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# The Impact of the U.S. and the Japanese Equity Markets on the Emerging Asia-Pacific Equity Markets

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**Abstract.** Using a tri-variate vector autoregression model, we study the relationships between the four Asian emerging equity markets: Hong Kong, Korea, Singapore and Taiwan, and the two largest equity markets in the world: U.S. and Japan. We find that while most of the unexpected variations in stock returns in these Asian emerging markets is explained by domestic own shocks, the impacts from the U.S. and Japan are larger in Hong Kong and Singapore than in Korea and Taiwan. This foreign effect is pronounced after the Crash of the October 1987, especially in Singapore.

**Key words:** Asia-Pacific equity markets, Vector Autoregressive Model.

## 1. Introduction

A considerable amount of work has been done on the interrelationships between national equity markets. For example, one of the major themes of modern portfolio theory concerns the merits of international diversification, i.e., it pays to diversify internationally, as long as stock returns in different national markets are less than perfectly correlated with a domestic market. The benefit of international portfolio diversification has been well documented by Grubel (1973), Levy and Sarnat (1970) and Solnik (1974). Some of the work examines the benefit of diversifying into emerging markets, see for example, Lessard (1973) and Errunza (1977, 1983). There is another body of literature which documents the comovement of world exchange indices, see for example, Granger and Morgenstern (1970), Grubel and Fadner (1971), Ripley (1973), Joy et al. (1976), Makridakis and Wheelwright (1974), Panton et al. (1976), Maldonado and Saunders (1981), and Philippatos et al. (1983).

Another body of the literature is to study the volatility spillover effect from among national stock markets. For example, Hamao, Masulis and Ng (1990) study the stock markets of the U.S., Japan and the U.K., using an Autoregressive Condi-

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tional Heteroskedastic (ARCH) family of statistical models on daily opening and closing prices. Some evidence is provided for spillovers of volatility from New York to other markets, but not in the opposite directions. Lin, Engle and Ito (1991), however, argue that volatility spillovers between the U.S. and Japan become symmetric when the problem of stale quotes or nonsynchronous trading in opening prices is explicitly taken into account. A similar approach is taken in Ng, Chang and Chow (1990) where volatility spillovers from the U.S. to the Pacific Basin countries are found. Bae and Cheung (1998) find that the spillover effects from the U.S. to Hong Kong have become more prominent after the October 1987 crash.

There is an increasing interest in examining the relationships between national equity markets after the Crash of October 1987. The predominant feature of the Crash was its global scale. The equity markets of the world reacted to the collapse of the Dow Jones index of the New York Stock Exchange with their own version of a crash. Malliaris and Urrutia (1992) analyze the lead-lag relationships for six major market indices before and after the Crash and argue that there is no lead-lag relationships for the sample period from May, 1987 to March, 1988. The Crash of October 1987 has, however, made people realize that various national equity markets are so integrated that the developed markets, especially the larger markets (e.g., the U.S. market), exert a strong influence on other smaller markets. In this context, Eun and Shim (1989) use vector autoregression to study the interdependence among world equity markets and find evidence of comovements among these markets with the U.S. market playing the leading role. By using a single-equation model, Cheung and Mak (1992) examine the causal relationships between the Asian markets and the developed markets. They also find that the U.S. market is a *global* factor.

On the other hand, while the above studies indicate that the U.S. market is the most influential in the world, it is premature to conclude that investors who invest in Asian markets can completely ignore the price movement of the Japanese equity market. Being the largest market in Asia, its price movement may have an important impact on the other smaller Asian markets. Cheung (1994) examines the impact of price movement of the Japanese market on the intraday Hong Kong stock returns and find that the Hong Kong stock prices react rapidly to the return information of the Japanese market. The objective of this paper is to empirically investigate the impact of the U.S. and the Japanese markets on the Asian emerging markets (AEMs) by using a tri-variate vector autoregression (VAR) model. The VAR model is particularly well suited for our purpose since it avoids the problems inherent in the single-equation method while it provides the best econometric evidence to examine the relative importance of the two major markets on the emerging markets.

The emerging markets which we analyze in this paper are those of the four little tigers: Stock Exchange of Hong Kong (SEHK) for Hong Kong, Korean Stock Exchange (KSE) for Korea, Stock Exchange of Singapore (SES) for Singapore, and Taiwanese Stock Exchange (TSE) for Taiwan. In terms of market capitalization, these are the largest Asian markets next to the Japanese market. Table I presents a brief description of the four emerging markets as well as the U.S. and the Japanese markets. All four AEMs have a huge growth potential and have already attracted a large amount of international investment. This is evidenced by the increasing number of international funds which have an explicit policy of investing their funds in these markets.[1]

We find that unexpected shocks in the U.S. market contributed significantly to explaining the unpredicted variation in stock returns for the SEHK and the SES after the crash of October 1987, but not for the KSE and the TSE. On the other hand, unexpected shocks in the Japanese market had no explanatory power for the variation in the stock returns of these AEMs except for the KSE before the crash of October 1987.

The rest of the paper is organized as follows: Sections 2 and 3 describe the data and the methodology employed, respectively. Section 4 presents the empirical results. Section 5 concludes the paper.

## 2. Data

This study includes the Hang Seng Index for the SEHK, the Composite Stock Index for the KSE, the Strait Times Index for the SES, and the Weighted Index for the TSE. For the U.S. and the Japanese markets, we use the Dow Jones Industrial Average Index and the Nekkei 225 Index. Then, stock returns are computed as the percentage log difference of the Wednesday closing price. Weekly indices are used because a representation bias due to some thinly traded stocks, i.e., the problem of nonsynchronous trading, is reduced with a weekly interval of the indices. Also, by choosing the Wednesday price, the seasonal pattern of the stock returns can be avoided.[2]

The data covers the period from March, 1975 to September, 1992. To examine the stability of the result, we divide the whole sample period into three subperiods: March 15, 1975–December 29, 1979 (Period I), January 5, 1980–October 10, 1987 (Period II), and October 31, 1987–September 5, 1992 (Period III). As is clear, the Crash of October 1987 divides Periods II and III. The period October 11–October 29, 1987 is excluded from the sample.

