-1} + \beta R^f_{t-1} + \theta \varepsilon_{t-1} + \varepsilon_t, \qquad (1)$$

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[11] The GARCH model was first suggested by Bollerslev (1986) as a generalization of the ARCH model developed by Engle (1982).

[12] The TGARCH family of statistical models was first introduced by Zakoian (1994) and Glosten, Jaganathan and Runkle (1993), and is a special case of the Box-Cox transformation of the absolute GARCH (AGARCH) model, as shown by Hentschel (1995).

[13] Black (1976) showed the existence of asymmetric effects (so called leverage effects) on the conditional variance, as negative equity returns are usually followed by larger increases in volatility than equally large positive returns.

[14] Scholes and Williams (1977) and Cohen et. al. (1980) show that nonsynchronous trading in individual stocks, bid-ask spreads, and minimum-price changes can cause serial correlation in stock returns. Hamao et. al. (1990) show that the inclusion of a MA(1) term is sufficient to extract serial correlation from the first moments of stock returns, finding no support for higher-order MA terms.

where the price return in the stock market, R, is a linear function of its 1 day lagged-return, the lagged return on the foreign stock market which is assumed to be the source of spillovers (spillover market), R^f_{t-1}, and the error term, ε_t, that follows a MA(1) process. The foreign return lag is specified so that it accommodates the time differences between the United States and the Asia-Pacific region, and among the countries of the Asia-Pacific region. The conditional variance of the error term, σ^2_t, is given by:

$$\sigma^2_t = \text{constant} + \alpha\varepsilon^2_{t-1} + \gamma\varepsilon^2_{t-1}d_{t-1} + \beta\sigma^2_{t-1} + \lambda X^f_t, \tag{2}$$

where the dummy variable, d_t, is equal to 1 if the error term, ε_t, is positive, and zero otherwise. . The inclusion of the dummy variable allows capturing possible asymmetric effects of good news (positive ε_t) and bad news (negative ε_t). The regressors ε^2_{t-1}, $\varepsilon^2_{t-1}d_{t-1}$, and σ^2_{t-1} are commonly denominated as the GARCH, TARCH, and ARCH component respectively. X^f_t is the volatility surprise from the spillover market, as in equation (1), and is lagged the same number of periods as the corresponding foreign stock return. Because the volatility surprise is an unobserved variable, econometric methods are needed to estimate it. In this paper, we follow the methodology first proposed by Hamao, Masulis, and Ng (1990).

Hamao et. al. (1990) suggest that the volatility surprise term correspond to the squared residual derived from a GARCH model estimated for spillover market without including other countries' variables among the regressors. Hence, in this paper, the volatility surprise term was estimated as the squared residual derived from the following TGARCH(1,1)-M(1) model applied to the daily close-to-close return of the stock price index in the spillover market:

$$R^f_t = \text{constant} + \alpha^f R^f_{t-1} + \theta^f \varepsilon_{ft-1} + \varepsilon_{ft}, \tag{3}$$

$$\sigma^2_t = \text{constant} + \zeta^t \varepsilon^2_{ft-1} + \beta^f \sigma^2_{t-1}. \tag{4}$$

Equation (3) indicates that in any given period the price return, R^f_t, is a function of its lag, the contemporaneous conditional variance, σ^2_t, and a moving average error term. The dynamics of the conditional variance are given by equation (4). To simplify the description of the model, equations (1)-(2) are referred to as a *spillover model*, and equations (3)-(4), as a *base model* throughout the rest of the paper.

The base model was estimated for the three different periods, specified in the introduction: (i) the period prior to the boom in technology stock prices, from January 1, 1990 to August 31, 1998 (called pre-bubble period); (ii) the technology boom period from September 1, 1998 to March 27, 2000 (bubble period); (iii) and the period of rapid technology stock price decline from March 28, 2000 to May 1, 2001 (post-bubble or price-

correction period). The choice of the periods, although rather arbitrary, roughly reflects the pattern of stock price trends across the United States and the Asia-Pacific region.[15] The estimation is performed for the TMT and TXT sectors for each country assumed to be a potential source of spillovers: the United States, Japan, Hong Kong SAR, Singapore, Malaysia, and Thailand. The United States and Japan were included as possible sources of spillovers to the Asian region because of their economic importance, Hong Kong SAR and Singapore because they are important regional financial centers, and Malaysia and Thailand because they were major sources of price and volatility spillovers during the 1997 Asian financial crisis.

For each sector and spillover market, volatility surprise terms were estimated from the base model, and used subsequently in the estimation of the spillover models for the remaining countries in the sample, for the corresponding sector. As in the case of the base model, the spillover models were estimated for the three different periods described above. Wald tests were conducted to evaluate the null hypothesis that spillover coefficients between the following two pairs of periods are the same: (i) technology bubble and pre-bubble periods, (ii) post-bubble and bubble periods, and (iii) post-bubble and pre-bubble. The main results are summarized in the next section.

V. Results

This section analyzes whether the United States, Japan, Hong Kong SAR, Singapore, Malaysia and Thailand were important sources of stock return and volatility spillovers in the Asian region, as well as whether spillovers from the five Asian stock markets above have had a significant impact in the United States stock markets.

