IUJ Research Institute Working Paper 03-2
International Development Series

Exchange Rate Volatility and Exports from East Asian Countries to Japan and the U.S.

SaangJoon Baak*

International Univ. of Japan
Yamato-machi
Minami Uonuma-gun
Niigata, 949-7277 Japan

Email: sbaak@iuj.ac.jp
Phone: 81-257-79-1510
Fax: 81-257-79-1187

Arif Al-Mahmood

Royal Holloway
University of London
Egham, Surrey
UK

Souksavanh Vixathep

Asian Development Bank
Lao Resident Mission
Laos

ABSTRACT

The purpose of this paper is to investigate the impact of exchange rate volatility on exports in four East Asian countries (Hong Kong, South Korea, Singapore, and Thailand). Specifically, this paper aims to determine whether the bilateral real exchange rate volatility between an East Asian country and its trading partner negatively affects the exports of the East Asian country. Considering the dominant roles of the U.S. and Japan as trading partners of those East Asian countries, this paper focuses on the monthly export volumes of East Asian countries to the U.S. and Japan for the period from 1990 to 2001. Except for the case of Hong Kong's exports to Japan, cointegration tests and estimations of error correction models indicate exchange rate volatility has negative impacts on exports either in the short run or in the long-run, or both. On the other hand, manufacturing production indices of importing countries and depreciation of real bilateral exchange rates turn out, in general, to have positive effects on the exports of the East Asian countries examined.

JEL Classification: C2, F1, F3

Keywords: Exchange rate volatility, Export, East Asia, Cointegration, Error correction model

* The corresponding author

ID No. Economics & management series 2003-01 (Former No. International development series 2003-2 June, 2003)

1. Introduction

The purpose of this paper is to investigate the impact of exchange rate volatility on exports in four East Asian countries (Hong Kong, South Korea, Singapore, and Thailand) where exports have been the major engine of economic growth.

Even though these East Asian countries has implemented export-oriented economic policies since their early stages of development, the impact of exchange rate volatility on exports, which has attracted the interests of researchers and policy makers since early 1970s, has rarely been studied for those countries. One major reason of this neglect may be rooted in the facts that the exchange rates of East Asian currencies against the U.S. dollar had been relatively stable since they had been implicitly pegged to the U.S. dollar until the 1997 financial crisis and that the U.S. has been the main export market of most East Asian countries.

As East Asian countries has moved to a floating exchange rate system since the 1997 financial crisis and as the share of non-US markets in the exports of East Asian countries has been increasing[1], however, the issue of the impact of exchange rate volatility on exports has gained some attentions of researchers and policy makers in East Asia.

Even though East Asian countries manage to stabilize their currency values against the U.S. dollar, it does not mean their currency values are also stable against the currencies of other major trading partners of theirs than the U.S., such as the Japanese yen. In fact, since the Japanese yen floated more freely against the U.S. dollar while other East Asian currencies were effectively pegged to the U.S. dollar, the exchange rates of East Asian currencies against the Japanese yen were relatively unstable. Therefore, the impact of exchange rate volatility on exports is an issue to a country whose exchange rate against the U.S. dollar is managed quite stable but where the U.S. is not the only dominant trading partner.

As Kawai and Takagi (2001) point out, this issue is especially important to the post-crisis East Asia which is seeking a new regional exchange rate regime because

[1] See Tables 1-1 through 1-4. Except for the case of Thailand, the share of the U.S. in the exports of the East Asian countries examined in this paper has declined for the last 15 years. According to

the impact of exchange rate volatility on exports should be examined to construct an optimal exchange rate scheme. Also, it should be considered by the local monetary authorities when they set the weights of different foreign currencies in the determination of the values of their own currencies.

Against this background, the present paper aims to determine whether the bilateral exchange rate volatility between an East Asian country and its trading partner negatively affects the exports of the East Asian country. Considering the dominant roles of the U.S. and Japan as trading partners of East Asian countries, this paper focuses the exports from East Asian countries to the U.S. and to Japan for the period from 1990 to 2001.

