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DOMESTIC AND FOREIGN CURRENCY-SPECIFIC SHOCKS IN ASIAN FOREIGN EXCHANGE MARKETS

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This paper investigates joint dynamics in three Asian emerging foreign exchange markets. The empirical results indicate that domestic and foreign currency-specific shocks have a significant impact on exchange rate changes and their volatility in the region. It also suggests that exchange rate changes and their volatility in these Asian countries respond asymmetrically to positive and negative residuals. But these effects on exchange rate changes become weaker after the Asian currency crises of 1997 came to an end.

JEL Classification: F3
Keywords: Currency-Specific shocks, VAR, EGARCH, Impulse Response

I. INTRODUCTION

As Asian capital and foreign exchange markets are liberalized and continue to open, the linkages across these emerging markets strengthen. Moreover, the correlations between Asian foreign exchange markets are sharply higher following the Asian currency crises of 1997. The 1997 Asian currency crises have been a surprise in their depth and spillover. Stock prices in these countries have also declined considerably for the same period.

Linkages between markets generally arise from two distinct sources - common information and information spillover(e.g., Fleming et al., 1998). Common information simultaneously affects expectations in more than one market. For example, the yen appreciation and the low interest rate increased export and GDP as well as the foreign investment in Asia(e.g., Ito, 1999). The Asian economy was good between 1994 and 1996, because the yen/dollar exchange rate appreciated and the interest rate in the industrialized countries remained low. Major economic shifts in the industrial countries such as the yen depreciation

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are dubbed "monsoonal effects" by Masson et al.(1995) and Masson(1998). "Information spillover" implies that a change in one country leads to a change in another country. Growth in any Asian country leads to growth in other countries in the region, since trade and investment flows are correlated among Asian countries. But the Asian economic situation has suddenly changed since 1996. Exports have rapidly declined in most Asian countries. Especially, the current account deficits of Thailand had reached 8 percent of GDP in 1996 and then the Thai baht was floated relative to the dollar on July 2, 1997. A depreciation of the Thai baht reduced the competitiveness of other Asian countries and other Asian exchange rates also depreciated sharply.

The goal of this paper is to explore joint dynamics in three Asian foreign exchange markets - Thailand, Indonesia, and Korea. This paper explicitly investigates how information creates cross-market linkages. Specifically, the paper examines whether or not currency-specific shocks and common external shocks have an important impact on exchange rates and their volatility in these three Asian currencies and whether sources of spillover shift from one country to another in Asian emerging markets or not. The main tool of analysis in this paper is a VAR framework with EGARCH errors. A VAR is adopted to model the dynamic response of the conditional mean, because a VAR is one of the best models of transition dynamics. It is also known that exchange rates exhibit volatility clustering. So an EGARCH model is chosen to model the dynamic process of the conditional volatility.

This analysis indicates that spillover effects exist in three Asian foreign exchange markets. In addition to currency-specific shocks, the common external shock such as the yen depreciation also has a significant impact on other exchange rates and their volatility in the region.[1] The empirical results also suggest that exchange rate changes and their volatility respond asymmetrically to positive and negative residuals in the region. But these effects on exchange rate changes become weaker when the period from September 1, 1998 to December 31, 2000 is only considered. On the other hand, these shocks still have an important impact on these exchange rate volatility.

The remainder of the paper is organized as follows: VAR models with EGARCH errors used for analysis are presented in Section 2. Section 3 describes the data summary. Section 4 is devoted to the estimations and tests of VAR and EGARCH models. In Section 5, impulse responses and variance decompositions are described and interpreted. The final section offers some concluding remarks.

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[1] Some authors(e.g., Masson, 1998) argue that currency crises may be due to a common cause such as the yen depreciation and the high interest rate policy of U.S. Federal Reserve Board(FRB), which is called monsoonal effects. But the empirical results show that the interest rate policy of U.S. Federal Reserve Board cannot seriously influence these emerging foreign exchange markets. Therefore, it is not mentioned any more in the paper.

II. THE ECONOMETRIC FRAMEWORK

To measure the effect of currency-specific shocks to exchange rate changes and their volatility, I use a vector autoregression(VAR) model with EGARCH errors. Let y_t denote an $n\times 1$ vector percentage exchange rate changes. In the conditional mean equation, the dynamics of y_t are presumed to be governed by a pth-order vector autoregression:

$$y_t = b_0 + \sum_{i=1}^{p} b_i y_{t-i} + \varepsilon_t \tag{1}$$

$$\varepsilon_t | F_{t-1} \sim N(0, \Omega_t)$$

$$\Omega_t = V_t \Gamma V_t$$

The information set F_t is the σ-field generated by past value of ε_t. Ω_t is the $n\times n$ covariance matrix. Γ is a $n\times n$ time invariant correlation matrix and V_t is a $n\times n$ diagonal matrix in which the ith diagonal element σ_{iit} is the conditional standard deviation of the ith exchange rate depreciation. The variances are assumed to follow EGARCH(1,1) processes(Nelson, 1991):

$$\ln \sigma^2_{iit} = \omega_i + \beta_{ii} \ln \sigma^2_{iit-1} + \Upsilon_{ii} \frac{\varepsilon_{iit-1}}{\sigma_{iit-1}} + \sum_{j=1}^{n} \alpha_{ij} \left[\frac{|\varepsilon_{jjt-1}|}{\sigma_{jjt-1}} - \sqrt{2/\pi} \right] \tag{2}$$

In the first step, equation (1) is estimated. In equation (1), a VAR is written in vector MA (∞) form as:

$$y_t = \delta_0 + \sum_{k=0}^{\infty} \tau_k \varepsilon_{t-k}, \text{ or}$$

$$y_t = \delta_0 + \sum_{k=0}^{\infty} \tau_k A\ \tilde{\varepsilon}_{t-k} \tag{3}$$

where $\delta_0 = (1 - \sum_{i=1}^{p} b_i)^{-1} b_0$, $\tau_0 = I$, $\tau_k = \sum_{i=1}^{k} b_i \tau_{k-i}$ for $p > k \geq 1$, and $\tau_k = \sum_{i=1}^{p} b_i \tau_{k-i}$, for $k \geq p$. A is the lower triangular Cholesky decomposition of $\Omega(\Omega = AA')$ and $\tilde{\varepsilon}_{t-k} = A^{-1} \varepsilon_{t-k}$ Then, an orthogonalized impulse response function is expressed as follows:

$$\frac{\partial y_{t+k}}{\partial \tilde{\varepsilon}_t} = \tau_k A \tag{4}$$

In this case, the MSE of the k-period-ahead forecast can be written as follows(e.g., Hamilton, 1994):

$$\text{MSE}\ (\hat{y}_{t+k/t}) = AA' + \tau_1 AA' \tau_1{}' + \tau_2 AA' \tau_2{}' + \ldots + \tau_{k-1} AA' \tau_{k-1}{}' \tag{5}$$

In the second step, the conditional variance-covariance matrix Ω_t is estimated with a multivariate EGARCH(1,1) model. Introducing vector notation, let $\ln \sigma_t^2 = (\ln \sigma_{11t}^2, \ldots, \ln \sigma_{nnt}^2)'$ represent the vector of conditional heteroskedasticity of all the markets on date t and let $z_t = (z_{11t}, \ldots, z_{nnt})'$ $(z_{iit} = \frac{\varepsilon_{iit}}{\sigma_{iit}})$ be the vector standardized innovations or news on this date. Then equation (2) can be written as :

$$\ln \sigma_t^2 = \omega + \beta \ln \sigma_{t-1}^2 + \gamma z_{t-1} + \alpha[|z_{t-1}| - \sqrt{2/\pi}] \tag{6}$$

$$\omega = \begin{bmatrix} \omega_1 \\ \cdot \\ \cdot \\ \cdot \\ \omega_n \end{bmatrix}, \quad \beta = \begin{bmatrix} \beta_{11} & 0 & \cdot & \cdot & \cdot & 0 \\ 0 & \beta_{22} & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & 0 \\ 0 & \cdot & \cdot & \cdot & 0 & \beta_{nn} \end{bmatrix}, \quad \gamma = \begin{bmatrix} \gamma_{11} & 0 & \cdot & \cdot & \cdot & 0 \\ 0 & \gamma_{22} & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & 0 \\ 0 & \cdot & \cdot & \cdot & 0 & \gamma_{nn} \end{bmatrix},$$

$$\alpha = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \cdot & \cdot & \cdot & \alpha_{1n} \\ \alpha_{21} & \alpha_{22} & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \alpha_{n1} & \cdot & \cdot & \cdot & \cdot & \alpha_{nn} \end{bmatrix},$$