Overall, the main results are: (ii) the United States has been the most important source of return spillovers to the Asia-Pacific region during the last ten years, but its relative importance during the post-bubble period has diminished as the importance of the stock markets in Japan, Hong Kong SAR, and Singapore has increased both in the TMT and non-TMT sectors; (iii) Asia-Pacific stock markets have had only a limited impact on the stock market price dynamics experienced in the United States, as there are neither large price changes nor volatility spillovers, regardless of the sector and period analyzed. In fact, the United States stock market has been one of the markets least affected by developments in foreign stock markets for the last ten years, both in the TMT and non-TMT sectors; (iv) generally, spillover patterns in the TMT and non-TMT sector differ across countries; (v) China and the United States are the least affected countries; in addition, Hong Kong SAR, and, especially, Korea have become the least affected countries since the tech-bubble period; and (vi) volatility spillovers are not as important as price change spillovers across all periods, irrespective of a spillover market chosen.

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[15] The results are generally robust to minor changes in the periods definition.

The results are summarized in Tables 1 to 3. Table 1 shows the three most and least affected countries for each of the spillover markets in the TMT and non-TMT sector, for each period. Table 2 presents the average spillover effects for all countries, as well as for the three most and least affected, for each period and for each sector of the stock market. Finally, Table 3 presents the spillover patterns. Tables 4 to 8 present results for individual spillover markets. We proceed to review in detail the results obtained for the United States and the five Asian stock markets selected as a source of spillovers below.

A. United States

Overall, return spillovers in the United States, as measured by the impact of the previous day price returns in the United States on the price return of Asia-Pacific stock markets, are significant in both the TMT and non-TMT sectors (Table 4). The sole exception in the Asia-Pacific region is China, which is not affected by spillovers from the United Sates, for both sectors. In the TMT sector, a one percent change in the stock return in the United States translated in an average 0.25 percent change in returns in the Asian region during the pre-bubble period, a 0.30 percent change in returns during the bubble period, and a 0.23 percent change in returns during the post-bubble period. The corresponding stock return changes for the non-TMT sector are somewhat higher – 0.35 percent, 0.34 percent, and 0.27 percent in the pre-bubble, bubble, and post-bubble periods respectively. On average, the magnitude of spillovers increases significantly during the bubble period in both sectors.

There is significant variation in the magnitude of spillovers across countries. In the TMT sector, average price spillovers in the three most affected countries are 0.34 percent, 0.40 percent, and 0.43 percent in the pre-bubble, tech-bubble and post-bubble periods, respectively. In the three least affected countries they are considerably smaller – 0.11, 0.13, and 0.04 percent in the same periods. The same large variation of spillovers is also observed in the non-TMT sector, where the average price spillovers in the three most affected countries are 0.49, 0.59, and 0.48 percent in the pre-bubble, tech-bubble and post-bubble periods, respectively. In the three least affected countries the spillovers are just about 0.05 percent during all three periods.

Spillovers pattern are also significantly different in the TMT and non-TMT sector in each country. The only exceptions are China, where spillovers were insignificant; New Zealand, where spillovers in the TMT and non-TMT sector decline continuously from the pre-bubble period to the post-bubble period; and Taiwan Province of China, where spillovers in the TMT and non-TMT sector decline during the tech-bubble period but recover in the post-bubble period (see Table 3). In addition, Wald test results indicate that price spillovers return to their pre-bubble levels in Singapore for the TMT sector; and in Malaysia and Thailand for the non-TMT sector.

With respect to volatility spillovers, the results indicate that they become significant in the TMT sector during the tech-bubble period. However, their magnitude is small, and only in Korea they are significantly different from zero. In the non-TMT sector, volatility spillovers tend to be significant in the pre-bubble period but their importance diminishes in

the subsequent periods. No country shows significant volatility spillovers from the United States in more than one period. Finally, the results also indicate that volatility in both the TMT and non-TMT sectors in the United States have been negligibly affected by volatility spillovers from other countries' TMT stock markets.

B. Japan

In the TMT sector, average price spillovers from Japan to other countries in the Asia-Pacific region are lower than those from the United States in the pre-bubble and tech-bubble periods, but become higher in the post-bubble period (see Tables 2 and 5). In the non-TMT sector, average price spillovers are lower than those from the United States only in the pre-bubble period, and roughly the same in the subsequent two periods. However, price spillovers in the three most affected countries are higher than those corresponding to the United States during the bubble and post-bubble period, amounting to 0.64 and 0.54 percent in those periods respectively, compared with only 0.59 and 0.48 percent in the United States,

In contrast to the United States, TMT spillovers from Japan did not increase significantly during the bubble period (i.e. the inverted V-shaped spillovers are not observed, see Table 3). The opposite is true for the non-TMT sector, where inverted V-shaped patterns predominate in 9 out of 13 countries, suggesting a surge in spillovers from the Japanese non-TMT sector during the bubble period. As in the case of the United States, spillover patterns were different between TMT and non-TMT sectors in each country, with the exception of Indonesia, which shows a one time-increase in the bubble period, and the United States, which shows a common V-shaped pattern. Spillovers to China are negative in both sectors, so that positive price changes in Japan are reflected in negative price changes in China.

It is worth noting that while before and during the bubble spillovers from Japan in the non-TMT sectors are higher than in the TMT sector, after the bubble spillovers in the TMT sector become higher than in the other sector.

C. Hong Kong SAR

On average, price change spillovers in both the TMT and non-TMT sectors increase throughout the three periods analyzed (see Table 2). Compared to Japan and the United States, TMT spillovers from Hong Kong SAR have been lower, especially in the price-correction period (see Table 6). Spillovers from the non-TMT sector increased almost twofold on average, from 0.15 percent in the pre-bubble period to 0.28 in post-bubble period. On average, spillovers from the Hong Kong SAR's non-TMT sector to other Asia-Pacific countries have become more important relative to those from the United States and Japan in the post-bubble period.