In fact, numerous studies, theoretically and empirically, have attempted to find the nature of the relationship between exchange rate volatility and exports, and reported both positive and negative relationships. In addition, some have reported no significant relationship. [2] However, as mentioned earlier, this issue was rarely investigated regarding the exports of East Asian countries.

It should be, however, noted that this paper distinguishes from the previous literature not only by the geographical focus of the study but also by the empirical research tools. Most of empirical research examining time series data in this area investigated quarterly data of the total export volumes of one or more countries.[3] In contrast, the present paper investigates monthly data of bilateral export volumes, which is expected to yield more accurate results as Baum, Caglayan and Ozkan (2001) and Dell'Ariccia (1999) argue.

Following Arize, Osang and Slottje (2000), Chowdhury (1993) and Hassan and Tufte (1998) among others, the long-run relationship between exchange rate volatility and exports is examined by performing cointegration tests, and the short run impacts of exchange rate volatility on exports is examined by estimating error-

---

Nakamura and Matsuzaki (1997) and Takagi (1996), Japan' share in the exports of the whole East Asian countries became close to the U.S. in mid 1990s.

[2] See De Grauwe (1988) and Secru and Uppal (2000, Ch. 6) for theoretical examples showing an ambiguous relationship and Baccheta and Wincoop (2000) for a theoretical example showing no relationship. The empirical researches of Arize, Osang and Slottje (2000), Chowdhurry (1993), Kim and Lee (1996) and Peree and Steinherr (1989) report a negative relationship while Bahmani-Oskooee and Payestech (1993) and Hooper and Kohlhagen (1978) report an insignificant relationship.

[3] See, for example, Arize, Osang and Slottje (1999, 2000), Chowdhurry (1993), Hassan and Tufte (1998), and Kim and Lee (1996).

correction models. Along with exchange rate volatility, manufacturing production indices and real bilateral exchange rates are also employed as explanatory variables of real export volumes.

Exchange rate volatility is measured by computing the monthly standard deviations of daily real bilateral exchange rates. Since daily exchange rates are nominal and price indices are not available on a daily basis, monthly price indices were converted into daily price indices using the method of "Quadratic-Match Average" available in the software package, E-Views 4, to compute daily real bilateral exchange rates.

In the case of exports to the U.S., preliminary empirical test results indicate a negative long-run relationship between exports and exchange rate volatility in South Korea and Singapore, and no long-run relationship in Hong Kong and Thailand. However, negative short-run impacts of exchange rate volatility on exports are detected in Hong Kong and South Korea.

In the case of the exports to Japan, empirical studies indicate a negative long-run relationship between exports and exchange rate volatility in South Korea and Thailand, and a positive long-run relationship in Hong Kong and Singapore. In contrast, negative short-run impacts of exchange rate volatility on exports are detected in all the countries examined, except for Hong Kong.

On the other hand, manufacturing production indices of importing countries and depreciation of real bilateral exchange rates turn out, in general, to have positive effects on export volumes of the East Asian countries examined.

2. Description of the model and data

2.1. The cointegration equation

This paper investigates the long-run relationship between exchange rate volatility and exports by performing cointegration tests and the short run impacts of volatility on exports by estimating error-correction models as in Arize, Osang and Slottje (1999, 2000), Chowdhury (1993) and Hassan and Tufte (1998).

Following the typical specification of other papers, the long-run equilibrium relation between exports and other economic variables is examined in this paper by the following equation:

$$X_t = \xi_0 + \xi_1 . i_t + \xi_2 p_t + \xi_3 \sigma_t + \varepsilon_t \qquad \text{------ (1)}$$

where X_t denotes real exports from an East Asian country to either the U.S. or Japan, p_t the real bilateral exchange rate reflecting the price competitiveness, i_t the manufacturing production index of the importing country, σ_t the exchange rate volatility, and ε_t a disturbance term. All variables are in natural logarithm.