In the conditional variance equation, impulse responses of volatility to the standardized absolute innovation are defined as:

$$\frac{\partial \ln \sigma_{t+k}^2}{\partial |z_t|} = \beta^{k-1}(\gamma + \alpha) \quad \text{for} \quad z_t > 0 \tag{7}$$

$$\frac{\partial \ln \sigma_{t+k}^2}{\partial |z_t|} = \beta^{k-1}(-\gamma + \alpha) \quad \text{for} \quad z_t < 0 \tag{8}$$

If the process is stationary, the k-period-ahead forecast in the volatility can be written as follows:

$$\begin{aligned} \text{MSE}(\ln \hat{\sigma}^2_{t+k/t}) = {} & (\gamma + \alpha)(\gamma + \alpha)' + \beta(\gamma + \alpha)(\gamma + \alpha)'\beta' \\ & + \ldots + \beta^{k-1}(\gamma + \alpha)(\gamma + \alpha)'\beta^{k-1\prime}, \quad \text{for} \quad z_t > 0 \end{aligned} \tag{9}$$

$$\begin{aligned} \text{MSE}(\ln \hat{\sigma}^2_{t+k/t}) = {} & (\gamma - \alpha)(\gamma - \alpha)' + \beta(\gamma - \alpha)(\gamma - \alpha)'\beta' \\ & + \ldots + \beta^{k-1}(\gamma - \alpha)(\gamma - \alpha)'\beta^{k-1\prime}, \quad \text{for} \quad z_t < 0 \end{aligned} \tag{10}$$

If γ is positive, MSE is larger in $z_t > 0$ than in $z_t < 0$. If γ is negative, the reverse is true.

III. DATA SUMMARY

The data consist of four daily currencies in terms of U.S. dollar-the Japanese yen, the Thai baht, the Indonesian rupiah, and the Korean won. The data for the yen, the baht, and the won were obtained from the Federal Reserve Board. They are noon buying rates in New York city for cable transfers payable in foreign currency. But the data for the Rupiah were separately obtained from the New York foreign exchange market, because they are not included in the Historical Data Set of the FRB. They consist of closing rates. The Malaysian ringgit are excluded, because it was fixed on September 2, 1998 and therefore data availability is limited. The sample period used here runs from April 11, 1994 to December 31, 2000, totalling 1663 observations. As mentioned above, these countries experienced their currency crises in 1997. The crisis first hit Thailand and then it spreads to Indonesia, Malaysia, and Korea in the following several months. The data for the yen/dollar exchange are contained in order to examine common external shocks.

Foreign exchange rates (S_t) are transformed to percentage changes in continuously compounded rates: $y_t = 100 \times (\ln S_t - \ln S_{t-1})$. Table 1 shows summary statistics on the data. During whole sample period, the yen, the baht, the rupiah, and the won depreciated. But this depreciation is not statistically significant at the 5% level. The standard deviation indicates that the rupiah was most volatile. Skewness of the baht and the rupiah is positive, but that of the won and the yen is negative. Kurtosis is much greater than 3(kurtosis of normal distribution) in all cases. The maximun and minimum changes in this sample are at least more than five standard deviations away from the mean. The Ljung-Box test shows that all series are highly serially correlated. These results suggest that VAR-EGARCH models are attractive candidates to model the series.

But the results are different for the period between September 1, 1998 and December 31, 2000 in three Asian emerging foreign exchange rates. Standard deviation and kurtosis as well as maximum and minimum become smaller. Exchange rate changes are less serially correlated.

Figure 1 shows the movements of exchange rates for sample period. After the Thai baht was floated on July 2, 1997, Asian exchange rates began to depreciate steeply. The baht, the rupiah, and the won depreciated approximately 63, 81, and 64 percent respectively against the U.S. dollar between June and December 1997. The baht depreciated most steeply from July to September, while the rupiah suddenly depreciated from the end of September. From the end of November, the won depreciated sharply. The baht and the won depreciated almost equally between June and December. From July to December 1997, the baht, the rupiah, and the won in turn lead to the overall depreciation in Asian emerging markets. The fact implies that sources of spillover move from one currency to another in Asian emerging markets. In this aspect, the 1997 Asian

[Table 1] Summary Statistics

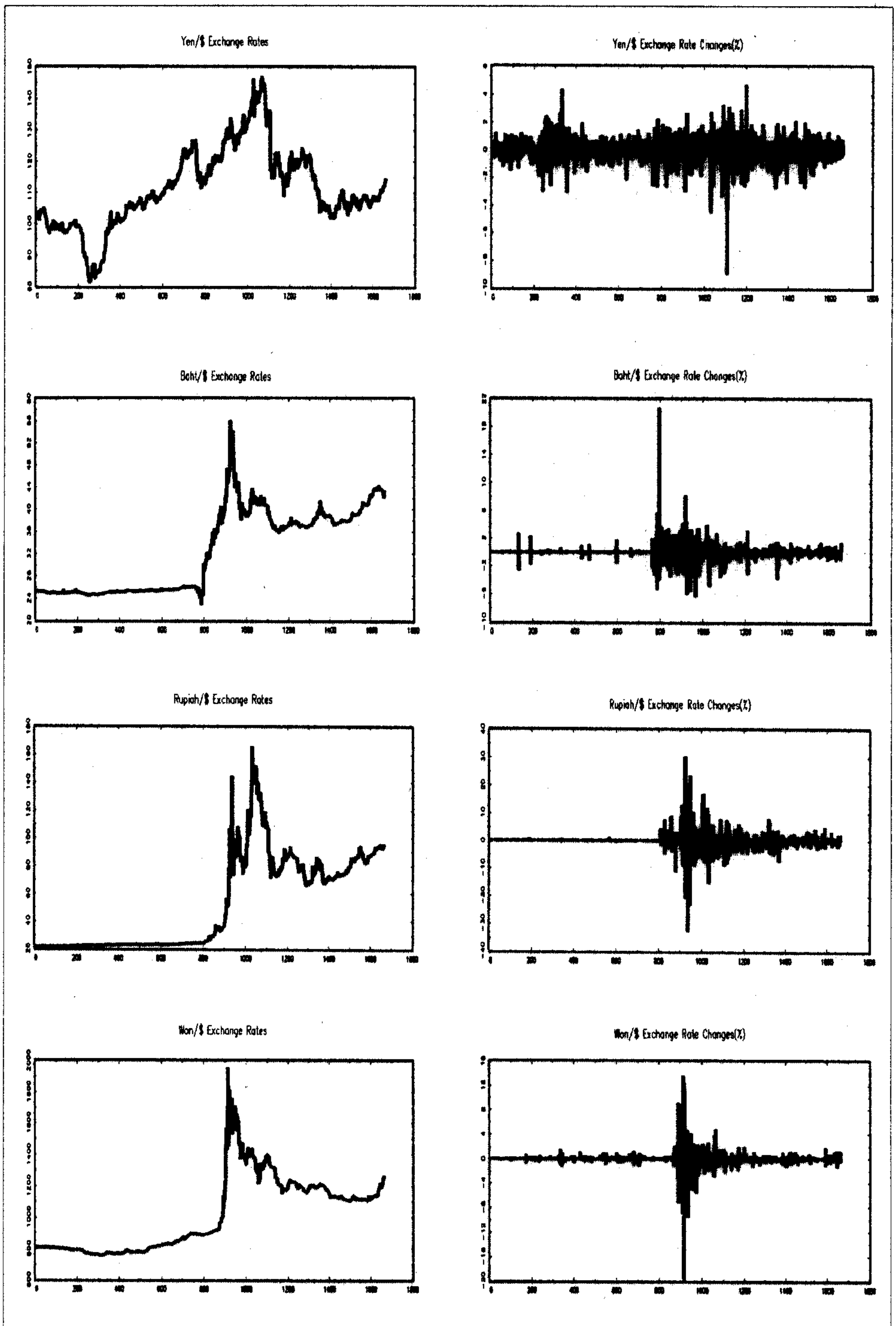
period	statistics	Yen/$	Baht/$	Rupiah/$	Won/$
1994.4.11 - 2000.12.31	mean	0.006	0.033	0.090	0.027
		(0.020)[a]	(0.025)	(0.063)	(0.028)
	standard deviation	0.805	1.018	2.563	1.150
	skewness	-1.012	5.035	0.200	-0.957
	kurtosis	15.554	114.806	50.210	91.373
	maximum	4.699	20.769	30.303	13.645
	minimum	-8.967	-6.353	-32.736	-19.759
	Q(10)[b]	17.066	55.020	119.283	451.699
		[0.073][d]	[0.000]	[0.000]	[0.000]
	$Q^2(10)$[c]	107.671	38.044	768.579	1203.247
		[0.000]	[0.000]	[0.000]	[0.000]
1998.9.1 - 2000.12.31	mean	-0.036	0.006	-0.025	-0.009
		(0.039)	(0.024)	(0.076)	(0.020)
	standard deviation	0.939	0.581	1.835	0.483
	skewness	-1.493	-1.044	-0.213	0.074
	kurtosis	18.865	12.141	7.447	5.930
	maximum	4.699	3.074	8.186	1.979
	minimum	-8.967	-3.779	-8.782	-2.222
	Q(10)	21.958	12.077	12.075	26.102
		[0.015]	[0.280]	[0.280]	[0.004]
	$Q^2(10)$	33.111	29.723	159.038	102.695
		[0.001]	[0.000]	[0.000]	[0.000]

a. Standard errors are in parentheses.