To examine the stationarity of the series, we apply the Augmented Dickey-Fuller test of the null hypothesis that a unit root exists in the autoregressive representation of the series.[3] The values of $\hat{\tau}$, $\hat{\tau}_\mu$ and $\hat{\tau}_\tau$ statistics are insignificant at the five percent level and do not reject the null hypothesis of the presence of a unit root. We also report the unit root test for the first difference of four stock indices in the lower part of Table II. The result indicates that the values of $\hat{\tau}$, $\hat{\tau}_\mu$ and $\hat{\tau}_\tau$ are significant at the five percent level, rejecting the null hypothesis of the existence of a unit root; and the first difference series are stationarity. The results are shown in Table II.

*Table I.* Description of the U.S., the Japanese, and the four emerging Asian markets (as of December 31, 1991)

| Country | U.S. | Japan | Hong Kong | Korea | Singapore | Taiwan |
|---|---|---|---|---|---|---|
| Exchange | New York Stock Exchange | Tokyo Stock Exchange | Stock Exchange of Hong Kong | Korean Stock Exchange | Stock Exchange of Singapore | Taiwanese Stock Exchange |
| Market capitalization (millions) | U.S.$3,712,835 | U.S.$2,982,828 | U.S.$121,189 | U.S.$98,182 | U.S.$155,394 | U.S.$121,528 |
| Trading values of equity shares | U.S.$1,520,164 | U.S.$879,385 | U.S.$38,536 | U.S.$85,285 | U.S.$17,195 | U.S.$369,570 |
| No. of listed companies | | | | | | |
| Domestic | 1780 | 1641 | 333 | 686 | 157 | 221 |
| Foreign | 105 | 125 | 24 | 0 | 156 | 0 |
| No. of listed stocks | 2426 | 1775 | 386 | 1013 | n.a. | 234 |

Source: *Fact Book 1991*, The Stock Exchange of Hong Kong, Ltd., 1992.

*Table II.* Univariate unit root tests, five Asian emerging equity indices, 1981–1992

| | HKG | KOR | SIn | TWN | ΔHKG | ΔKOR | ΔSIN | ΔTWN |
|---|---|---|---|---|---|---|---|---|
| $k = 3$ | | | | | | | | |
| $\hat{T}$ | 0.75 | 1.45 | 0.65 | 1.07 | –12.25[a] | –11.62[a] | –10.93[a] | –11.11[a] |
| $\hat{T}_\mu$ | –0.60 | –0.52 | –1.63 | –0.88 | –12.29[a] | –11.63[a] | –10.95[a] | –11.11[a] |
| $\hat{T}_T$ | –2.85 | –1.35 | –2.72 | –1.79 | –12.35[a] | –11.67[a] | –10.95[a] | –11.13[a] |

$k$ is the number of lags being chosen in the unit root test. To test for the existence of a unit root (i.e., nonstationary), we apply the Augmented Dickey-Fuller (ADF) test with a constant term, and a constant term ($\mu$) with a time trend ($T$). The values reported in Table I are the $t$-statistics of the parameter $\rho$ for the variables $X_t$ in the following test equations:

$$\Delta X_t = \rho X_{t-1} + \Sigma\phi_i \Delta X_{t-i} + v_t,\ i = 1, \ldots, k$$
$$\Delta X_t = \mu + \rho X_{t-1} + \Sigma\phi_i \Delta X_{t-i} + v_t,\ i = 1, \ldots, k$$
$$\Delta X_t = \mu + T + \rho X_{t-1} + \Sigma\phi_i \Delta X_{t-i} + v_t,\ i = 1, \ldots, k$$

where Δ is the first difference operator. A significant value of $\rho$ will reject the null hypothesis that a unit root exists, i.e., $I(1)$ and in favor of the alternative hypothesis of stationarity, i.e., $I(0)$.

[a] Indicates significance at the 5% level. The critical value with sample size of 500 is –1.94 (–1.61) for $\tau$, –2.86 (–2.56) for $\tau_\mu$ (with constant term) and –3.42 (–3.13) for $\tau_\tau$ (with constant and trend) at 5% (10%). See Dickey-Fuller (1979 and 1981).

Various lag lengths have been tried and examined. Similar results are obtained. When the unit root test is applied to each subperiod, i.e., January 1981–September 1987 and November 1987–December 1991, consistent results are also found.

*Table III.* Sample statistics of return rates

| | U.S. | Japan | Hong Kong | Korea | Singapore | Taiwan |
|---|---|---|---|---|---|---|
| *Whole sample period: 75/3/15–92/9/5* | | | | | | |
| Mean | 0.159 | 0.157 | 0.317 | 0.218 | 0.179 | 0.303 |
| Standard deviation | 2.196 | 2.570 | 3.936 | 2.879 | 3.045 | 4.696 |
| *Period I: 75/3/15–79/12/29* | | | | | | |
| Mean | 0.031 | 0.210 | 0.412 | 0.164 | 0.193 | 0.294 |
| Standard deviation | 2.083 | 1.606 | 3.325 | 2.329 | 1.859 | 3.596 |
| *Period II: 80/1/5–87/10/10* | | | | | | |
| Mean | 0.264 | 0.312 | 0.361 | 0.372 | 0.293 | 0.466 |
| Standard deviation | 2.089 | 2.588 | 4.211 | 2.742 | 2.841 | 3.233 |
| *Period III: 87/10/31–92/9/5* | | | | | | |
| Mean | 0.225 | –0.077 | 0.347 | 0.033 | 0.222 | 0.150 |
| Standard deviation | 2.119 | 3.136 | 3.292 | 3.522 | 3.014 | 6.965 |

Table III provides some descriptive statistics for the data. In Table III, it is interesting to see that all four AEMs have higher mean returns and also higher level of risk than the Japanese and the U.S. markets for the whole sample period. This is also true for each subperiod except for Singapore in Periods I and III. Another interesting observation is that the mean return is negative for the Japanese market after the Crash.[4]

## 3. Methodology

In general, an $m$-th order VAR model for an $n \times 1$ vector $Y$ is written as

$$Y_t = D + \sum_{j=1}^{m} B_j Y_{t-j} + e_t, \qquad t = 1, \ldots, T \tag{1}$$

where $D$ is an $n \times 1$ deterministic part and $e$ is an $n \times 1$ serially uncorrelated residual term with $E[e_t] = 0$ and $\mathrm{Var}[e_t] = \Sigma < \infty$.[5] The residual $e_t$ is said to be the *innovation* of $Y_t$ in that it is the component in $Y_t$ which cannot be predicted from past values of variables in the system.[6]

For each of the four Asian markets, a tri-variate VAR was constructed including the stock return series in the U.S. market, the Japanese market, and for the relevant AEM. A constant term was used for the deterministic part. We estimated the tri-variate VAR model with four lags for the three subperiods.[7] Then, using the estimated residuals for each series, the corresponding moving average representation (MAR) was constructed as

$$Y_t = F + \sum_{s=0}^{\infty} A_s e_{t-s}\,, \tag{2}$$

where $F$ is the corresponding deterministic part.