Price spillover patterns in the TMT and non-TMT sectors in each country are the same only for Korea, which shows an increasing pattern, and Malaysia, which shows a V-shaped pattern (see Table 3). Interestingly, the V-shaped pattern predominated in six of the markets under study, pointing towards a declining influence from the Hong Kong SAR TMT

sector during the bubble period. In contrast, there is no predominant spillover pattern in the non-TMT sector.

D. Singapore

The importance of Singapore as a source of price spillovers in the TMT sector is similar to that of Hong Kong SAR (see Table 2 and Table 7). It should be noted, though, that the magnitude of the spillovers to the three most affected countries have increased relative to that of Hong Kong SAR since the bubble period, and matches the magnitude of spillovers from the United States. In the non-TMT sector, the average price spillover effect from Singapore declined from 0.31 percent in the pre-bubble period to 0.25 percent in the post-bubble period. However, for the three most affected countries, Singapore is the most important source of spillovers in the pre-bubble period, and the second most important one in the bubble and post-bubble periods.

Among the affected countries, only Malaysia showed the same spillover pattern in the TMT and non-TMT sector (increasing pattern, see Table 3). The predominant increasing spillover pattern in the TMT sector suggests a more influential role of Singapore as a regional spillover source that may be explained by the increased importance of information- and computer-related manufacturing activities as a share of Singapore's GDP. The evidence in the non-TMT sector is mixed, as four markets exhibit continuing spillover declines (Australia, Japan, Malaysia and the Philippines) and other five exhibit a V-shaped pattern (Hong Kong SAR, Indonesia, New Zealand, Taiwan Province of China and the United States).

E. Malaysia

The Malaysian stock market is the least important of all the possible TMT spillover sources analyzed in this study so only average results are reported in this paper. Relative to the United States and the Asian markets described above, spillovers effects from the Malaysian TMT sector are roughly equal to one third of the effects from the countries listed above (see Table 2). Spillovers from the TMT sector to the three most affected countries have remained constant during the last ten years, and equal to 0.20 percent. In the non-TMT sector, spillovers recovered to 0.48 percent in the post-bubble period after experiencing a decline from 0.45 percent in the pre-bubble period to 0.23 percent in the bubble period.

Spillovers from the TMT and non-TMT sectors exhibited the same pattern in three countries: Korea (increasing), New Zealand and Singapore (V-shaped) (see Table 3). There was no predominant pattern in the TMT sector, while the predominant spillover pattern in the non-TMT sector is V-shaped (6 countries). This suggests an increasing importance of the Malaysian non-TMT sector in the Asian region, though the magnitude of the spillovers remain low.

F. Thailand

TMT spillovers from Thailand surged dramatically during the last ten years: they doubled from 0.06 percent in the pre-bubble period to 0.12 percent in the bubble period, and then doubled again to 0.26 percent in the post-bubble period (see Table 2 and Table 8). It is worth noting that in the post-bubble period, the magnitude of the Thai TMT spillovers is only surpassed by those from Japan.

Regarding non-TMT sector spillovers, Thailand seems to be one of the least important player. On average, the spillovers never surpassed 0.15 percent. The numbers are two to three times as high when only the three most affected countries are considered. However, the magnitude of the spillovers is still about one half of the other countries analyzed.

The spillovers patterns across the TMT and non-TMT sectors were the same for Hong Kong SAR and Korea (increasing), and India (inverted-V shaped) (see Table 3). The increasing importance of Thai TMT spillovers described in the previous paragraph is also supported by the fact that 9 out of 13 countries exhibited an increasing pattern. In the non-TMT sector, four countries exhibit a V-shaped pattern (Indonesia, Malaysia, Taiwan Province of China, and the United States) while other five countries exhibit an inverted V-shaped pattern (Australia, India, New Zealand, the Philippines and Singapore).

VI. Conclusions

This study contributes to the knowledge of price dynamics in the technology and non-technology sectors of the stock market in the United States and a number of Asian countries, by focusing on price changes and volatility spillovers across countries in both sectors prior to, during, and after the run-up in tech stock prices.

The empirical findings suggests that, when it comes to price change spillovers between the United States and the Asian region, the Wall Street virus is the most important carrier of the "disease" rather than the Asian flu, regardless of stock market sector. The results also point out that spillover mechanisms have experienced structural changes during the periods analyzed, and that spillover patterns in the TMT and non-TMT sectors in each country differ significantly.

In sharp contrast to results in some earlier papers, volatility spillovers do not appear to play an important role, as the volatility surprise term was insignificant in most of the cases. This result is likely driven by allowing for asymmetric effects in the conditional variance Some caution is warranted in deriving policy conclusions from the results, though, as the analysis did not look in detail into particular crisis episodes, such as the 1997 Asian financial crisis or the 1998 Long-Term Capital Management debacle, which took place during the period analyzed.