b(c). Ljung-Box statistics for 10th-order correlation in $y_t(y_t^2)$

d. Numbers in brackets are p-values.

[Figure 1] Daily Exchange Rates



currency crises seem to be more complex than the 1994 Mexican currency crisis. The yen/dollar exchange rate depreciated steeply just before the currency crises happened in three Asian emerging markets.

IV. ESTIMATIONS AND TESTS

The conditional mean and the conditional variance equations were estimated with VAR and EGARCH models, respectively.

4.1 The Conditional Mean

A VAR model was estimated using 10 lags of y_t = {Yen/$, Baht/$, Rupiah/$, Won/$} for the whole period. Lag length was selected based on the Akaike Information Criterion(AIC) and the Schwarz Criterion, and Q statistic regarding the serial correlation in a VAR error term.[2] Since 10 lags of 4 variables are included in a VAR, 164 parameters must be estimated. Since there are too many parameters in the mean equation, the results of several specification tests are only reported. Adjusted R^2 for four exchange rate changes is 0.058, 0.221, 0.389, and 0.437 respectively.

Firstly, I check whether common information, that is, the yen/dollar exchange rate has a significant impact on three Asian exchange rates or not. Table 2 reports the empirical results. In the F test, the null hypothesis $b_{11} = b_{12} = \cdot\cdot\cdot = b_{110} = 0$ implies that lagged yen/dollar exchange rate changes cannot affect other current exchange rate changes. The null hypothesis is rejected at the 10% significant level in Yen/$ and Won/$ cases. That is, the past yen depreciation has a significant impact on the Korean foreign exchange market.

The second set of tests checks whether past three Asian exchange rate changes respectively have explanatory powers on current three Asian exchange rate changes or not. For example, the null hypothesis $b_{21} = b_{22} = \cdot\cdot\cdot = b_{210} = 0$ implies that lagged baht/dollar exchange rate changes cannot affect other current exchange rate changes. Because these F tests are significant even at the 1% level, each exchange rate change can be forecasted better using other previous exchange rate changes as well as its own lagged value.

The third test investigates day of the week effects on the conditional mean of exchange rate changes. Equation (11) is estimated as follows:

$$y_t = b_0 + b_{0T} D_{Tt} + b_{0W} D_{Wt} + b_{0R} D_{Rt} + b_{0F} D_{Ft} + \sum_{i=1}^{10} b_i y_{t-i} + \varepsilon_t \qquad (11)$$

[2] The Ljung-Box test indicates that VAR error terms are not serially correlated. Modified Ljung-Box statistics for *10*th-order correlation $Q_M(10)$ are respectively 0.262[1.000], 0.744[1.000], 3.635[0.962], and 2.570[0.990] in case of y_t = {Yen/$, Baht/$, Rupiah/$, Won/$}. Numbers in brackets are p-values.

[Table 2] The Specification Tests in a VAR Model

period	tests	Yen/$	Baht/$	Rupiah/$	Won/$
1994.4.11 - 2000.12.31	$b_{11} = b_{12} = \cdots = b_{110} = 0$	1.622[a] [0.095][b]	0.899 [0.534]	1.365 [0.191]	2.494 [0.006]
	$b_{21} = b_{22} = \cdots = b_{210} = 0$	0.749 [0.678]	8.988 [0.000]	18.279 [0.000]	5.409 [0.000]
	$b_{31} = b_{32} = \cdots = b_{310} = 0$	0.885 [0.546]	9.822 [0.000]	13.045 [0.000]	10.081 [0.000]
	$b_{41} = b_{42} = \cdots = b_{410} = 0$	1.075 [0.378]	4.721 [0.000]	14.451 [0.000]	53.344 [0.000]
	$b_{OT} = b_{OW} = b_{OR} = b_{OF} = 0$	0.551 [0.698]	2.160 [0.071]	0.441 [0.779]	1.653 [0.159]
	$b_{OD} = 0$	3.278 [0.070]	7.512 [0.006]	3.858 [0.050]	4.873 [0.027]
	$b_{11}^{+} = b_{12}^{+} = \cdots = b_{110}^{+} = 0$	1.959 [0.034]	1.286 [0.233]	2.201 [0.016]	2.393 [0.008]
	$b_{21}^{+} = b_{22}^{+} = \cdots = b_{210}^{+} = 0$	0.623 [0.796]	5.076 [0.000]	5.621 [0.000]	2.144 [0.019]
	$b_{31}^{+} = b_{32}^{+} = \cdots = b_{310}^{+} = 0$	0.741 [0.686]	4.206 [0.000]	7.029 [0.000]	9.675 [0.000]
	$b_{41}^{+} = b_{42}^{+} = \cdots = b_{410}^{+} = 0$	1.026 [0.419]	7.312 [0.000]	8.225 [0.000]	15.266 [0.000]
1998.9.1 - 2000.12.31	$b_{11} = 0$	0.660 [0.417]	0.329 [0.567]	2.605 [0.107]	8.586 [0.004]
	$b_{21} = 0$	0.026 [0.871]	0.009 [0.925]	20.856 [0.000]	2.645 [0.104]
	$b_{31} = 0$	3.822 [0.051]	3.938 [0.048]	0.108 [0.742]	0.569 [0.451]
	$b_{41} = 0$	0.007 [0.935]	0.303 [0.582]	1.199 [0.274]	3.573 [0.059]
	$b_{OT} = b_{OW} = b_{OT} = b_{OF} = 0$	0.251 [0.909]	0.650 [0.627]	0.084 [0.987]	0.279 [0.892]
	$b_{11}^{+} = 0$	0.002 [0.963]	5.266 [0.022]	0.190 [0.663]	0.013 [0.908]
	$b_{21}^{+} = 0$	0.899 [0.344]	3.103 [0.079]	0.276 [0.600]	0.019 [0.891]
	$b_{31}^{+} = 0$	0.008 [0.929]	1.627 [0.203]	1.882 [0.348]	0.830 [0.363]
	$b_{41}^{+} = 0$	0.325 [0.569]	0.202 [0.653]	0.276 [0.600]	0.146 [0.702]

a. F test statistic.
b. Numbers in brackets are p-values.

D_{Tt}, D_{Wt}, D_{Rt}, and D_{Ft} are dummy variables for Tuesday, Wednesday, Thursday, and Friday. The F test shows that the null hypothesis $b_{0T} = b_{0W} = b_{0R} = b_{0F} = 0$ is accepted at the 5% significance level in all cases. Weekday effects reveal no explanatory powers in Yen/$, Rupiah/$, and Won/$ cases.

Fourthly, the dummy variable is used for the period between July 2, 1997 on which the Thai baht was floated and August 31, 1998, in order to check the currency crisis effect on the conditional mean. Equation (12) is estimated as follows:

$$y_t = b_0 + b_{0D} D_{0t} + \sum_{i=1}^{10} b_i y_{t-i} + \varepsilon_t \tag{12}$$

D_{0t} is the dummy variable for the currency crisis period. The null hypothesis $b_{0D} = 0$ is not accepted at the 5% significance level in three Asian emerging markets.