In this paper, we used the MAR in two ways. First, we decomposed the unexpected variations in the AEM's return rate among the U.S., the Japanese, and the AEM's own domestic innovations (variance decomposition). With the MAR (2), the $k$-step ahead forecast error of $Y$ at time $t - k$ becomes

$$A_0 e_t + A_1 e_{t-1} + \cdots + A_{k-1} e_{t-k+1} = \sum_{s=0}^{k-1} A_s e_{t-s}\,. \tag{3}$$

We computed the variance of this $k$-step ahead forecast error of the AEM's return rate and decomposed it into the U.S., the Japanese, and the own domestic innovations. By numerically measuring the relative contribution of the U.S. and the Japanese shocks on variations in stock returns in each AEM, variance decomposition provides the best econometric evidence of the relative importance of the U.S. and the Japanese markets to the AEMs.[8]

Second, we computed the dynamic responses of the AEM's return rate to random shocks in the U.S., the Japanese, and the AEM market (impulse response functions). By tracing out the coefficients of the MAR, we computed the dynamic responses of the stock returns in each AEM to the U.S. and the Japanese innovations up to 10 steps. These impulse responses investigate how unexpected movements in the U.S. and the Japanese return rates change the return rates in the emerging markets through time.[9]

## 4. Empirical Results

Table IV decomposes forecast error variance of the AEM's return rate up to 10 weeks. The explanatory power of each innovation is measured as a percentage so that the horizontal sum of each row is 100.

Table IV shows that, the stock returns in all four AEMs are clearly exogenous in that most of forecast error variance of the return rates in these markets are explained by domestic own innovations. There is, however, a clear distinction among countries. For the four little tigers, domestic innovations have more explanatory power in Korea and Taiwan than in Hong Kong and Singapore. In Korea, domestic shocks are responsible for more than 95% of the variations in the Korean stock return rate for the Periods I and III. The portion attributed to the domestic innovations drops slightly to 86% for Period II apparently due to the impact of Japanese innovations which explain almost 12% of the unexpected movement in Korean stock returns. This may be explained by the bull market started in Japanese market during the 1980s and bear market began at the beginning of 1990s. This is interesting in that an important Japanese influence is not present in the other three countries for any subperiod.

The strong explanatory power of domestic innovations and the negligible contribution of U.S. and Japanese innovations is also apparent in Taiwan. For the whole sample period, domestic innovations explain more than 91% of the variation in Taiwanese stock return rate. Unlike Korea, domestic innovations have stronger explanatory power for Period II than for Periods I and III.

In Hong Kong and Singapore, the dominance of domestic shocks can still be found, but to a much lesser degree than in Korea and Taiwan. In Hong Kong, the relative share of Japanese innovations is very low for the whole sample period. However, U.S. innovations explain more than 8% of the variation in the Hong Kong return rate for Periods I and II, and the impact of the U.S. increases noticeably after the Crash up to 16%.

Among the four Asian markets, the Singapore market is the one that is most affected by U.S. and Japanese shocks. After the Crash, more than 28% of the variation in the Singapore stock returns is explained by U.S. innovations. Japanese innovations also contribute more than 10% of the variation. These impacts from the U.S. and Japan are the highest of all four AEMs. Even before the Crash, U.S. innovations explain about 13% and 9% of the unexpected movement in Singapore

*Table IV.* Standard error and percentage of $k$-step ahead forecast error variance of each Asian market's return accounted for by the U.S., the Japanese, and domestic innovations

| $k$ | Standard error | U.S. | Japan | Hong Kong |
|---|---|---|---|---|
| HONG KONG | | | | |
| *Period I: 75/3/15–79/12/29* | | | | |
| 1 | 2.95785 | 6.32 | 1.82 | 91.87 |
| 2 | 2.99827 | 7.09 | 2.19 | 90.73 |
| 3 | 3.01132 | 7.65 | 2.36 | 89.99 |
| 4 | 3.02788 | 8.39 | 2.39 | 89.22 |
| 5 | 3.04637 | 8.43 | 2.42 | 89.16 |
| 6 | 3.04698 | 8.44 | 2.43 | 89.14 |
| 7 | 3.04720 | 8.44 | 2.43 | 89.13 |
| 8 | 3.04766 | 8.44 | 2.43 | 89.13 |
| 9 | 3.04804 | 8.45 | 2.43 | 89.12 |
| 10 | 3.04807 | 8.45 | 2.43 | 89.12 |
| *Period II: 80/1/5–87/10/10* | | | | |
| 1 | 4.14477 | 6.35 | 0.12 | 93.53 |
| 2 | 4.15734 | 6.42 | 0.28 | 93.30 |
| 3 | 4.19715 | 6.52 | 0.35 | 93.13 |
| 4 | 4.20121 | 6.51 | 0.36 | 93.13 |
| 5 | 4.20988 | 6.49 | 0.37 | 93.14 |
| 6 | 4.20999 | 6.49 | 0.37 | 93.14 |
| 7 | 4.21077 | 6.49 | 0.37 | 93.13 |
| 8 | 4.21099 | 6.49 | 0.37 | 93.13 |
| 9 | 4.21102 | 6.49 | 0.37 | 93.13 |
| 10 | 4.21103 | 6.49 | 0.37 | 93.13 |
| *Period III: 87/10/31–92/9/5* | | | | |
| 1 | 3.06445 | 16.49 | 2.59 | 80.92 |
| 2 | 3.08161 | 16.87 | 2.68 | 80.45 |
| 3 | 3.08711 | 16.81 | 2.68 | 80.52 |
| 4 | 3.09717 | 16.71 | 3.10 | 80.18 |
| 5 | 3.10391 | 16.81 | 3.13 | 80.07 |
| 6 | 3.10463 | 16.84 | 3.13 | 80.03 |
| 7 | 3.10520 | 16.84 | 3.16 | 80.00 |
| 8 | 3.10581 | 16.85 | 3.17 | 79.98 |
| 9 | 3.10587 | 16.85 | 3.17 | 79.98 |
| 10 | 3.10589 | 16.85 | 3.17 | 79.98 |