Table 1: Countries Most And Least Affected By Price Spillover

Panel A: Most Affected Countries 1/

	United States		Japan		Hong Kong SAR		Singapore		Malaysia		Thailand	
	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT
Australia	1,2	1	2	1	3						1	
China												
Hong Kong	1,2,3	1,2,3	1,2,3	1,2,3			2,3	1,2,3	1	1,2,3	2,3	1,2,3
India			1		1		1		1,2		1,2	
Indonesia			3	3			3				3	
Japan	3				2,3				3			
Korea	2,3	2,3	2,3	2,3	2,3	2,3	2,3	2,3	2,3	3	2,3	2,3
Malaysia					1	1	1	1			1	1
New Zealand	1											
Philippines										3		
Singapore		2	1			1,2,3				1,2		2,3
Taiwan		1		1								1
Thailand		3		2	1,2	1,2,3	1,2	1,2,3	1,2,3	1,2		
United States												

1/ 1 = country affected in pre-bubble period, Jan. 2, 1990-Aug. 31, 1998; 2 = country affected in tech-bubble period, Sep. 1, 1998-Mar. 27, 2000; 3 = country affected in post-bubble period, Mar. 28, 2000-May 1, 2001.

Panel B: Least Affected Countries 2/

	United States		Japan		Hong Kong SAR		Singapore		Malaysia		Thailand	
	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT	TMT	Non-TMT
Australia		3		3			2	3		2		3
China	1,2,3	1,2,3	3		1,3	1,2,3	3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Hong Kong									3			
India	3	3		1,3	3	3			3	3	3	
Indonesia	1	1,2	1	1,2			1,2	1,2	1,3	2,3	1	2
Japan											2	
Korea	1	1	1		1	1						
Malaysia	2,3				2	2	2					
New Zealand				2	2	2	1,2		2	1	1	1
Philippines			3				3	3	3			
Singapore	2		2						2			
Taiwan		2							2,3			
Thailand			2									
United States			1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2	1,2,3	1,2,3	1,2,3	1,2,3

2/ 1 = country affected in pre-bubble period, Jan. 2, 1990-Aug. 31, 1998; 2 = country affected in tech-bubble period, Sep. 1, 1998-Mar. 27, 2000; 3 = country affected in post-bubble period, Mar. 28, 2000-May 1, 2001; if more than three countries are reported for any given period, spillovers were insignificant.

Table 2. Price Spillovers in the TMT and non-TMT sectors

TMT Sector
(average price change spillover)

	All countries			Three most affected countries			Three least affected countries		
	Period			Period			Period		
	Pre-bubble	Tech-bubble	Post-bubble	Pre-bubble	Tech-bubble	Post-bubble	Pre-bubble	Tech-bubble	Post-bubble
United States	0.22	0.26	0.23	0.34	0.40	0.43	0.11	0.13	0.04
Japan	0.14	0.16	0.27	0.20	0.36	0.57	0.07	0.00	0.03
Hong Kong SAR	0.14	0.14	0.21	0.24	0.34	0.38	0.03	0.02	0.04
Singapore	0.11	0.09	0.21	0.22	0.21	0.43	0.01	0.00	0.00
Malaysia	0.09	0.08	0.07	0.18	0.21	0.20	0.01	0.00	0.00
Thailand	0.06	0.12	0.26	0.12	0.26	0.49	0.00	0.02	0.08

Non-TMT Sector
(average price change spillover)

	All countries			Three most affected countries			Three least affected countries		
	Period			Period			Period		
	Pre-bubble	Tech-bubble	Post-bubble	Pre-bubble	Tech-bubble	Post-bubble	Pre-bubble	Tech-bubble	Post-bubble
United States	0.30	0.32	0.25	0.49	0.59	0.48	0.05	0.05	0.06
Japan	0.15	0.31	0.24	0.24	0.64	0.54	0.04	0.05	0.16
Hong Kong SAR	0.17	0.23	0.28	0.31	0.53	0.63	0.07	0.00	0.03
Singapore	0.31	0.24	0.25	0.67	0.53	0.60	0.07	0.00	0.03
Malaysia	0.17	0.10	0.20	0.45	0.23	0.48	0.03	0.00	0.00
Thailand	0.11	0.13	0.14	0.19	0.24	0.30	0.03	0.00	0.01

1/ Price spillovers measured as the percentage change in price return corresponding to a one percent change in the price return in the country originating the spillover.

Table 3. Spillover Patterns from the United States, Japan, Hong Kong SAR, Singapore, Malaysia and Thailand

	United States		Japan		Hong Kong	
	TMT	non-TMT	TMT	non-TMT	TMT	non-TMT
Australia	⅂	↓	Γ	Λ	V	↓
China	–	–	V	↓	Λ	⊾
Hong Kong SAR	Γ	Λ	↑	Λ		
India	⅂	Λ	V	Λ	↓	Λ
Indonesia	Γ	⊥	⊥	⊥	⊥	⊥
Japan	⊥	↓			↑	Γ
Korea	↑	Γ	↑	Γ	↑	↑
Malaysia	Λ	⅂	⊥	Λ	V	V
New Zealand	↓	↓	↑	Λ	V	–
Philippines	Λ	Γ	↓	Λ	⊾	↑
Singapore	V	Λ	V	Λ	V	Γ
Taiwan POC	V	V	↑	Λ	⅂	V
Thailand	Λ	⅂	V	Λ	V	Λ
United States			V	V	V	⊾

	Singapore		Malaysia		Thailand	
	TMT	non-TMT	TMT	non-TMT	TMT	non-TMT
Australia	V	↓	⊥	V	V	Λ
China	Λ	–	Γ	Λ	–	–
Hong Kong SAR	↑	V	⅂	V	↑	↑
India	↓	Λ	Λ	↓	Λ	Λ
Indonesia	⊥	V	Λ	–	↑	V
Japan	↑	↓	↑	⊾	↑	Γ
Korea	↑	↑	↑	↑	↑	↑
Malaysia	V	↓			↑	V
New Zealand	⊥	V	V	V	↑	Λ
Philippines	⅂	↓	↓	V	↑	Λ
Singapore			V	V	↑	Λ
Taiwan POC	⊥	V	⊾	↓	↑	V
Thailand	↑	Λ	⅂	V		
United States	⊾	V	⊾	–	⊥	V