Finally, I examines whether three Asian current exchange rates respond asymmetrically to the depreciation of lagged exchange rates. To test this hypothesis, equation (13) is estimated as follows:

$$y_t = b_0 + \sum_{i=1}^{10} (b_i + b_i^+ D_{it}) y_{t-i} + \varepsilon_t \tag{13}$$

D_{it} equals one for the day at which each exchange rate depreciates. It is equal to zero otherwise. These threshold terms also confirm that the asymmetry in the variances are not caused by a misspecification in the mean. The null hypothesis $b_{11}^+ = b_{12}^+ = \cdots = b_{110}^+ = 0$ in Table 2 means that current exchange rate changes don't respond asymmetrically to the depreciation of lagged yen/dollar exchange rates. The F test suggests that the null hypothesis $b_{11}^+ = b_{12}^+ = \cdots = b_{110}^+ = 0$ is rejected at the 5% significance level in Yen/$, Rupiah/$, and Won/$ cases. Current three Asian exchange rate changes also respond asymmetrically to the depreciation of lagged three Asian exchange rate changes respectively.

On the basis of the test results represented above, the following equation is used in examining dynamic responses of exchange rate changes and their volatility:

$$y_t = b_0 + b_{0D} D_{0t} \sum_{i=1}^{10} (b_i + b_i^+ D_{it}) y_{t-i} + \varepsilon_t \tag{14}$$

For the period between September 1, 1998 and December 31, 2000, 1 lag of y_t = {Yen/$, Baht/$, Rupiah/$, Won/$} is used. Lag length was selected based on the Akaike Information Criterion(AIC) and the Schwarz Criterion, and Q statistic regarding the serial correlation in a VAR error term.

In Table 2, the null hypothesis b_{11}=0 is only rejected at the 5% significant level in Won/$ case. The past yen depreciation has a significant impact on the Korean foreign exchange market. The null hypotheses $b_{21} = 0$, $b_{31} = 0$, and $b_{41} = 0$

also show that past three Asian exchange rate changes respectively have less explanatory powers on current three Asian exchange rate changes. The null hypothesis $b_{0T} = b_{0W} = b_{0R} = b_{0F} = 0$ is accepted at the 10% significance level in all cases. In contrast to the whole period, the null hypothesis $b_{11}^{+} = 0$ is not rejected at the 10% significance level in Yen/$, Rupiah/$, and Won/$ cases. The null hypotheses $b_{21}^{+} = 0$, $b_{31}^{+} = 0$, and $b_{41}^{+} = 0$ are not similarly rejected at the 5% significance level in all cases. Current three Asian exchange rate changes don't respond asymmetrically to the depreciation of lagged three Asian exchange rate changes respectively. Therefore, for the period from September 1, 1998 to December 31, 2000, equation (1) is estimated with p=1.

4.2 The Conditional Variance

In Table 1, the Ljung-Box tests show that the squared data exhibit substantially more autocorrelation than the raw data, which is indicative of strong conditional heteroskedasticity. The serial dependence in the conditional second monents is one of the implications of the ARCH or GARCH model. Many papers strongly favor GARCH(1,1) over ARCH(q) for the high-frequency exchange rate data. But, in this paper, Nelson's(1991) EGARCH is used instead of GARCH, because it is less likely to result in integrated variances and volatility is not symmetric in some cases.

Table 3 reports estimations and tests in EGARCH(1,1) models. β_{ii} is less than unity in all currencies, implying that variance is not integrated and unconditional variance is finite. For the whole period, the asymmetric relation between z_{t-1} and $\ln \sigma_t^2$, as represented by γ_{ii}, is significant at the 10% level in all cases. Volatility tends to rise more steeply in $z_t > 0$ than in $z_t < 0$, because γ_{ii} is positive in Rupiah/$ and Won/$ cases. But the results are reversed in Yen/$ and Baht/$ cases. Table 3 also indicates that yesterday's currency-specific shocks have an important impact on today's volatility in three Asian emerging markets. On the whole, the results suggest that there are volatility spillovers which imply cross currency news autocorrelation. The LR test suggests that the null hypothesis $\alpha_{ij} = 0$ for $j \neq i$ is rejected at the 1% level. It is called the "heat wave" hypothesis by Engle et al.(1990) and Ito et al.(1992). The "meteor shower" hypothesis is the alternative. I also use the dummy variable for the period between July 2, 1997 on which the Thai baht was floated and August 31, 1998. ω_i^* is statistically significant at the 1% level in cases of Baht/$, Rupiah/$, and Won/$.

For the period between September 1, 1998 and December 31, 2000, the asymmetric relation between z_{t-1} and $\ln \sigma_t^2$, as represented by γ_{ii}, is different from that of the whole period. Table 3 shows that yesterday's currency-specific shocks also have an important impact on today's volatility in three Asian emerging

[Table 3] Estimations in a Multivariate EGARCH Model

period		Yen/$	Baht/$	Rupiah/$	Won/$
	ω_i	0.003	-0.006	0.038	-0.066
		(0.002)[a]	(0.008)	(0.004)**	(0.014)**
	ω_i^*	0.009	0.121	0.071	0.142
		(0.005)$^+$	(0.019)**	(0.010)**	(0.019)**
	β_{ii}	0.990	0.953	0.978	0.944
		(0.002)**	(0.004)**	(0.002)**	(0.006)**
	γ_{ii}	-0.011	-0.088	0.024	0.063
		(0.006)$^+$	(0.011)**	(0.008)**	(0.014)**
1994.4.11	α_{i1}	0.131	0.163	0.119	0.099
-		(0.013)**	(0.013)**	(0.018)**	(0.022)**
2000.12.31	α_{i2}	0.010	0.439	0.192	0.099
		(0.012)	(0.027)**	(0.017)**	(0.024)**
	α_{i3}	0.016	0.178	0.184	0.092
		(0.013)	(0.023)**	(0.015)**	(0.021)**
	α_{i4}	0.012	0.003	0.122	0.366
		(0.012)	(0.016)	(0.018)**	(0.023)**
	$\alpha_{ij}=0(i\neq j)$		χ^2(f) = 2587.811(12)[b]		
	(i,j=1,2,3,4)		[p-value] = [0.000]		
	ω_i	-0.011	-0.021	0.101	-0.229
		(0.005)*	(0.011)$^+$	(0.018)**	(0.058)**
	β_{ii}	0.971	0.961	0.925	0.840
		(0.009)**	(0.009)**	(0.014)**	(0.029)**
	γ_{ii}	-0.056	0.065	-0.028	-0.062
		(0.016)**	(0.023)**	(0.021)	(0.035)$^+$
	α_{i1}	0.050	0.136	0.099	0.253
1998.9.1		(0.028)$^+$	(0.035)**	(0.045)*	(0.058)**
-	α_{i2}	-0.027	0.181	0.054	0.053
2000.12.31		(0.024)	(0.020)**	(0.023)*	(0.048)
	α_{i3}	0.046	0.072	0.253	0.081
		(0.025)$^+$	(0.032)*	(0.031)**	(0.039)*
	α_{i4}	0.014	0.058	-0.061	0.537
		(0.023)	(0.033)$^+$	(0.033)$^+$	(0.064)**
	$\alpha_{ij}=0(i\neq j)$		χ^2 (f) = 70.476(12)		
	(i,j=1,2,3,4)		[p-value] = [0.000]		

a. Standard errors are in parentheses. * and ** denote significance at the 5% and 1% levels, respectively.

b. LR test statisitc. f implies degree of freedom.

markets. The LR test suggests that the null hypothesis $\alpha_{ij}=0$ for $j\neq i$ is rejected at the 1% level. But the "meteor shower" effect is relatively weaker in this period than in the whole period.

V. IMPULSE RESPONSE ANALYSIS

5.1 The Conditional Mean

This section examines impulse responses of three Asian exchange rate changes to standardized shocks in foreign exchange rates using equation (14). When D_{it} is equal to one in equation (14), $\tau_0=I$, $\tau_k=\sum_{i=1}^{k}(b_i+b_i^+)\tau_{k-i}$, for $p>k\geq 1$, and $\tau_k=\sum_{i=1}^{p}(b_i+b_i^+)\tau_{k-i}$, for $k\geq p$ in equation (3). Impulse response functions were calculated assuming a Wold ordering of {yen, baht, rupiah, won}, because the yen/dollar exchange rate simultaneously affects three Asian exchange rates and the currency crises moved from the baht through the rupiah to the won. But as already shown in Table 2, since the three Asian exchange rate changes are closely linked with each other, the main results don't seriously depend on Wold ordering. A number of statistics could be constructed to summarize the shape of the impulse response functions. For example, Eichenbaum et al.(1993) investigated whether the impulse response function is identically equal to zero. They examined the average response of y_t to $\tilde{\varepsilon}_t$ from time $t+i$ to time $t+j$. This response is denoted by $\mu_y(i,j)$. Tables 4 through 6 report the average response of y_t, $\mu_y(i,j)$ emerging from the estimated VAR. Numbers in parentheses denote standard errors about average estimates of the coefficients in the impulse response functions.