*Table IV. (Continued)*

| *k* | Standard error | U.S. | Japan | Hong Kong |
|---|---|---|---|---|
| KOREA | | | | |
| *Period I: 75/3/15–79/12/29* | | | | |
| 1 | 2.25994 | 0.01 | 0.77 | 99.22 |
| 2 | 2.28186 | 0.24 | 2.12 | 97.65 |
| 3 | 2.30337 | 0.30 | 3.84 | 95.85 |
| 4 | 2.31865 | 0.55 | 3.80 | 95.65 |
| 5 | 2.32858 | 0.77 | 4.28 | 94.95 |
| 6 | 2.32868 | 0.77 | 4.28 | 94.95 |
| 7 | 2.32923 | 0.81 | 4.28 | 94.90 |
| 8 | 2.32926 | 0.82 | 4.28 | 94.90 |
| 9 | 2.32938 | 0.82 | 4.28 | 94.89 |
| 10 | 2.32939 | 0.83 | 4.28 | 94.89 |
| *Period II: 80/1/5–87/10/10* | | | | |
| 1 | 2.57735 | 0.01 | 7.74 | 92.24 |
| 2 | 2.65223 | 0.93 | 11.95 | 87.12 |
| 3 | 2.65659 | 0.93 | 12.04 | 87.03 |
| 4 | 2.66670 | 1.02 | 12.38 | 86.61 |
| 5 | 2.67417 | 1.30 | 12.40 | 86.30 |
| 6 | 2.67540 | 1.39 | 12.39 | 86.22 |
| 7 | 2.67578 | 1.39 | 12.39 | 86.22 |
| 8 | 2.67617 | 1.42 | 12.38 | 86.20 |
| 9 | 2.67623 | 1.42 | 12.38 | 86.20 |
| 10 | 2.67625 | 1.42 | 12.38 | 86.20 |
| *Period III: 87/10/31–92/9/5* | | | | |
| 1 | 3.44829 | 1.78 | 1.53 | 96.69 |
| 2 | 3.48089 | 1.76 | 2.40 | 95.84 |
| 3 | 3.50623 | 1.77 | 2.97 | 95.26 |
| 4 | 3.51875 | 1.76 | 2.95 | 95.29 |
| 5 | 3.53306 | 1.79 | 2.95 | 95.27 |
| 6 | 3.53361 | 1.79 | 2.95 | 95.26 |
| 7 | 3.53479 | 1.80 | 2.98 | 95.22 |
| 8 | 3.53520 | 1.80 | 2.98 | 95.22 |
| 9 | 3.53530 | 1.81 | 2.98 | 95.22 |
| 10 | 3.53531 | 1.81 | 2.98 | 95.22 |

*Table IV. (Continued)*

| *k* | Standard error | U.S. | Japan | Hong Kong |
|---|---|---|---|---|
| SINGAPORE | | | | |
| *Period I: 75/3/15–79/12/29* | | | | |
| 1 | 1.62592 | 5.39 | 0.30 | 94.31 |
| 2 | 1.69907 | 9.66 | 0.84 | 89.49 |
| 3 | 1.72455 | 11.85 | 0.98 | 87.17 |
| 4 | 1.74604 | 13.12 | 1.67 | 85.21 |
| 5 | 1.75847 | 13.14 | 1.68 | 85.18 |
| 6 | 1.75959 | 13.15 | 1.68 | 85.18 |
| 7 | 1.76032 | 13.18 | 1.68 | 85.14 |
| 8 | 1.76121 | 13.23 | 1.70 | 85.07 |
| 9 | 1.76142 | 13.23 | 1.70 | 85.06 |
| 10 | 1.76144 | 13.24 | 1.70 | 85.06 |
| *Period II: 80/1/5–87/10/10* | | | | |
| 1 | 2.75333 | 6.74 | 0.00 | 93.25 |
| 2 | 2.81085 | 9.51 | 0.59 | 89.90 |
| 3 | 2.81706 | 9.73 | 0.59 | 89.67 |
| 4 | 2.82891 | 9.77 | 0.79 | 89.44 |
| 5 | 2.83809 | 9.72 | 0.79 | 89.49 |
| 6 | 2.83869 | 9.72 | 0.80 | 89.48 |
| 7 | 8.83877 | 9.72 | 0.80 | 89.48 |
| 8 | 2.83899 | 9.73 | 0.80 | 89.47 |
| 9 | 2.83908 | 9.72 | 0.80 | 89.48 |
| 10 | 2.83908 | 9.72 | 0.80 | 89.48 |
| *Period III: 87/10/31–92/9/5* | | | | |
| 1 | 2.79051 | 28.23 | 7.58 | 64.19 |
| 2 | 2.83795 | 28.79 | 9.14 | 62.07 |
| 3 | 2.85244 | 28.70 | 9.85 | 61.45 |
| 4 | 2.86462 | 28.47 | 10.12 | 61.46 |
| 5 | 2.87509 | 28.49 | 10.55 | 60.96 |
| 6 | 2.87854 | 28.59 | 10.58 | 60.83 |
| 7 | 2.87882 | 28.59 | 10.59 | 60.82 |
| 8 | 2.87898 | 28.59 | 10.59 | 60.82 |
| 9 | 2.87922 | 28.59 | 10.59 | 60.82 |
| 10 | 2.87926 | 28.59 | 10.59 | 60.82 |