In this equation, i_t is used as a proxy for economic activity in the importing country because monthly data for GDP are not available. It is expected that the higher the economic activity in the importing country, the higher the demand for exports. Therefore, the value for ξ_1 is expected to be positive. Since a higher real exchange rate implies a lower relative price, the value for ξ_2 is also expected to be positive.

Exchange rate volatility is measured by computing the monthly standard deviations of daily real bilateral exchange rates. Since daily exchange rates are nominal and price indices are not available on a daily basis, monthly price indices were converted into daily price indices using the method of “Quadratic-Match Average” available in the software package, E-Views 4, to compute daily real bilateral exchange rates.

The following subsection shows more specifically how the data for the variables were computed.

2.2. The variables

Real exports (X_{it})

In order to ensure consistency in data[4], exports of the East Asian economies under consideration are converted from US dollar into the respective local currency unit (LCU) using corresponding nominal exchange rates, since the export unit value index is based on domestic currency[5]. Real exports of country *i* are defined as follow:

$$X_{it} = \ln\left(\frac{EX_{it}}{EXUV_{ti}} \times 100\right), \qquad i=1, 2, 3, 4$$

where X_{it} denotes real exports of country *i* in domestic currency in natural logarithm scale, EX_{it} is monthly nominal exports of country *i* in domestic currency, $EXUV_{it}$ denotes the index of export unit value of country *i* and the index *t* symbolizes the time.

Industrial production index (i_t)

As mentioned in the previous section, lack of monthly data for income or GDP of the importing countries leads to the application of the industrial production index as a proxy variable for the economic condition of the importing country. Industrial production indices are commonly used as a proxy for income in literature, for example Baum, Calagyan and Ozkan (2002). The variable i_t is the natural logarithm of the industrial production index of an importing country in time *t.*

Real bilateral exchange rate (p_t)

Bilateral trade between two countries depends upon, among other things, exchange rates and the relative price level of the two partners. Hence, the following definition of real exchange rates for country *i* captures both effects related to the price of currencies, and of goods and services.

[4] Variables, which were not seasonally pre-adjusted, were adjusted for seasonality prior to taking logarithm by applying the method Census X12 available in the software package Eviews 4.
[5] See IFS documents, such as IFS yearbook 2001, for detailed explanation about the unit value index for exports.

$$p_{it} = \ln\left(E_{it} \times \frac{CPI_{jt}}{CPI_{it}}\right), \qquad i=1, 2, 3, 4$$

where p_{it} symbolizes real monthly exchange rate in natural logarithm scale; E_{it} is the nominal monthly exchange rate; CPI_{it} and CPI_{jt} denote the monthly consumer price index of an exporting country *i* and an importing country *j*, respectively; and *t* symbolizes the time index.

Real exchange rate volatility (σ_t)

Although there exist numerous measures for exchange rate risks, the present study applies standard deviation of exchange rates, since this measure is common in literature, for instance Akhtar and Hilton (1984) and Baum et al. (2002). The monthly real exchange rate volatility σ_t is defined as the natural logarithm of the standard deviation of daily real exchange rates (RER_{ij}) within one month.

$$\sigma_{ijt} = \ln\left(\sqrt{\frac{1}{n-1}\sum_{k=1}^{n}\left(RER_{ik} - \overline{RER_i}\right)^2}\right), \qquad i=1, 2, 3, 4$$

where RER_{ik} is the daily real exchange rate of country *i* in normal scale; $\overline{RER}_i$ denotes the monthly average of daily real exchange rates in normal scale and *k* is the index of the days in a month, on which exchange rate data are available. RER_{ik} is defined as the product of country *i*'s daily nominal exchange rate and the ratio of the daily CPI of the importing country over the daily CPI of the exporting country.

As illustrated above, the computation of daily real exchange rates requires daily data for the consumer price index. Hence, monthly CPI was used to compute daily CPI for the six economies involved because of lack of daily CPI data. Derived from the methodology applied in Baum et al. (2002), the frequency conversion from low frequency (monthly) to high frequency (daily) was conducted by applying the method “Quadratic-match Average” available in the software package Eviews4.