Standard deviations are derived using the bootstrap method. The bootstrap is described by Efron(1979, 1982), Bickel et al.(1981), and Brock et al.(1991). The key idea is to resample the residuals, preserving this statistical structure, so that standard errors are generated using the model's own assumptions. The procedure is as follows:

First, define the residuals.

$$\hat{\varepsilon}_t=y_t-\hat{b}_0-\hat{b}_{0D}D_{0t}-\sum_{i=1}^{10}(\hat{b}_i+\hat{b}_i^+)\,y_{t-i} \tag{15}$$

and then bootstrap residuals ε_t^* are created by sampling with replacement from $\hat{\varepsilon}_t$. Bootstrap response variables are produced by:

$$y_t^*=\hat{b}_0+\hat{b}_{0D}D_{0t}+\sum_{i=1}^{10}(\hat{b}_i+\hat{b}_i^+)y_{t-i}+\varepsilon_t^* \tag{16}$$

Second, a sample $\hat{b}_{is}^*$ is drawn from y_t^*, s=1, · · · , 500.

Third, for each of the 500 replications, I calculate the average impulse response functions of y_t^* to $\tilde{\varepsilon}_t^*$.

Fourth, I calculate the standard deviation of $\mu_y(i, j)$ in these impulse response functions.

Table 4 shows average impulse responses of baht/dollar exchange rate changes to $\tilde{\varepsilon}_t$. Dynamic responses of yen/dollar exchange rate changes to $\tilde{\varepsilon}_t$ are not mentioned, because it is important whether yen/dollar exchange rate changes have a significant impact on three Asian emerging markets or not. The first 5 day average impact of a one standard deviation shock to {yen, baht, rupiah, won} is repectively a {0.044, 0.151, 0.008, 0.052} depreciation of the baht, when D_{it} is equal to one. In this case, for the yen, the baht, and the won, the null hypothesis $\mu_y(1,5)=0$ can be rejected at the 1% significance level. The first 5 day average impact of a one standard deviation shock is greater in $D_{it}=1$ than in $D_{it}=1$. I now discuss the overall contribution of each currency shock to the exchange rate changes. For this goal, I compute the percentage of the variance of the k step ahead forecast error that is attributable to each currency shock. As k goes to infinity, this corresponds to the percentage of the variance of exchange rate changes that is due to currency shocks. If one item of currency-specific news is more important in generating exchange rate changes than other currency-specific news, we can expect the proportion of this currency

[Table 4] Dynamic Responses of Baht/$ Exchange Rate Changes to $\tilde{\varepsilon}_t$

	Yen/$		Baht/$		Rupiah/$		Won/$	
	$D_{1t}=0$	$D_{1t}=1$	$D_{2t}=0$	$D_{2t}=1$	$D_{3t}=0$	$D_{3t}=1$	$D_{4t}=0$	$D_{4t}=1$
				Impulse Responses				
$\mu_y(1,5)^a$	0.018	0.044	0.155	0.151	0.004	0.008	-0.021	0.052
	(0.013)^b	(0.014)**	(0.024)**	(0.019)**	(0.013)	(0.010)	(0.012)$^+$	(0.010)**
$\mu_y(6,10)$	-0.004	-0.001	0.013	0.020	0.010	-0.056	0.035	-0.052
	(0.015)	(0.016)	(0.015)	(0.013)	(0.015)	(0.015)**	(0.013)**	(0.015)*
$\mu_y(11,15)$	0.011	-0.002	0.034	-0.006	0.009	-0.005	-0.048	-0.018
	(0.013)	(0.011)	(0.019)$^+$	(0.009)	(0.011)	(0.010)	(0.022)*	(0.011)$^+$
$\mu_y(16,20)$	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
				Variance Decompositions				
16-20	0.041	0.059	0.747	0.743	0.025	0.075	0.187	0.122
days	(0.015)**	(0.021)**	(0.072)**	(0.060)**	(0.015)$^+$	(0.026)*	(0.067)**	(0.039)**

a. 5 day average impulse responses of the baht to $\tilde{\varepsilon}_t$.
b. Standard errors are in parentheses. +, *, and ** denote significance at the 10%, 5%, and 1% levels, respectively.

variance in total variance to be large. The last row of Table 4 reports the average of this percentage of each currency shock over the 16 to 20 day horizon for the Thai baht. The estimated percentages range from a high of 74.3%(baht) to a low of 5.9%(yen) in $D_{it}=1$. The percentage of the variance of Baht/$ exchange rate changes that is due to its own shock is larger in $D_{2t}=0$ than $D_{2t}=1$. In all cases, one can easily reject the null hypothesis that the percentage is zero.

Table 5 represents average impulse responses of the Indonesian rupiah to $\tilde{\varepsilon}_t$ in the mean equation. The first 5 day average impact of a one standard deviation shock to {yen, baht, rupiah, won} is respectively a {0.066, 0.165, 0.315, 0.097} depreciation of the rupiah, when $D_{it}=0$. For a one standard shock to {yen, baht, rupiah, won}, the null hypothesis $\mu_y(1,5)=0$ is rejected at the 5% significance level. The first 5 day average impact of a one standard deviation shock to {yen, baht, won} is larger, when D_{it} is equal to zero. For a one standard deviation to the yen, the null hypothesis is not rejected for every specification of (i,j) at the conventional significance level in $D_{it}=1$. The last row of Table 5 reports the average of the variance percentage of each currency shock over the 16 to 20 day horizon for the Indonesian rupiah. The estimated percentages range from a high of 57.6%(rupiah) to a low of 1.2%(yen) in $D_{it}=0$. The yen depreciation is not relatively important in generating exchange rate changes in the Indonesian market, compared with the other two markets. The rupiah-specific shock is more important, when D_{it} equals one.

[Table 5] Dynamic Responses of Rupiah/$ Exchange Rate Changes to $\tilde{\varepsilon}_t$

	Yen/$		Baht/$		Rupiah/$		Won/$	
	$D_{1t}=0$	$D_{1t}=1$	$D_{2t}=0$	$D_{2t}=1$	$D_{3t}=0$	$D_{3t}=1$	$D_{4t}=0$	$D_{4t}=1$
				Impulse Responses				
$\mu_y(1,5)^a$	0.066	0.040	0.165	0.141	0.315	0.365	0.097	0.074
	(0.032)*[b]	(0.036)	(0.038)**	(0.027)**	(0.037)**	(0.033)**	(0.029)**	(0.027)**
$\mu_y(6,10)$	0.041	0.008	0.108	0.005	0.056	-0.030	0.084	-0.033
	(0.039)	(0.041)	(0.042)*	(0.028)	(0.043)	(0.036)	(0.036)*	(0.033)
$\mu_y(11,15)$	0.017	-0.017	0.023	0.003	0.002	-0.004	-0.076	0.031
	(0.030)	(0.021)	(0.041)	(0.016)	(0.029)	(0.020)	(0.048)	(0.020)
$\mu_y(16,20)$	-0.000	-0.002	-0.000	-0.000	-0.000	-0.001	-0.000	0.004
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)
				Variancec Decompositions				
16-20	0.012	0.045	0.178	0.062	0.576	0.761	0.234	0.132
days	(0.009)	(0.019)*	(0.047)**	(0.028)*	(0.052)**	(0.045)**	(0.045)**	(0.036)**

a. 5 day average impulse responses of the rupiah to $\tilde{\varepsilon}_t$.

b. Standard errors are in parentheses. +, *, and ** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6 indicates average impulse responses of won/dollar exchange rate changes to $\tilde{\varepsilon}_t$. The first 5 day average impact of a one standard deviation shock to {yen, baht, rupiah, won} is respectively a {0.044, 0.039, 0.002, 0.157} increase in the won, when $D_{it}=1$. The first 5 day average impact is greater when $D_{it}=1$. The null hypothesis $\mu_y(1,5)=0$ is rejected at the 5% significant level in cases of shocks to the yen, the baht, and the won in $D_{it}=1$. Foreign shocks have relatively less impact on won/dollar exchange rate changes than a domestic shock, compared with other two exchange rate changes. Especially, the rupiah-specific shock has a negative impact on the won in $\mu_y(6,10)$. The estimated variance percentages range from a high of 77.4%(won) to a low of 2.3%(baht) in $D_{it}=1$. The percentage of the variance of Won/$ exchange rate changes that is due to its own shock is rather smaller, when $D_{4t}=1$.