*Table IV.* *(Continued)*

| *k* | Standard error | U.S. | Japan | Hong Kong |
|---|---|---|---|---|
| TAIWAN | | | | |
| *Period I: 75/3/15–79/12/29* | | | | |
| 1 | 3.44690 | 2.64 | 3.02 | 94.34 |
| 2 | 3.49770 | 3.71 | 3.06 | 93.23 |
| 3 | 3.54729 | 4.67 | 3.46 | 91.87 |
| 4 | 3.54962 | 4.76 | 3.46 | 91.78 |
| 5 | 3.55679 | 4.77 | 3.51 | 91.73 |
| 6 | 3.55757 | 4.79 | 3.51 | 91.70 |
| 7 | 3.55855 | 4.81 | 3.52 | 91.68 |
| 8 | 3.55858 | 4.81 | 3.52 | 91.68 |
| 9 | 3.55864 | 4.81 | 3.52 | 91.67 |
| 10 | 3.55865 | 4.81 | 3.52 | 91.67 |
| *Period II: 80/1/5–87/10/10* | | | | |
| 1 | 3.04672 | 2.65 | 0.08 | 97.28 |
| 2 | 3.09130 | 3.47 | 0.21 | 96.32 |
| 3 | 3.11216 | 3.50 | 1.39 | 95.11 |
| 4 | 3.13377 | 4.10 | 1.53 | 94.37 |
| 5 | 3.23360 | 3.95 | 2.14 | 93.91 |
| 6 | 3.24175 | 3.98 | 2.14 | 93.88 |
| 7 | 3.24249 | 3.99 | 2.17 | 93.84 |
| 8 | 3.24637 | 4.06 | 2.17 | 93.77 |
| 9 | 3.25192 | 4.05 | 2.18 | 93.77 |
| 10 | 3.25267 | 4.05 | 2.19 | 93.77 |
| *Period III: 87/10/31–92/9/5* | | | | |
| 1 | 6.74767 | 1.80 | 2.06 | 96.14 |
| 2 | 6.81113 | 2.69 | 2.50 | 94.81 |
| 3 | 6.83964 | 2.87 | 2.64 | 94.49 |
| 4 | 6.86935 | 3.17 | 3.15 | 93.68 |
| 5 | 6.88834 | 3.68 | 3.14 | 93.18 |
| 6 | 6.88993 | 3.68 | 3.18 | 93.14 |
| 7 | 6.89025 | 3.68 | 3.18 | 93.13 |
| 8 | 6.89113 | 3.68 | 3.20 | 93.12 |
| 9 | 6.89142 | 3.69 | 3.20 | 93.11 |
| 10 | 6.89155 | 3.69 | 3.20 | 93.11 |

*Table V.* Minimum and maximum values of responses

| | Period I | | Period II | | Period III | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| *Responses to the U.S. innovations* | | | | | | |
| Hong Kong | –0.035 | 0.743 | –0.197 | 1.045 | –0.060 | 1.244 |
| Korea | –0.109 | 0.118 | –0.081 | 0.254 | –0.072 | 0.460 |
| Singapore | –0.043 | 0.377 | –0.098 | 0.715 | –0.119 | 1.483 |
| Taiwan | –0.109 | 0.560 | –0.085 | 0.496 | –0.503 | 0.906 |
| *Responses to the Japanese innovations* | | | | | | |
| Hong Kong | –0.132 | 0.400 | –0.142 | 0.170 | –0.206 | 0.494 |
| Korea | –0.306 | 0.266 | –0.571 | 0.717 | –0.053 | 0.426 |
| Singapore | –0.028 | 0.148 | –0.216 | 0.018 | –0.382 | 0.768 |
| Taiwan | –0.247 | 0.599 | –0.338 | 0.124 | –0.088 | 0.967 |
| *Responses to domestic innovations* | | | | | | |
| Hong Kong | –0.307 | 2.835 | –0.264 | 4.008 | –0.149 | 2.757 |
| Korea | –0.238 | 2.251 | –0.008 | 2.475 | –0.339 | 3.391 |
| Singapore | –0.190 | 1.579 | –0.004 | 2.659 | –0.198 | 2.236 |
| Taiwan | –0.006 | 3.348 | –0.019 | 3.005 | –0.079 | 6.616 |

stock returns for Periods I and II, respectively. However, Japanese innovations have no explanatory power during the before-Crash periods.[10]

We have also examined impulse responses for the AEMs' return rates to a positive one-standard deviation shock in the U.S., the Japanese, and the domestic return rates. This measure how the AEMs respond to shocks. The responses are computed up to 10 weeks and drawn using the same scale. Table V also presents the minimum and the maximum values of the responses. On the other hand, the U.S. and the Japanese shocks generate relatively smaller responses in the AEMs' return rates. The U.S. shock increases the return rates noticeably in Hong Kong and Singapore. As the variance decomposition results suggest, the Korean and the Taiwanese markets are insensitive to the U.S. shock. The AEMs' return rates seem to respond positively to the Japanese shock, especially for Period III, but the size of the responses is much smaller. Overall, the AEMs appear to be efficient in that foreign and domestic shocks are absorbed quickly, in most cases within 3 weeks.

In all four countries, the stock return rates respond immediately to their domestic own shocks in a positive way. The response to the own shock is the biggest in Taiwan for Period I, in Hong Kong for Period II, and in Singapore for Period III. The response to the own shock in Singapore for the after-Crash period has the biggest peak effect of 6.6% among all the responses shown in Figure 1. In most cases, the effect dies out within 3 weeks.