Spillover patterns

Λ	inverted v-shaped	⅂	one time decline in post-bubble period
V	v-shaped	Γ	one time increase in tech-bubble period
↑	increasing	⊥	one time increase in post-bubble period
↓	decreasing	–	no change
⊾	one time decline in tech-bubble period		

Table 4. Price and Volatility Spillovers from the United States

	TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Australia						
Price	0.401	0.000	0.301	0.000	0.316	0.000
Volatility	0.007	0.602	0.049	0.173	0.035	0.281
China						
Price	0.305	0.243	0.067	0.222	0.029	0.418
Volatility	-0.124	0.166	-0.007	0.701	0.079	0.006
Hong Kong SAR						
Price	0.361	0.000	0.451	0.000	0.344	0.000
Volatility	0.053	0.072	-0.031	0.126	-0.002	0.696
India						
Price	0.267	0.000	0.330	0.000	0.116	0.009
Volatility	0.118	0.283	-0.100	0.466	-0.003	0.931
Indonesia						
Price	0.213	0.214	0.257	0.000	0.278	0.000
Volatility	-0.305	0.000	-0.009	0.622	-0.007	0.326
Japan						
Price	0.258	0.000	0.260	0.000	0.405	0.000
Volatility	0.009	0.457	-0.003	0.812	0.048	0.117
Korea						
Price	0.148	0.000	0.382	0.000	0.395	0.000
Volatility	0.052	0.082	-0.158	0.000	0.028	0.006
Malaysia						
Price	0.193	0.000	0.209	0.007	0.042	0.401
Volatility	0.031	0.262	0.065	0.408	0.160	0.018
New Zealand						
Price	0.268	0.000	0.206	0.000	0.168	0.000
Volatility	0.041	0.365	0.042	0.192	0.035	0.146
Philippines						
Price	0.243	0.000	0.303	0.000	0.145	0.000
Volatility	0.032	0.219	-0.024	0.778	-0.037	0.000
Singapore						
Price	0.181	0.000	0.162	0.002	0.240	0.000
Volatility	0.002	0.908	0.075	0.114	0.054	0.222
Taiwan POC						
Price	0.238	0.000	0.228	0.000	0.277	0.000
Volatility	0.005	0.863	-0.025	0.589	0.021	0.267
Thailand						
Price	0.168	0.001	0.352	0.000	0.183	0.000
Volatility	-0.014	0.631	-0.187	0.000	0.017	0.073

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 4 (concluded). Price and Volatility Spillovers from the United States 1/

	Non-TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Australia						
Price	0.496	0.000	0.313	0.000	0.166	0.000
Volatility	0.015	0.036	0.006	0.297	0.024	0.249
China						
Price	0.333	0.000	-0.024	0.669	-0.029	0.517
Volatility	-0.416	0.000	0.004	0.473	0.027	0.592
Hong Kong SAR						
Price	0.537	0.000	0.629	0.000	0.515	0.000
Volatility	0.022	0.399	0.007	0.457	0.399	0.001
India						
Price	0.202	0.000	0.339	0.000	0.114	0.408
Volatility	2.479	0.032	0.095	0.285	0.030	0.318
Indonesia						
Price	-0.144	0.099	0.101	0.107	0.220	0.019
Volatility	-0.126	0.000	0.004	0.909	0.037	0.529
Japan						
Price	0.341	0.000	0.324	0.000	0.169	0.014
Volatility	0.010	0.444	0.027	0.084	0.187	0.003
Korea						
Price	0.137	0.001	0.604	0.000	0.478	0.001
Volatility	0.030	0.290	0.164	0.508	0.250	0.326
Malaysia						
Price	0.342	0.000	0.226	0.000	0.203	0.003
Volatility	0.011	0.445	0.013	0.797	0.067	0.490
New Zealand						
Price	0.429	0.000	0.248	0.000	0.187	0.000
Volatility	0.030	0.116	0.018	0.171	0.079	0.035
Philippines						
Price	0.259	0.000	0.290	0.000	0.188	0.646
Volatility	0.060	0.020	0.039	0.235	-0.111	0.575
Singapore						
Price	0.314	0.000	0.491	0.000	0.324	0.000
Volatility	0.018	0.277	-0.005	0.670	0.327	0.002
Taiwan POC						
Price	0.286	0.000	0.196	0.005	0.231	0.005
Volatility	-0.003	0.905	-0.021	0.157	-0.028	0.359
Thailand						
Price	0.379	0.000	0.428	0.000	0.329	0.001
Volatility	0.078	0.066	0.046	0.027	-0.028	0.667

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 5. Price and Volatility Spillovers from Japan 1/

	TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.057	0.000	0.016	0.718	0.139	0.036
Volatility	-0.001	0.784	-0.004	0.725	0.007	0.838
Australia						
Price	0.175	0.000	0.279	0.000	0.358	0.000
Volatility	0.009	0.168	-0.002	0.907	0.070	0.071
China						
Price	0.112	0.161	-0.054	0.352	0.036	0.371
Volatility	0.056	0.740	0.015	0.342	0.028	0.415
Hong Kong SAR						
Price	0.247	0.000	0.410	0.000	0.616	0.000
Volatility	0.010	0.464	0.039	0.207	0.023	0.436
India						
Price	0.213	0.000	0.130	0.079	0.189	0.482
Volatility	0.116	0.194	-0.051	0.159	-0.047	0.817
Indonesia						
Price	-0.028	0.196	0.147	0.032	0.534	0.000
Volatility	-0.126	0.177	0.011	0.874	0.002	0.952
Korea						
Price	-0.003	0.911	0.308	0.002	0.526	0.000
Volatility	0.005	0.656	0.126	0.176	0.157	0.038
Malaysia						
Price	0.170	0.000	0.117	0.028	0.168	0.002
Volatility	0.003	0.799	0.007	0.851	0.055	0.599
New Zealand						
Price	0.122	0.000	0.170	0.000	0.211	0.000
Volatility	0.005	0.658	0.002	0.876	0.078	0.124
Philippines						
Price	0.134	0.000	0.153	0.001	0.214	0.001
Volatility	0.017	0.287	-0.014	0.739	0.313	0.021
Singapore						
Price	0.131	0.000	0.079	0.108	0.250	0.000
Volatility	0.000	0.938	0.071	0.239	0.101	0.165
Taiwan POC						
Price	0.155	0.000	0.199	0.001	0.230	0.000
Volatility	0.005	0.709	0.008	0.850	-0.021	0.395
Thailand						
Price	0.163	0.000	0.256	0.004	0.285	0.000
Volatility	0.011	0.446	0.123	0.314	0.007	0.757

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 5 (concluded). Price and Volatility Spillovers from Japan 1/

	Non-TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.054	0.000	0.047	0.332	0.116	0.048
Volatility	0.000	0.931	0.000	0.983	0.074	0.069
Australia						
Price	0.208	0.000	0.270	0.000	0.146	0.000
Volatility	0.013	0.037	0.037	0.036	0.022	0.085
China						
Price	-0.019	0.700	-0.227	0.006	-0.064	0.105
Volatility	-0.070	0.048	-0.045	0.000	0.042	0.299
Hong Kong SAR						
Price	0.283	0.000	0.637	0.000	0.462	0.000
Volatility	0.017	0.255	0.107	0.141	0.138	0.147
India						
Price	0.104	0.015	0.261	0.006	0.224	0.032
Volatility	-0.025	0.000	0.233	0.092	0.064	0.012
Indonesia						
Price	-0.058	0.205	0.019	0.760	0.305	0.002
Volatility	-0.058	0.000	-0.044	0.279	0.080	0.341
Korea						
Price	0.045	0.114	0.714	0.000	0.811	0.000
Volatility	0.032	0.002	0.126	0.480	0.111	0.579
Malaysia						
Price	0.208	0.000	0.313	0.000	0.217	0.001
Volatility	0.003	0.373	0.118	0.104	0.045	0.513
New Zealand						
Price	0.128	0.000	0.151	0.000	0.088	0.035
Volatility	0.005	0.167	-0.001	0.848	0.063	0.154
Philippines						
Price	0.034	0.108	0.233	0.000	0.403	0.000
Volatility	0.002	0.597	0.115	0.003	-0.035	0.119
Singapore						
Price	0.169	0.000	0.500	0.000	0.288	0.000
Volatility	0.012	0.073	0.045	0.288	0.252	0.031
Taiwan POC						
Price	0.155	0.000	0.272	0.000	0.151	0.033
Volatility	0.019	0.204	-0.018	0.078	-0.027	0.083
Thailand						
Price	0.145	0.000	0.576	0.000	0.231	0.021
Volatility	0.013	0.192	0.345	0.393	-0.022	0.575

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 6. Price and Volatility Spillovers from Hong Kong SAR 1/

	TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.042	0.002	0.047	0.139	0.117	0.022
Volatility	0.002	0.420	0.015	0.058	0.018	0.233
Australia						
Price	0.188	0.000	0.090	0.042	0.255	0.000
Volatility	0.005	0.114	0.014	0.335	0.023	0.038
China						
Price	-0.022	0.686	0.062	0.218	0.087	0.002
Volatility	0.032	0.419	0.107	0.053	-0.009	0.028
India						
Price	0.247	0.000	0.151	0.010	0.141	0.009
Volatility	0.272	0.000	0.002	0.934	-0.009	0.697
Indonesia						
Price	0.048	0.113	0.149	0.006	0.266	0.000
Volatility	-0.001	0.602	-0.012	0.540	0.295	0.001
Japan						
Price	0.146	0.000	0.207	0.000	0.341	0.000
Volatility	0.005	0.097	0.024	0.053	0.013	0.141
Korea						
Price	0.065	0.004	0.400	0.000	0.513	0.000
Volatility	0.009	0.151	0.118	0.047	0.067	0.006
Malaysia						
Price	0.234	0.000	0.151	0.081	0.159	0.001
Volatility	0.060	0.004	-0.020	0.045	0.118	0.023
New Zealand						
Price	0.091	0.000	0.084	0.007	0.126	0.001
Volatility	0.054	0.003	0.004	0.714	0.056	0.013
Philippines						
Price	0.184	0.000	0.162	0.000	0.165	0.006
Volatility	0.017	0.012	0.034	0.319	-0.015	0.411
Singapore						
Price	0.139	0.000	0.104	0.010	0.305	0.000
Volatility	0.014	0.008	0.056	0.014	0.071	0.005
Taiwan						
Price	0.185	0.000	0.096	0.024	0.139	0.010
Volatility	0.018	0.105	0.005	0.683	0.009	0.641
Thailand						
Price	0.235	0.000	0.383	0.000	0.241	0.000
Volatility	0.058	0.000	0.143	0.081	0.007	0.357