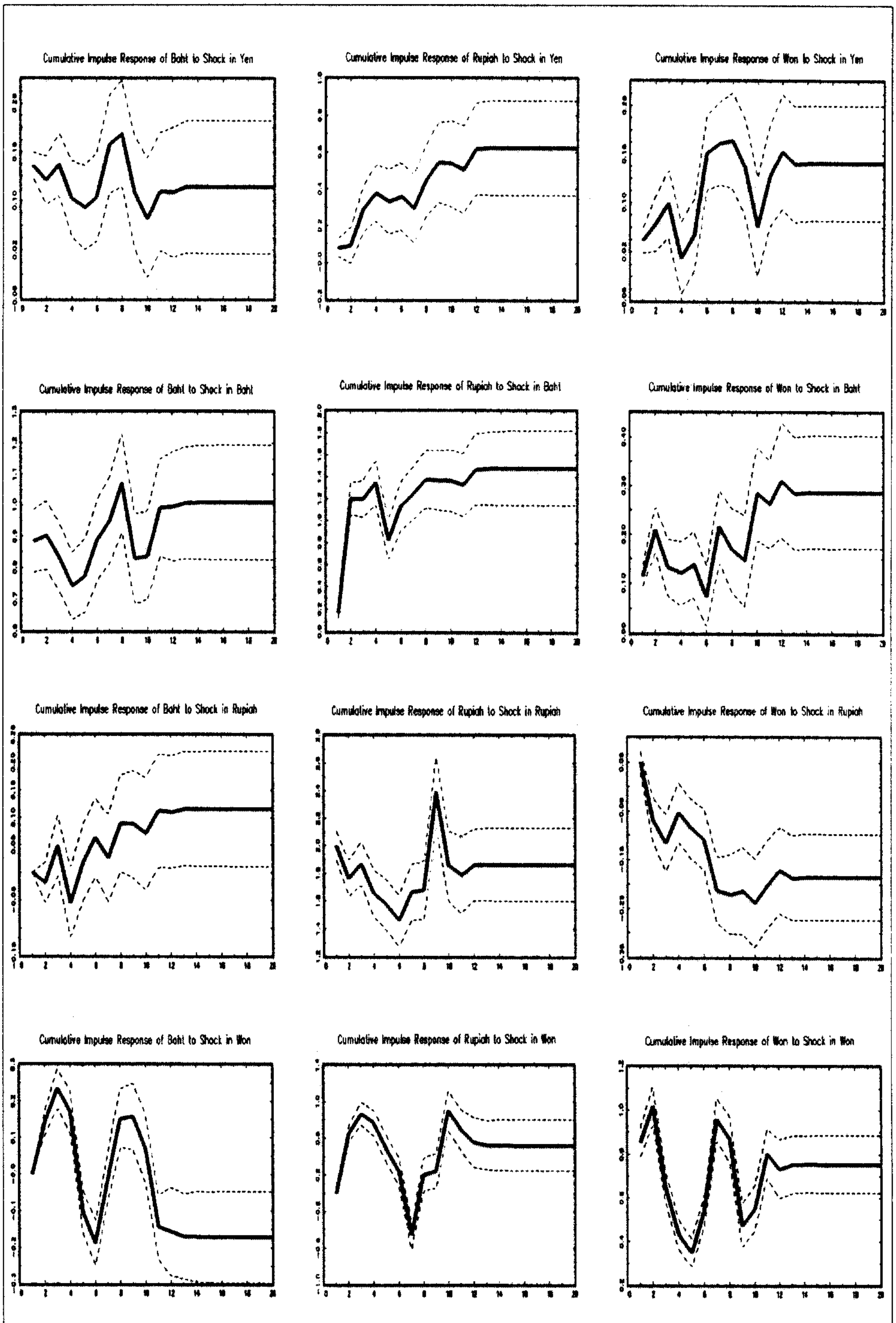
[Table 6] Dynamic Responses of Won/$ Exchange Rate Changes to $\tilde{\varepsilon}_t$

	Yen/$		Baht/$		Rupiah/$		Won/$	
	$D_{1t}=0$	$D_{1t}=1$	$D_{2t}=0$	$D_{2t}=1$	$D_{3t}=0$	$D_{3t}=1$	$D_{4t}=0$	$D_{4t}=1$
				Impulse Responses				
$\mu_y(1,5)^a$	0.010	0.044	0.028	0.039	-0.018	0.002	0.070	0.157
	(0.012)[b]	(0.019)*	(0.012)	(0.013)**	(0.012)	(0.013)	(0.013)**	(0.018)**
$\mu_y(6,10)$	0.003	-0.028	0.029	-0.021	-0.030	-0.059	0.040	0.127
	(0.014)	(0.024)	(0.013)*	(0.016)	(0.014)*	(0.020)**	(0.015)**	(0.022)**
$\mu_y(11,15)$	0.021	0.019	0.001	0.006	0.011	0.019	0.041	-0.043
	(0.013)+	(0.016)	(0.016)	(0.011)	(0.013)	(0.014)	(0.021)+	(0.016)**
$\mu_y(16,20)$	-0.000	0.000	-0.000	0.000	-0.000	0.000	0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
				Variance Decompositions				
16-20	0.033	0.031	0.050	0.023	0.025	0.173	0.893	0.774
days	(0.019)+	(0.018)+	(0.024)*	(0.014)+	(0.016)	(0.038)**	(0.034)**	(0.042)**

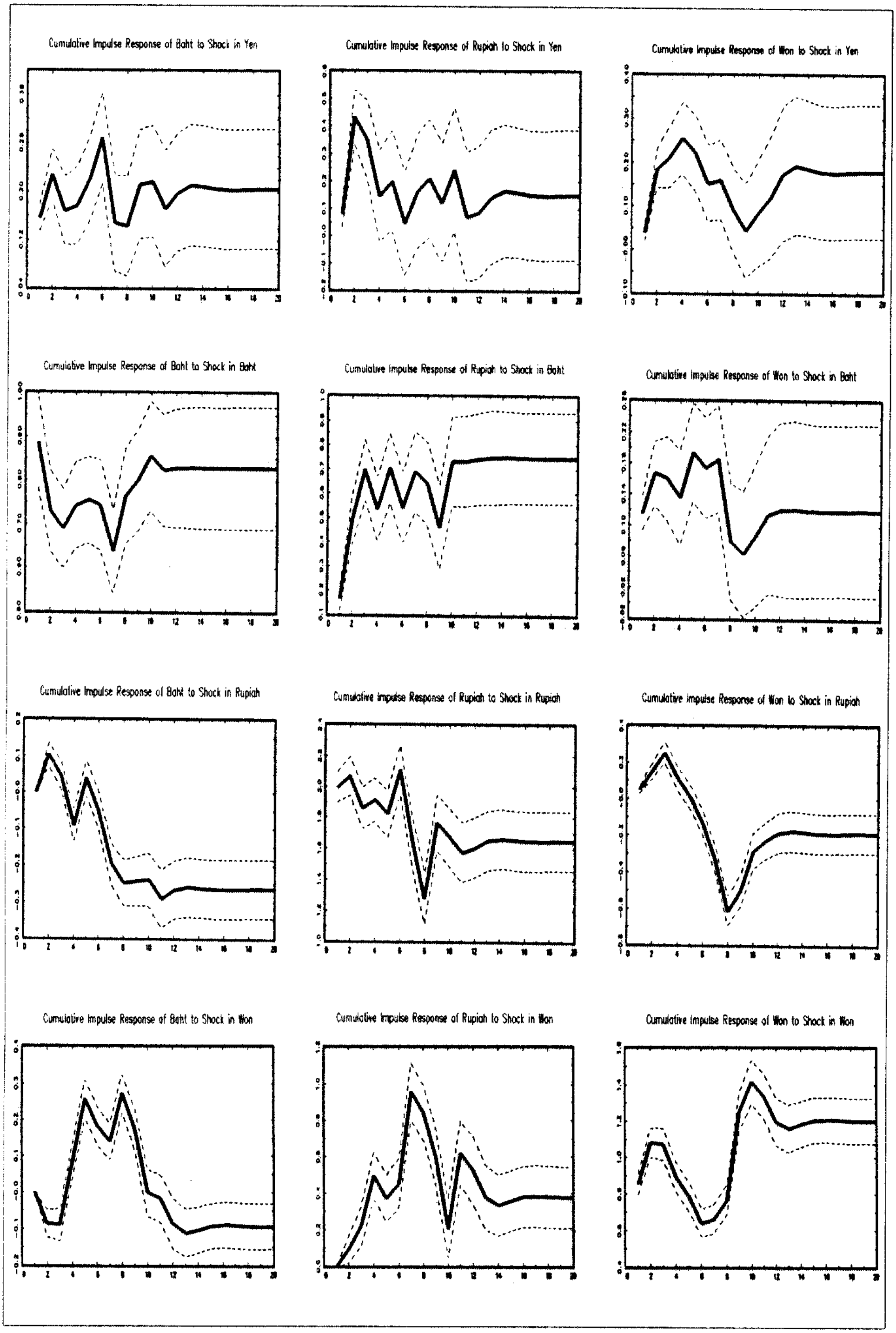
a. 5 day average impulse responses of the won to $\tilde{\varepsilon}_t$.
b. Standard errors are in parentheses. +, *, and ** denote significance at the 10%, 5%, and 1% levels, respectively.