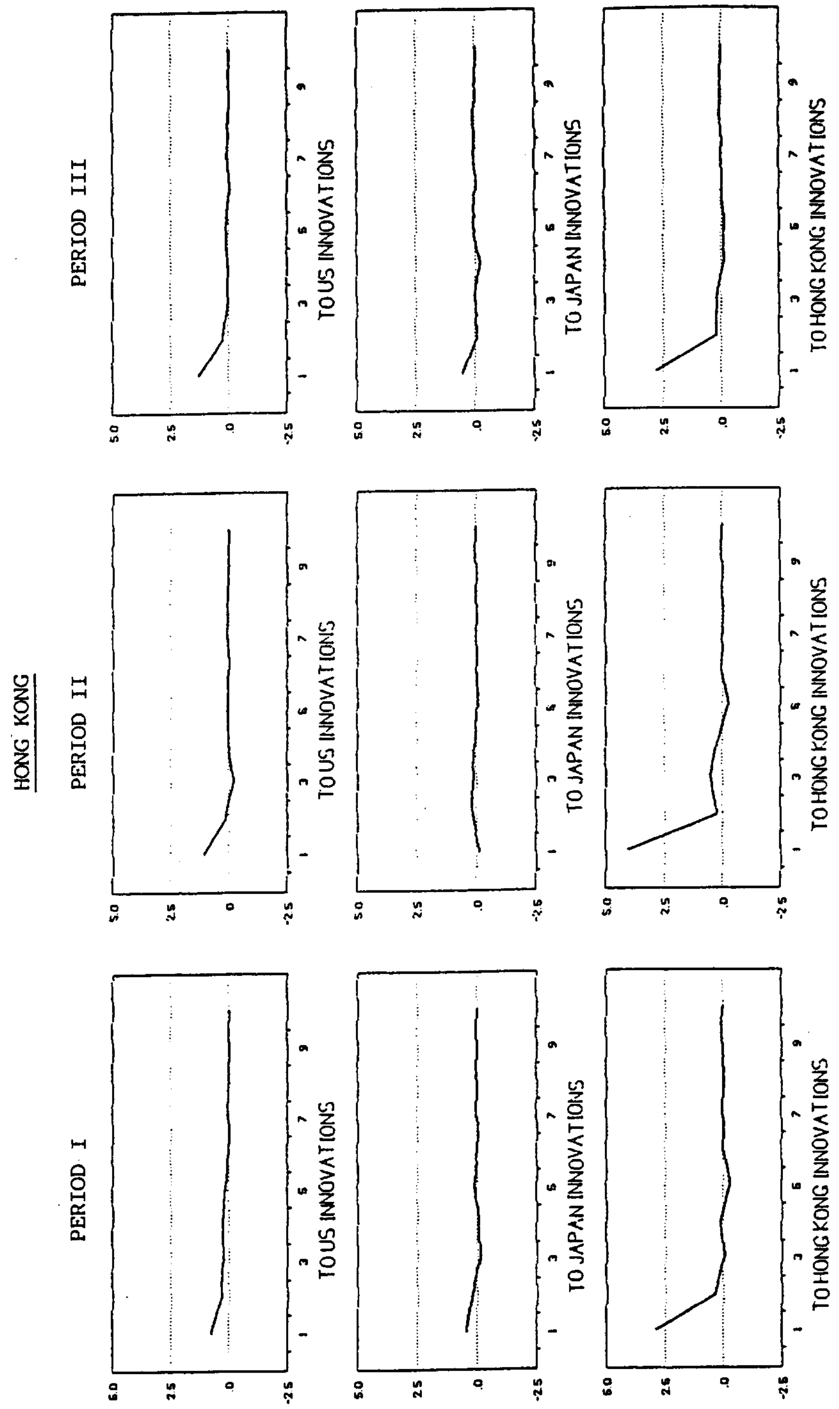
HONG KONG
PERIOD I
PERIOD II
PERIOD III
TO US INNOVATIONS
TO JAPAN INNOVATIONS
TO HONG KONG INNOVATIONS
5.0
2.5
.0
-2.5
1
3
5
7
9

*Figure 1a.*

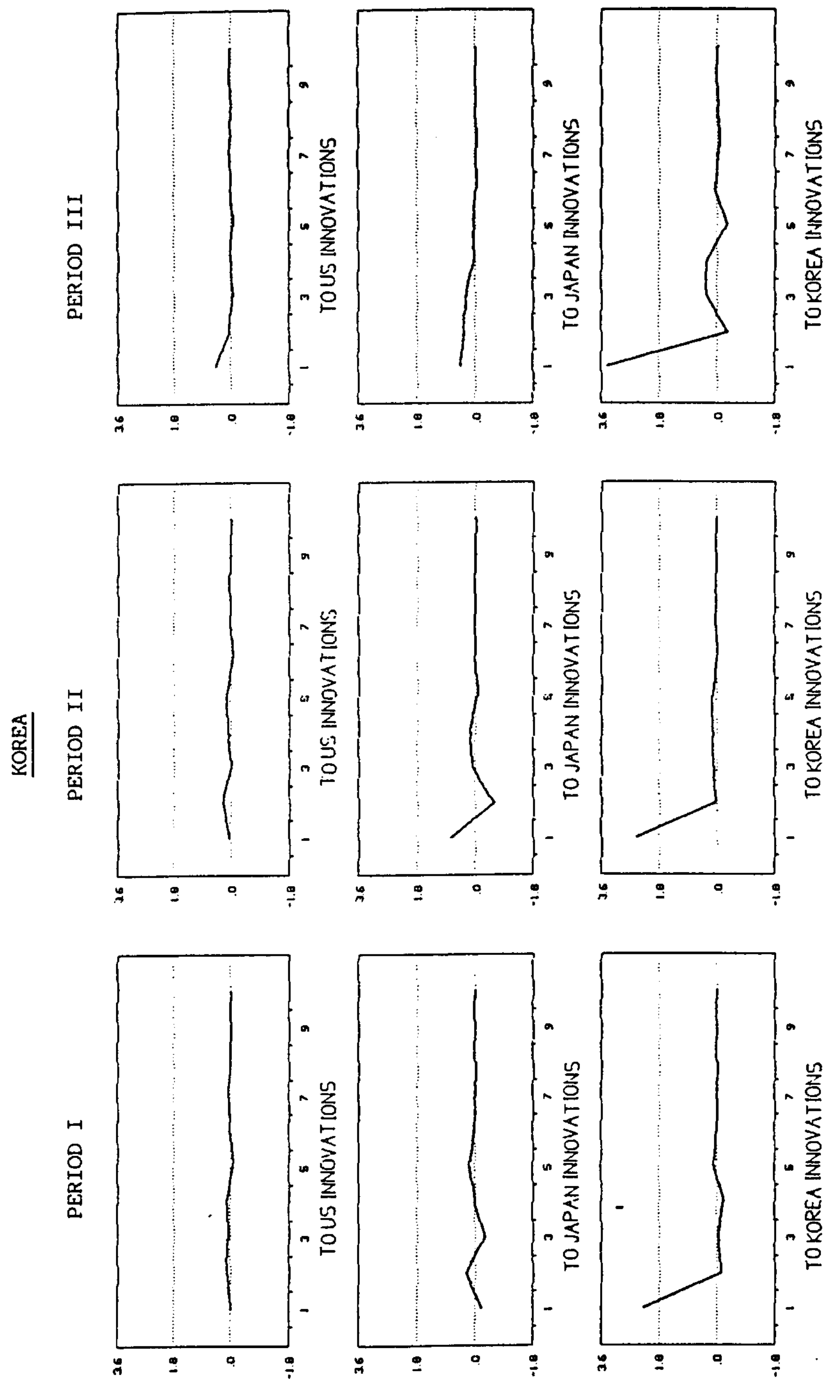
KOREA
PERIOD I
PERIOD II
PERIOD III
TO US INNOVATIONS
TO JAPAN INNOVATIONS
TO KOREA INNOVATIONS