Data Sources

The monthly data starts from January 1990 and ends at November 2001. Consumer Price Indices (CPI) have been collected from the *International Financial Statistics (IFS)* of the International Monetary Fund (IMF).

The data for exports from each East Asian country to Japan and to the U.S. have been obtained from the *Direction of Trade Statistics (DOTS)* of the IMF. The data for the industrial production index of Japan have been collected from the Ministry of Economy, Trade and Industry (METI) of Japan, while the data for the industrial production index of the U.S. have been collected from the Federal Reserve Board (FRB) of the U.S. Daily exchange rate data have also been collected from the FRB of the U.S.

2.3. The error-correction model

After observing the results of cointegration tests, the following dynamic error correction (EC) model is constructed and estimated to see the short-run impacts of exchange rate volatility on exports:

$$\Delta X_t = k_0 + \lambda EC_{t-1} + \sum_{i=0}^{n} \alpha_{1i} \Delta X_{t-i-1} + \sum_{i=o}^{n} \alpha_{2i} \Delta p_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta i_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta \sigma_{t-i} + u_t \text{ --- (2)}$$

If the variables in equation (1) are not cointegrated, the error correction term, EC_{t-1}, will be eliminated from equation (2).

3. Empirical test results

3.1. Unit Root tests

As preparation for cointegration tests, the presence of unit roots in the variables included in equation (1) are examined using the augmented Dickey-Fuller (ADF) tests. Tables <2-1> and <2-2> present the augmented Dickey-Fuller test statistics for the first differences all the four variables in equation (1). The length of the lags included in the tests were determined by the Akaike infomation criterion. The ADF statistics for the levels of all the series were below the critical values implying the presence of unit roots. However, the statistics obtained from the first differences of the variables reject the null hypothesis of a unit root at the five percent significance level.

3.2. Cointegration tests and Error correction model

Johansen (1988,1991) cointegration tests were applied to test for the presence of a long-run equilibrium relationship in the variables in equation (1). The results of cointegration tests are presented in Tables <3-1> and <3-2>, where *r* denotes the number of cointegrating vectors. The test statistics imply the presence of one cointegrating relationship for all the four countries examined. .

The estimated coefficients for the long-run relationship are presented in Tables <4-1> and <4-2> and the estimated coefficients for the error corrected models are presented in Tables <5-1> and <5-2>. In all countries, the level of economic activity measured by the manufacturing production index turns out to positively affect exports to Japan and exports to the U.S. both in the long run and in the short run.

In contrast, the impact of exchange rate volatility turns out to be a little bit ambiguous as in other literature. In the case of exports to the U.S., preliminary empirical test results indicate a negative long-run relationship between exports and exchange rate volatility in South Korea and Singapore, and no long-run relationship in Hong Kong and Thailand. However, negative short-run impacts of exchange rate volatility on exports are detected in Hong Kong and South Korea.

In the case of the exports to Japan, empirical studies indicate a negative long-run relationship between exports and exchange rate volatility in South Korea and Thailand, and a positive long-run relationship in Hong Kong and Singapore. In contrast, negative short-run impacts of exchange rate volatility on exports are detected in all the countries examined, except for Hong Kong.

References

Arize, Augustine C., Thomas. Osang and Daniel J. Slottje (2000), "Exchange-rate volatility in Latin America and its impact on foreign trade," manuscript, Texas A&M University.

Arize, Augustine C., Thomas. Osang and Daniel J. Slottje (2000), "Exchange-rate volatility and foreign trade: evidence from thirteen LDC's," *Journal of Business & Economic Statistics*, vol. 18, no. 1, pp. 10-17.

Baak, S. J. (2001), "Japanese yen and East-Asian currencies: before and after the Asian fianacial crisis," International Development Series 7, International University of Japan.

Bacchetta, Philippe and Eric van Wincoop (2000), "Does exchange-rate stability increase trade and welfare?" The American Economic Review, vol. 90, no. 5, pp. 1093-1109.