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 6 (concluded). Price and Volatility Spillovers from Hong Kong SAR 1/

	Non-TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.054	0.000	0.017	0.635	0.016	0.754
Volatility	0.001	0.573	-0.003	0.525	0.006	0.782
Australia						
Price	0.204	0.000	0.170	0.000	0.108	0.000
Volatility	0.023	0.000	0.005	0.000	0.017	0.261
China						
Price	0.040	0.227	0.023	0.635	0.014	0.702
Volatility	-0.052	0.000	0.139	0.149	0.036	0.101
India						
Price	0.378	0.000	0.356	0.000	0.148	0.104
Volatility	0.024	0.853	0.060	0.279	0.185	0.177
Indonesia						
Price	0.001	0.790	0.095	0.029	0.278	0.000
Volatility	-0.011	0.000	-0.014	0.166	-0.029	0.407
Japan						
Price	0.164	0.000	0.281	0.000	0.287	0.000
Volatility	0.007	0.004	0.008	0.306	0.022	0.202
Korea						
Price	0.094	0.000	0.574	0.000	0.865	0.000
Volatility	0.010	0.087	0.032	0.000	0.294	0.027
Malaysia						
Price	0.320	0.000	0.163	0.001	0.287	0.000
Volatility	0.055	0.000	0.056	0.216	0.031	0.323
New Zealand						
Price	0.112	0.000	0.118	0.000	0.152	0.000
Volatility	0.006	0.057	0.008	0.209	0.007	0.314
Philippines						
Price	0.161	0.000	0.164	0.000	0.557	0.000
Volatility	0.026	0.001	0.095	0.013	-0.018	0.381
Singapore						
Price	0.265	0.000	0.524	0.000	0.534	0.000
Volatility	0.058	0.000	0.063	0.021	0.031	0.283
Taiwan						
Price	0.185	0.000	0.191	0.000	0.313	0.000
Volatility	-0.001	0.715	-0.009	0.097	-0.048	0.156
Thailand						
Price	0.332	0.000	0.560	0.000	0.446	0.000
Volatility	0.053	0.001	0.306	0.091	0.012	0.832

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 7. Price and Volatility Spillovers from Singapore 1/

	TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.037	0.019	0.020	0.645	0.037	0.019
Volatility	0.007	0.003	0.027	0.158	0.007	0.003
Australia						
Price	0.109	0.000	0.113	0.222	0.139	0.003
Volatility	0.000	0.995	-0.036	0.373	0.095	0.028
China						
Price	-0.094	0.097	0.009	0.857	0.001	0.983
Volatility	0.090	0.305	-0.006	0.739	0.010	0.253
Hong Kong SAR						
Price	0.186	0.000	0.212	0.000	0.292	0.000
Volatility	0.025	0.073	0.041	0.310	0.071	0.021
India						
Price	0.144	0.000	0.188	0.024	0.111	0.092
Volatility	0.109	0.009	0.556	0.003	-0.003	0.791
Indonesia						
Price	-0.031	0.344	-0.014	0.810	0.446	0.000
Volatility	-0.008	0.079	0.058	0.325	0.216	0.016
Japan						
Price	0.074	0.000	0.084	0.020	0.233	0.000
Volatility	0.004	0.351	0.003	0.798	0.127	0.067
Korea						
Price	0.025	0.402	0.152	0.080	0.525	0.000
Volatility	0.018	0.077	0.133	0.370	0.626	0.000
Malaysia						
Price	0.182	0.000	0.016	0.808	0.242	0.000
Volatility	-0.001	0.878	0.166	0.008	0.124	0.058
New Zealand						
Price	0.042	0.015	0.057	0.142	0.145	0.001
Volatility	-0.009	0.193	0.028	0.328	0.039	0.097
Philippines						
Price	0.128	0.000	0.103	0.030	0.015	0.730
Volatility	0.006	0.346	0.075	0.341	0.053	0.038
Taiwan POC						
Price	0.112	0.001	0.088	0.138	0.244	0.000
Volatility	-0.001	0.920	0.076	0.383	0.004	0.709
Thailand						
Price	0.179	0.000	0.193	0.040	0.252	0.000
Volatility	0.002	0.877	0.829	0.031	0.143	0.011

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 7 (concluded). Price and Volatility Spillovers from Singapore 1/

	Non-TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.069	0.000	0.023	0.478	0.143	0.008
Volatility	0.001	0.366	0.000	0.885	0.059	0.063
Australia						
Price	0.289	0.000	0.149	0.000	0.087	0.001
Volatility	0.058	0.000	-0.001	0.356	0.029	0.025
China						
Price	-0.052	0.402	0.039	0.326	0.004	0.928
Volatility	-0.014	0.094	-0.028	0.000	0.034	0.015
Hong Kong SAR						
Price	0.660	0.000	0.549	0.000	0.577	0.000
Volatility	0.059	0.004	0.002	0.740	0.076	0.001
India						
Price	0.519	0.000	0.378	0.000	0.231	0.014
Volatility	0.020	0.860	0.225	0.013	0.049	0.304
Indonesia						
Price	0.123	0.058	0.053	0.124	0.260	0.001
Volatility	-0.027	0.000	-0.018	0.007	-0.009	0.760
Japan						
Price	0.275	0.000	0.225	0.000	0.211	0.000
Volatility	0.020	0.014	0.005	0.517	0.048	0.057
Korea						
Price	0.190	0.000	0.521	0.000	0.777	0.000
Volatility	0.029	0.021	0.219	0.075	0.177	0.152
Malaysia						
Price	0.758	0.000	0.228	0.000	0.229	0.000
Volatility	0.066	0.000	0.053	0.081	0.029	0.001
New Zealand						
Price	0.202	0.000	0.115	0.000	0.128	0.000
Volatility	0.019	0.029	0.005	0.320	0.068	0.003
Philippines						
Price	0.330	0.000	0.206	0.000	0.029	0.673
Volatility	0.043	0.001	0.087	0.004	0.346	0.410
Taiwan POC						
Price	0.276	0.000	0.226	0.000	0.236	0.000
Volatility	-0.001	0.432	0.000	0.935	-0.014	0.242
Thailand						
Price	0.612	0.000	0.637	0.000	0.479	0.000
Volatility	0.104	0.003	0.246	0.036	-0.015	0.620