*Figure 1b.*

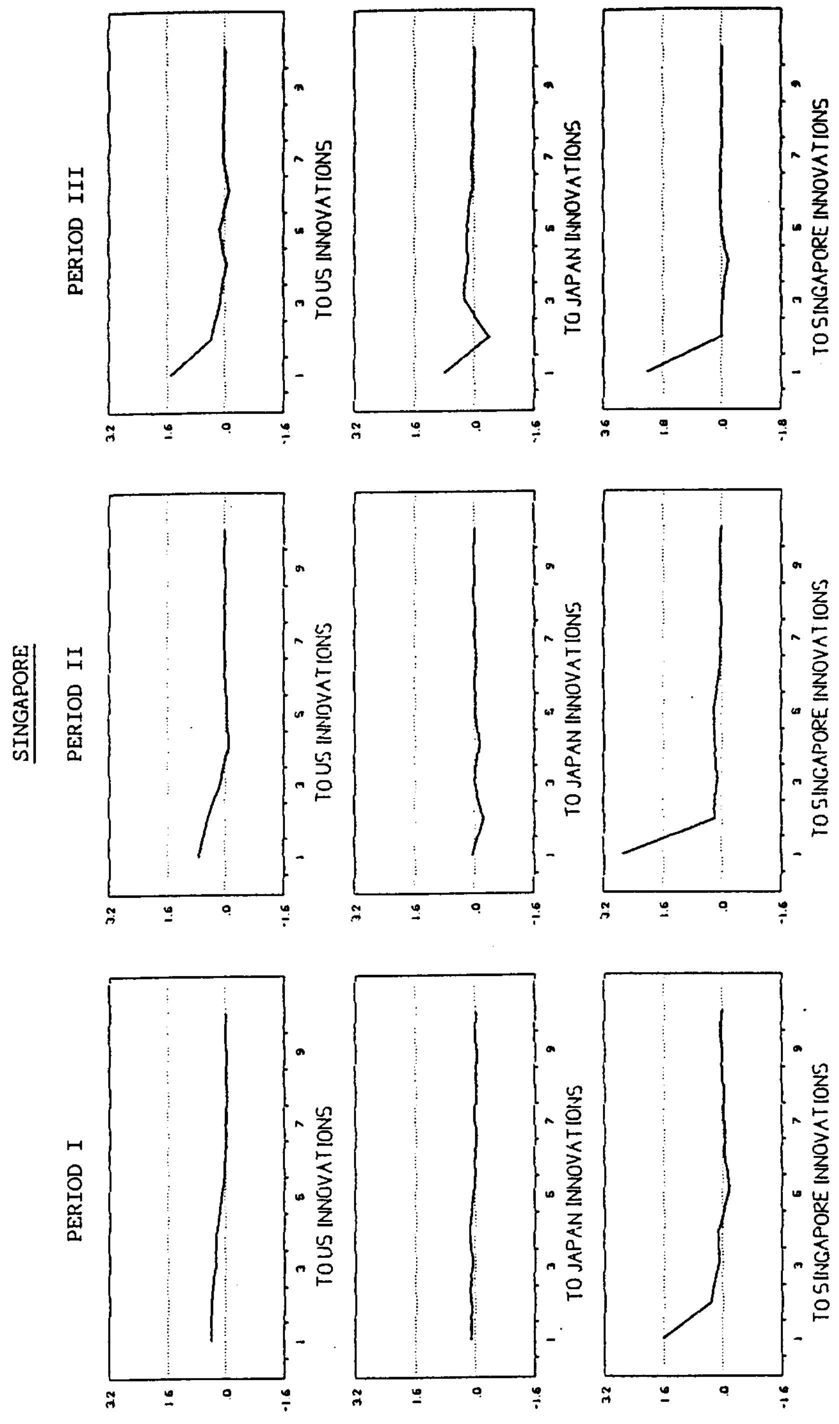
SINGAPORE
PERIOD I
PERIOD II
PERIOD III
TO US INNOVATIONS
TO JAPAN INNOVATIONS
TO SINGAPORE INNOVATIONS