Bahmani-Oskooee, Mohsen and Sayeed Payesteh (1993), Does exchange rate volatility deter trade volume of LDCs? Journal of Economic Development, vol. 18, pp. 189-205.

Baum, Christopher F., Mustafa Caglayan and Neslihan Ozkan (2001), Exchange rate effects on the volume of trade flows: an empirical analysis employing high-frequency data, manuscript, Boston College.

Chowdhury, Abdur R. (1993), "Does exchange rate volatility depress trade flows? Evidence from Error-Correction Models," *The Review of Economics and Statistics*, vol. 75, no. 4, pp. 700-706.

Côté, Agathe (1994), "Exchange rate volatility and trade: a survey," Working Paper 94-5, Bank of Canada.

De Grauwe, Paul (1988), "Exchange rate variability and slowdown in growth of international trade," *IMF Staff Papers*, vol. 35, pp. 63-84.

Dell'Ariccia, Giovanni (1999), Exchange rate fluctuations and trade flows: evidence from the European Union, IMF Staff Papers, vol. 46, no. 3, pp. 315-334.

Dickey, D. A., and W. A. Fuller (1979), "Distribution of the estimators for autoregressive time series with a unit root," *Journal of the American Statistical Association*, vol. 74, pp. 427-31.

Dickey, D. A. and W. A. Fuller (1981), “Likelihood ratio statistics for autoregressive time series with a unit root,” *Journal of the American Statistical Association*, vol. 74, pp. 1057-1072.

Frankel, J. A. and S. J. Wei (1994), “Yen bloc or dollar bloc? Exchange rate policies of the East Asian economies,” Ito, T and A. O. Krueger eds., Macroeconomic linkage: savings, exchange rates, and capital flows, NBER-East Asia seminar on economics, vol 3, National Bureau of Economic Research, Cambridge.

Hassan, M. Kabir and David R.Tufte (1998), “Exchange rate volatility and aggregate export growth in Bangladesh”, *Applied Economics*, vol. 30, pp. 189-201.

Hooper, Peter and Steven Kohlhagen (1978), The effect of exchange rate uncertainty on the prices and volume of international trade, Journal of International Economics, vol. 8, pp. 483-511.

Ito, T., E. Ogawa and Y. N. Sasaki (1998), “How did the dollar peg fail in Asia?” Journal of Japanese and International Economies, vol. 12, no. 4, pp. 256-304.

Johansen, Søren (1988), “Statistical analysis of cointegration vectors,” *Journal of Economic Dynamics and Control*, vol.12, pp. 231-254.

Johansen, Søren (1991), "Estimation and hypothesis testing of cointegration vectors in Gaussian Vector Autoregressive Models," *Econometrica*, Vol. 59, pp. 1551-1580.

Kawai, Masahiro and Shinji Takagi (2001), “Proposed strategy for a regional exchange rate arrangement in post-crisis East Asia,” unpublished manuscript, World Bank.

Kwan, C. H. (1995), Economics of the yen zone: A perspective on currency union in Asia, Nihon Keizai shimbunsha (written in Japanese).

Nakamura, Yoichi and Izumi Matsuzaki (1997), “Economic Interdependence: Japan, Asia, and the World,” Journal of Asian Economics, vol. 8, no. 2, pp. 199-244.

Ohno, K. (1999), “Exchange rate management in developing Asia: Reassessment of the pre-crisis soft dollar zone,” ADBI working paper 1. Asian Development Bank Institute, Tokyo.

Secru, Piet and Uppal, Raman (2000), *Exchange Rate Volatility, Trade, Capital Flows under Alternative Exchange Rate Regimes*. Cambridge: Cambridge University Press. Chapter 6.

Takagi, S. (1996), “The Yen and its Asian neighbors, 1980-95: cooperation or competition,” NBER working paper 5720, National Bureau of Economic Research, Cambridge.