In summary, three Asian emerging markets were influenced by domestic currency-specific shocks and other currency-specific shocks for the whole period. The rupiah-specific shock has relatively a little impact on the other two currencies. In Rupiah/$ case, the first 5 day average impact is greater when

[Figure 2] Responses of Exchange Rate Changes ($D_{i\,t}=0$)



[Figure 3] Responses of Exchange Rate Changes ($D_{i\,t}=1$)



$D_{it}=0$. But the reverse is case in Baht/\$ and Won/\$ cases. The empirical results may come from the fact that the dummy variable is used for the currency crisis period. They may be also due to the time lag between the rupiah data and the other three exchange rate data, as already mentioned in Data Summary. Domestic currency-specific shocks are relatively more important in the won than in the baht and the rupiah.

Figure 2 and Figure 3 show cumulative impulse responses emerging from the estimated VAR. Columns 1 through 3 of Figure 2 depict results for cases of the Thai baht, the Indonesian rupiah, and the Korean won in $D_{it}=0$. The solid lines in Figure 2 report the cumulative impulse responses of y_t to $\tilde{\varepsilon}_t$ in the mean equation. The dotted lines denote a one standard deviation band about point estimates of the coefficients in the impulse response functions. The standard deviation bands are derived by the bootstrap method, already mentioned above. According to Figure 2, a one standard deviation shock to each currency depreciates exchange rates within a few days. Figure 3 shows that each currency doesn't always depreciate more steeply in $D_{it}=1$ than in $D_{it}=0$. For example, a one standard deviation shock to {yen, baht, rupiah, won} depreciates the rupiah/dollar exchange rate more steeply in $D_{it}=0$ than in $D_{it}=1$ in the long run. A one standard deviation shock to rupiah appreciates the baht/dollar and won/dollar exchange rates in the long run.

5.2 The Conditional Variance

This section examines impulse responses of exchange rate volatility to domestic and foreign currency-specific shocks in Asian foreign exchange markets. Tables 7 through 9 show average impulse responses of exchange rate volatility to absolute standardized innovations for the whole period. Because there exists the asymmetric relation between z_t and $\ln \sigma_t^2$, I report the results in cases of $z_t>0$ and $z_t<0$, separately.

Table 7 indicates average impulse responses of baht/dollar exchange rate volatility to $|z_t|$. The average impact of a one standard deviation shock to {yen, baht, rupiah, won} increases baht/dollar exchange rate volatility ($\ln \sigma_{11t}{}^2$). Average impulse responses of baht/dollar exchange rate volatility to a one standard deviation shock in the baht are larger in $z_{2t}<0$ than in $z_{2t}>0$, because γ_{22} is negative. I also apply the second moment variance decompositions to evaluate the contribution of common and country specific news to the volatility of exchange rates. The variance decompositions measure the proportion of currency specific shocks in explaining volatility within the sample period. If one currency specific shock is more important in generating exchange rate volatility than other currency specific shocks, one can expect the proportion of this currency variance in total variance to be large. The estimated percentages range from a high of

67.8%(baht) to a low of 0.0%(won) in case of $z_t>0$. The proportion of the baht variance in total variance is smaller in $z_t>0$ than in $z_t<0$. Exchange rate volatility responds asymmetrically to positive and negative residuals.

[Table 7] Dynamic Responses of Baht/$ Exchange Rate Volatility to $|z_t|$

	Yen/$		Baht/$		Rupiah/$		Won/$	
	$z_{1t}>0$	$(z_{1t}<0)$	$z_{2t}>0$	$(z_{2t}<0)$	$z_{3t}>0$	$(z_{3t}<0)$	$z_{4t}>0$	$(z_{4t}<0)$
				Impulse Responses				
$\mu_{\ln\sigma^2}(1,5)$[a]	0.148	(〃)	0.319	(0.481)	0.163	(〃)	0.003	(〃)
$\mu_{\ln\sigma^2}(1,5)$	0.117	(〃)	0.251	(0.378)	0.128	(〃)	0.002	(〃)
$\mu_{\ln\sigma^2}(1,5)$	0.092	(〃)	0.198	(0.298)	0.101	(〃)	0.002	(〃)
$\mu_{\ln\sigma^2}(1,5)$	0.072	(〃)	0.156	(0.234)	0.079	(〃)	0.002	(〃)
				Variance Decompositions				
16-20 days	0.146	(0.079)	0.678	(0.827)	0.176	(0.095)	0.000	(0.000)

a. 5 day average impulse responses of the baht to $|z_t|$.

Table 8 shows average impulse responses of rupiah/dollar exchange rate volatility to $|z_t|$. The average impact of a one standard deviation shock to {yen, baht, rupiah, won} increases rupiah/dollar exchange rate volatility. The average impact of a shock in the yen is similar to that of a shock in the won. γ_{33} is positive so that impulse responses of rupiah/dollar exchange rate volatility to a

[Table 8] Dynamic Responses of Rupiah/$ Exchange Rate Volatility to $|z_t|$

	Yen/$		Baht/$		Rupiah/$		Won/$	
	$z_{1t}>0$	$(z_{1t}<0)$	$z_{2t}>0$	$(z_{2t}<0)$	$z_{3t}>0$	$(z_{3t}<0)$	$z_{4t}>0$	$(z_{4t}<0)$
				Impulse Responses				
$\mu_{\ln\sigma^2}(1,5)$[a]	0.114	(〃)	0.184	(〃)	0.199	(0.153)	0.117	(〃)
$\mu_{\ln\sigma^2}(1,5)$	0.102	(〃)	0.165	(〃)	0.178	(0.138)	0.105	(〃)
$\mu_{\ln\sigma^2}(1,5)$	0.091	(〃)	0.148	(〃)	0.160	(0.123)	0.094	(〃)
$\mu_{\ln\sigma^2}(1,5)$	0.082	(〃)	0.133	(〃)	0.143	(0.111)	0.085	(〃)
				Variance Decompositions				
16-20 days	0.129	(0.154)	0.339	(0.403)	0.395	(0.280)	0.137	(0.164)

a. 5 day average impulse responses of the rupiah to $|z_t|$.

one standard deviation shock in the rupiah are larger in $z_t>0$ than in $z_t<0$. The estimated percentages of variance decompositions range from a high of 39.5%(rupiah) to a low of 12.9%(yen) in case of $z_t>0$. The proportion of rupiah/dollar exchange rate's variance is smaller in $z_t<0$ than in $z_t>0$.

Table 9 shows average impulse responses of won/dollar exchange rate volatility to $|z_t|$. The average impact of a one standard deviation shock to {yen, baht, rupiah, won} increases won/dollar exchange rate volatility. A one standard deviation shock to {yen, baht, rupiah} has a similar impact on won/dollar exchange rate volatility. Average impulse responses of won/dollar exchange rate volatility to a one standard deviation shock in the won are larger in $z_{4t}>0$ than in $z_{4t}<0$, because γ_{44} is positive. The proportion of won/dollar exchange rate variance in total variance is relatively larger, compared with cases of the other two emerging markets. It is larger in $z_t>0$ than in $z_t<0$.