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 8. Price and Volatility Spillovers from Thailand 1/

	TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.010	0.203	0.019	0.492	0.092	0.185
Volatility	0.001	0.112	0.013	0.003	0.002	0.893
Australia						
Price	0.068	0.000	0.048	0.014	0.165	0.000
Volatility	0.000	0.622	0.010	0.300	0.086	0.009
China						
Price	-0.010	0.255	0.050	0.054	0.009	0.834
Volatility	-0.012	0.000	-0.002	0.642	0.016	0.015
Hong Kong SAR						
Price	0.099	0.000	0.221	0.000	0.412	0.000
Volatility	0.032	0.000	0.001	0.858	0.033	0.035
India						
Price	0.150	0.000	0.260	0.000	0.210	0.006
Volatility	0.061	0.001	0.162	0.009	0.065	0.379
Indonesia						
Price	0.012	0.524	0.087	0.005	0.433	0.000
Volatility	0.005	0.191	-0.026	0.000	-0.025	0.072
Japan						
Price	0.052	0.000	0.064	0.036	0.313	0.000
Volatility	0.004	0.010	0.002	0.786	0.003	0.839
Korea						
Price	0.051	0.001	0.306	0.000	0.544	0.000
Volatility	-0.001	0.662	0.050	0.289	0.107	0.257
Malaysia						
Price	0.117	0.000	0.119	0.001	0.212	0.003
Volatility	0.013	0.021	0.023	0.278	0.017	0.042
New Zealand						
Price	0.020	0.105	0.070	0.007	0.188	0.000
Volatility	0.012	0.023	0.015	0.077	0.041	0.257
Philippines						
Price	0.097	0.000	0.151	0.000	0.263	0.018
Volatility	0.051	0.001	0.018	0.216	0.195	0.127
Singapore						
Price	0.062	0.000	0.093	0.002	0.203	0.008
Volatility	0.000	0.774	0.031	0.009	0.285	0.112
Taiwan POC						
Price	0.072	0.000	0.097	0.017	0.365	0.000
Volatility	0.004	0.169	0.022	0.052	0.022	0.340

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

Table 8 (concluded). Price and Volatility Spillovers from Thailand 1/

	Non-TMT Sector					
	1/1/1990-8/31/1998		9/1/1998-3/27/2000		3/28/2000-5/1/2001	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
United States						
Price	0.033	0.000	0.023	0.254	0.014	0.620
Volatility	0.001	0.111	0.003	0.219	-0.005	0.320
Australia						
Price	0.084	0.000	0.098	0.000	0.036	0.041
Volatility	0.017	0.000	0.004	0.062	0.011	0.452
China						
Price	0.021	0.554	0.021	0.389	0.009	0.752
Volatility	-0.086	0.000	-0.002	0.493	0.025	0.202
Hong Kong SAR						
Price	0.211	0.000	0.246	0.000	0.254	0.000
Volatility	0.051	0.000	-0.002	0.509	0.068	0.113
India						
Price	0.329	0.000	0.204	0.000	0.074	0.230
Volatility	0.005	0.934	0.045	0.155	0.035	0.000
Indonesia						
Price	0.098	0.003	0.017	0.563	0.046	0.379
Volatility	-0.019	0.000	0.007	0.464	0.000	0.996
Japan						
Price	0.074	0.000	0.118	0.000	0.082	0.010
Volatility	0.006	0.007	0.016	0.048	-0.002	0.674
Korea						
Price	0.092	0.000	0.359	0.000	0.450	0.000
Volatility	0.010	0.012	0.023	0.510	0.247	0.020
Malaysia						
Price	0.185	0.000	0.106	0.001	0.146	0.000
Volatility	0.018	0.048	0.017	0.215	0.032	0.562
New Zealand						
Price	0.054	0.000	0.085	0.000	0.053	0.007
Volatility	0.002	0.112	0.004	0.006	-0.002	0.375
Philippines						
Price	0.109	0.000	0.120	0.000	0.253	0.005
Volatility	0.042	0.000	0.031	0.046	0.053	0.312
Singapore						
Price	0.158	0.000	0.262	0.000	0.237	0.000
Volatility	0.030	0.000	0.041	0.012	0.071	0.158
Taiwan POC						
Price	0.103	0.000	0.059	0.055	0.181	0.000
Volatility	-0.001	0.393	0.001	0.787	-0.007	0.706

1/ The price coefficient corresponds to the foreign country's stock market return; the volatility coefficient corresponds to the foreign country's volatility surprise.

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