*Figure 1c.*

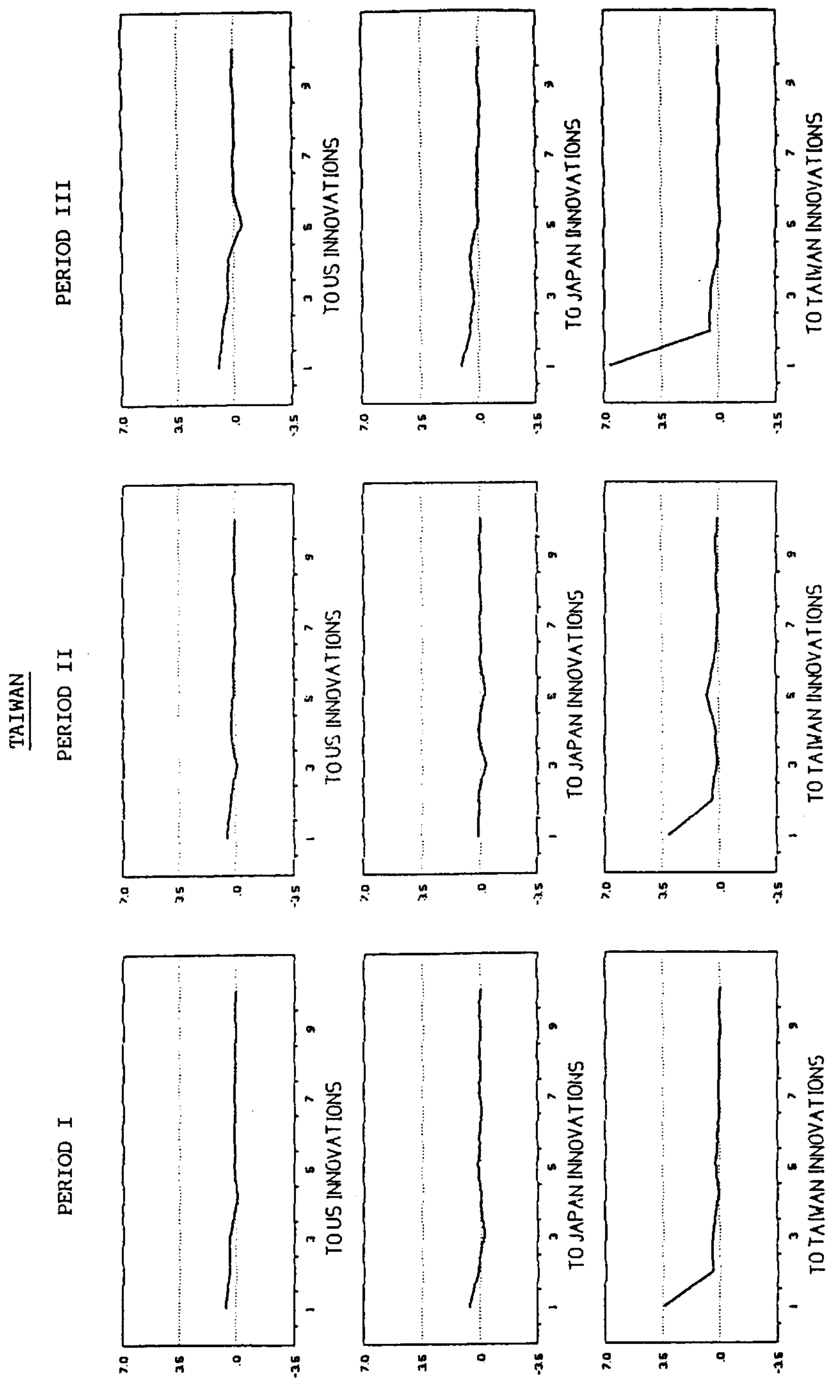
TAIWAN
PERIOD I
PERIOD II
PERIOD III
TO US INNOVATIONS
TO JAPAN INNOVATIONS
TO TAIWAN INNOVATIONS

*Figure 1d.*

## 5. Conclusion

By using the VAR method, this paper empirically investigates the relationships between the four Asian emerging markets: Hong Kong, Korea, Singapore and Taiwan, and the two largest markets in the world: U.S. and Japan.

It is found that the four AEMs react differently to the price movements in the U.S. and the Japanese markets. Our findings are consistent with those of Eun and Shim (1989) and Cheung and Mak (1992) that the U.S. plays an important role in leading other equity markets. This paper provides additional evidence in remaining this relationship during different periods. While most of forecast error variance of the return rates in these markets is explained by domestic own innovations, U.S. and Japanese innovations have more explanatory power in Hong Kong and Singapore than in Korea and Taiwan. This foreign effect is pronounced after the Crash of the October 1987, especially in Singapore. The results show that the U.S. market affects the Hong Kong and the Singapore markets, but not the Korean and the Taiwanese markets while the Japanese market has little impact except on the Korean market. Second, the AEMs appear to be efficient in that foreign and domestic shocks are absorbed quickly, in most cases within 3 weeks.

In fact, the Hong Kong and the Singapore markets are relatively more open and impose less restrictions on foreign investors. We observe that the U.S. market's influence on Hong Kong increased substantially in Period III. This may be explained by the linked exchange rate system between the U.S. dollar and the Hong Kong dollar set up in 1983. The linked system reduces the exchange rate risk of U.S. investors for investing in the Hong Kong equity market. By contrast, until recently in Korea and Taiwan, foreign investors were not allowed to invest directly in the equity markets and faced stringent restrictions which limit international investment in these two markets. This factor provides a partial explanation of why the Korean and the Taiwanese markets are less responsive to the U.S. and the Japanese markets.

## Notes

1. Cheung and Ho (1991) and Cheung (1993) demonstrate the benefit of investing in these AEMs.
2. It is well known that stock returns are lower at the beginning of the week and is higher at the end of the week. For instance, Ho (1990) documents the existence of the seasonal pattern in Asia-Pacific stock returns.
3. Hung and Cheung (1995) report that there is no evidence that the AEMs are cointegrated using weekly data during 1981–1991.
4. It should be noted that the returns are computed in domestic currency and the exchange rate fluctuation is not considered here. Hung and Cheung (1993) find that these markets are co-integrated when stock prices are measured in the U.S. dollar. This relationship is caused by the coherence among the Asian currencies response against the U.S. dollar. There was a general appreciation trend for the Asian currencies against the U.S. dollar in the 1980's and this comovement can affect the results. In addition, the currency risk can be hedged by taking a short position in the forward market.
5. For details, see Doan (1990) and Sims (1980, 1982).

6. For a stochastic process $\{x_t\}$, $e_t$ is the innovation in $x_t$ if and only if $e_t = x_t - E(x_t|x_{t-s}, s \geq 1)$, where $E(x_t|x_{t-s}, s \geq 1)$ is defined to be the limit $\hat{x}_t$ of linear combinations of $\{x_{t-s}, s \geq 1\}$ which minimizes variance of $(x_t - \hat{x}_t)$. Since $e_{t-1}$ is again a limit of linear combinations of $\{x_{t-s}, s \geq 1\}$, $e_t$ is serially uncorrelated.
7. We tested shorter lags as restrictions on four lags by using the likelihood ratios and rejected the null hypotheses.
8. In computing the forecast error variance, we used the orthogonalized innovation $u = G^{-1}e$ where $G$ satisfies $GG' = \Sigma$. In factorizing $\Sigma$ into $GG'$, we used the Choleski Factorization in which $G$ is lower triangular.
9. Specifically, the response of $Y$ in the MAR at $t = k$ to a time 0 shock of size $z$ in the residual terms is $A_k z$. With the orthogonalized innovations, a shock of size one to the $i$-th variable is equivalent to a shock of the size of the $i$-th column of $G$ to $e$. Therefore, the analysis traced out the $i$-th column of the $A_k G$ matrix to a unit shock to the $i$-th orthogonalized innovation.
10. We checked whether or not the results in Table IV favored a particular ordering of the variables in the orthogonalization and found that our results are robust to the alternative orderings of the variables.

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