In summary, exchange rate volatility in these three Asian countries were affected by foreign currency-specific shocks as well as domestic shocks. Foreign currency-specific shocks are more important in the rupiah than in the other currencies. On the other hand, the rupiah/dollar exchange rate's shock has a relatively weaker impact on each of the other two currencies' exchange rate volatility. Domestic shocks are relatively stronger in won/dollar exchange rate volatility than in the other two currencies' exchange rate volatility. Rupiah/$ and Won/$ exchange rate volatility is larger in $z_t>0$ than in $z_t<0$, because γ_{33} and γ_{44} are positive.

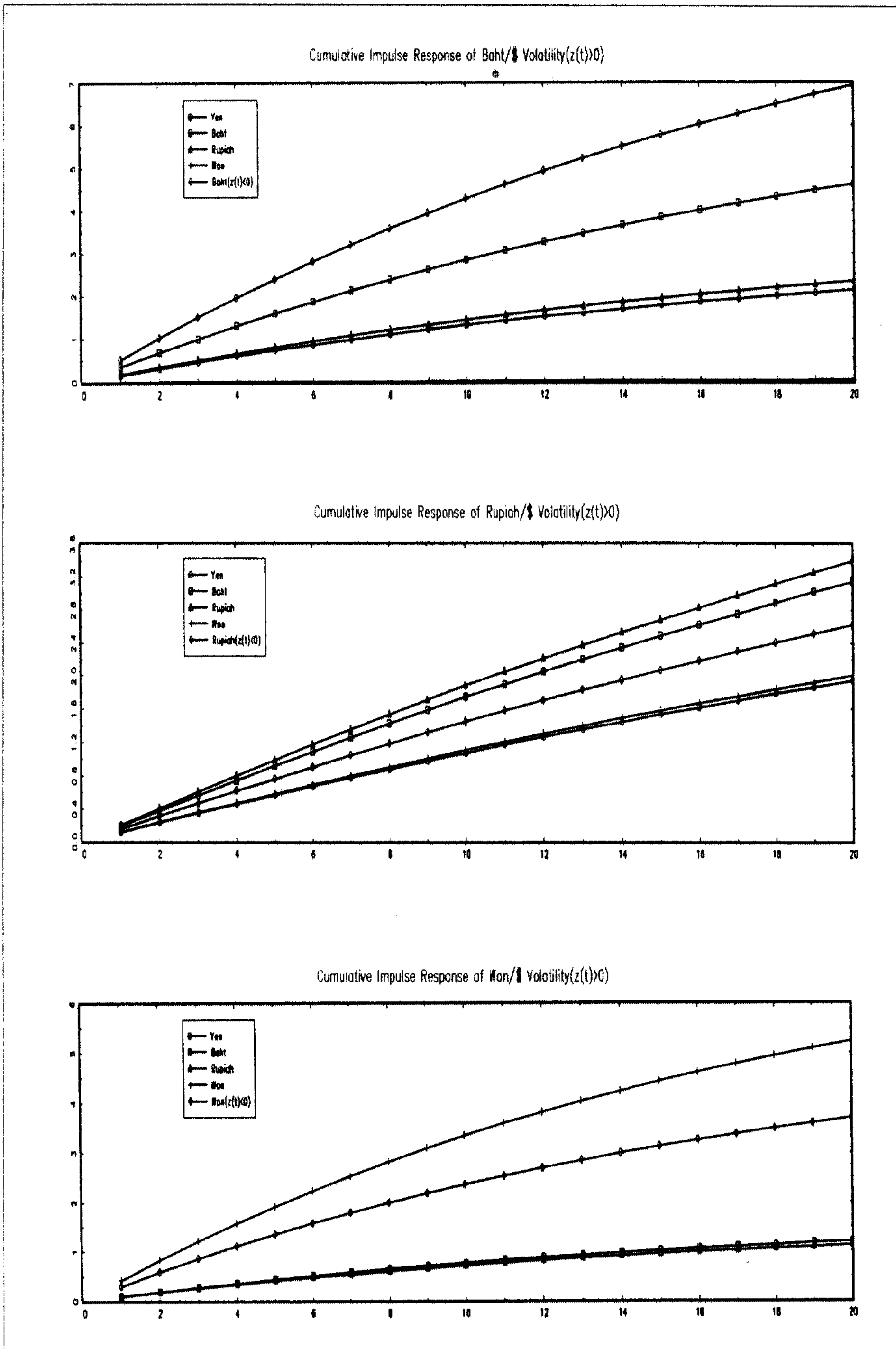
[Table 9] Dynamic Responses of Won/$ Exchange Rate Volatility to $|z_t|$

	Yen/$		Baht/$		Rupiah/$		Won/$	
	$z_{1t}>0$	$(z_{1t}<0)$	$z_{2t}>0$	$(z_{2t}<0)$	$z_{3t}>0$	$(z_{3t}<0)$	$z_{4t}>0$	$(z_{4t}<0)$
				Impulse Responses				
$\mu_{\ln\sigma^2}(1,5)$[a]	0.088	(〃)	0.088	(〃)	0.082	(〃)	0.383	(0.271)
$\mu_{\ln\sigma^2}(1,5)$	0.066	(〃)	0.066	(〃)	0.062	(〃)	0.287	(0.203)
$\mu_{\ln\sigma^2}(1,5)$	0.050	(〃)	0.049	(〃)	0.046	(〃)	0.215	(0.152)
$\mu_{\ln\sigma^2}(1,5)$	0.037	(〃)	0.037	(〃)	0.035	(〃)	0.161	(0.114)
				Variance Decompositions				
16-20 days	0.046	(0.081)	0.046	(0.081)	0.040	(0.070)	0.868	(0.767)

a. 5 day average impulse responses of the won to $|z_t|$.

Figure 4 shows cumulative impulse responses of exchange rate volatility emerging from the estimated EGARCH. Given the shock in each exchange rate,

[Figure 4] Responses of Exchange Rate Volatiliy



how volatility in one exchange rate will be affected is plotted in Figure 4. Each exchange rate volatility is more influenced by its own shock rather than other exchange rate's shock. But the Indonesian rupiah responds relatively more to shocks from other currencies. The impulse response of each exchange rate volatility to its own shock is larger in $z_t>0$ than in $z_t<0$ in cases of Rupiah/$ and Won/$.

The results of impulse response analyses for the period between September 1, 1998 and December 31, 2000 are omitted in order to save pages. But, as already mentioned in Section 4, currency-specific shocks and the common external shock such as the yen depreciation have little impact on the three exchange rate changes. Dynamic responses of three exchange rate changes to $\tilde{\varepsilon}_t$ become much smaller in this period than in the whole period.[3] But exchange rate volatility in these three Asian countries were still affected by domestic and foreign currency-specific shocks in contrast to exchange rate changes, even if dynamic responses of three exchange rate volatility to $|z_t|$ become weaker.

VI. CONCLUSIONS

This paper studies joint dynamics in Asian emerging foreign exchange markets. VAR models with EGARCH(1, 1) errors are chosen to examine the effect of currency-specific shocks to exchange rates and their volatility.

The empirical results show that spillover and monsoonal effects exist in three Asian foreign exchange markets. Currency-specific shocks have significant impact on other exchange rates and their volatility in the region. The common external shock such as the yen depreciation also affect these emerging foreign exchange markets.

According to impulse response analyses, currency-specific shocks depreciated the three Asian exchange rates examined within a few days in most cases. Further, other currency-specific shocks are relatively more important in the rupiah than in the baht and the won. The rupiah-specific shock has little impact on the other two currencies in the conditional mean. Exchange rate volatility in the three Asian currencies considered are also affected by currency-specific shocks. Currency-specific shocks increase exchange rate volatility in the region. Foreign currency-specific shocks are relatively more important in rupiah/dollar exchange rate volatility than the other two currencies' exchange rate volatility. Impulse responses of each exchange rate changes and their volatility are not necessarily larger in $D_{it}=1$ than in $D_{it}=0$.

But when the period between September 1, 1998 and December 31, 2000 is

[3] But, when Bollerslev's(1990) model is estimated, constant conditional correlation between exchange rate changes is generally bigger in this period than in the whole period. In Bollerslev's(1990) model, the conditional covariance matrix Ω_t is time varying, but the conditional correlation is assumed to be constant.

considered, common and country-specific shocks have less impact on three Asian exchange rate changes and their volatility. Especially, these shocks have little impact on these exchange rate changes. On the other hand, they still have an important impact on these exchange rate volatility. It is expected that Asian emerging exchange markets tend to follow these movements in the future. In other word, it becomes more difficult to forecast Asian foreign exchange rate changes. On the other hand, Asian exchange rates and their volatility become more correlated.

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