<Table 1-1> Exports of Hong Kong 1986-1999

Year	DOTS World Total (in million USD)	Share of Exports to the U.S. (in percent)	Share of Exports to Japan (in percent)	Share of Exports to China (in percent)
1986	35,438	31.34	4.66	21.31
1987	48,473	27.87	5.10	23.29
1988	63,182	24.83	5.85	26.95
1989	73,113	25.31	6.19	25.74
1990	82,143	24.13	5.70	24.75
1991	98,578	22.71	5.38	27.12
1992	119,512	23.08	5.24	29.63
1993	134,996	23.08	5.15	32.36
1994	151,379	23.24	5.57	32.81
1995	173,556	21.81	6.11	33.34
1996	180,530	21.25	6.55	34.33
1997	187,870	21.80	6.08	34.91
1998	173,693	23.43	5.25	34.45
1999	173,793	23.88	5.42	33.37

Source: IMF, Direction of Trade Statistics, Yearbook (various issues)

<TABLE 1-2> EXPORTS OF KOREA 1986-1999

Year	DOTS World Total (in million USD	Share of Exports to the U.S. (in percent)	Share of Exports to Japan (in percent)	Share of Exports to China (in percent)
1986	34,792	40.01	15.60	N.A.
1987	47,303	38.86	17.84	N.A.
1988	60,683	35.39	19.78	N.A.
1989	62,496	32.33	21.07	N.A.
1990	65,027	29.90	19.44	N.A.
1991	71,875	25.89	17.19	1.40
1992	76,641	23.60	15.13	3.46
1993	85,808	21.23	13.48	6.00
1994	96,389	21.32	14.03	6.44
1995	125,588	19.25	13.61	7.32
1996	130,994	16.62	12.22	8.77
1997	136,354	15.82	10.84	9.97
1998	132,703	17.39	9.24	9.03
1999	143,647	20.61	11.04	9.53

Source: IMF, Direction of Trade Statistics, Yearbook (various issues)
Note: N.A. denotes not available

<TABLE 1-3> EXPORTS OF SINGAPORE 1986-1999

Year	DOTS World Total (in million USD)	Share of Exports to the U.S. (in percent)	Share of Exports to Japan (in percent)	Share of Exports to China (in percent)
1986	22,501	23.36	8.58	2.54
1987	28,696	24.39	9.05	2.57
1988	39,318	23.83	8.63	3.03
1989	44,769	23.30	8.55	2.68
1990	52,753	21.26	8.75	1.51
1991	59,219	19.71	8.67	1.45
1992	63,437	21.12	7.61	1.75
1993	74,041	20.36	7.46	2.57
1994	96,911	18.67	6.98	2.16
1995	118,187	18.26	7.80	2.33
1996	125,125	18.43	8.19	2.71
1997	125,326	18.44	7.06	3.23
1998	109,886	19.89	6.58	3.70
1999	114,730	19.22	7.42	3.42

Source: IMF, Direction of Trade Statistics, Yearbook (various issues)

<TABLE 1-4> EXPORTS OF THAILAND 1986-1999

Year	DOTS World Total (in million USD)	Share of Exports to the U.S. (in percent)	Share of Exports to Japan (in percent)	Share of Exports to China (in percent)
1986	8,864	18.12	14.22	3.11
1987	11,563	18.71	14.98	3.36
1988	15,910	20.11	16.00	2.99
1989	20,175	21.60	16.96	2.68
1990	23,072	22.71	17.20	1.17
1991	28,811	21.06	17.82	1.16
1992	32,473	22.49	17.51	1.19
1993	37,158	21.54	16.95	1.16
1994	45,583	20.90	16.95	2.04
1995	57,201	17.62	16.57	2.87
1996	55,743	17.99	16.81	3.35
1997	57,560	19.38	15.17	3.03
1998	54,489	22.34	13.72	3.25
1999	61,797	21.54	14.45	3.57

Source: IMF, Direction of Trade Statistics, Yearbook (various issues)

<Table 2-1> ADF Unit Root Test for Exports to US

Economy/ Country	Variable First Difference	Observations	Lags	ADF Test Statistic
Hong Kong	Δy	143	1 – 12	-3.081
	Δx_1	143	1 – 5	-2.598
	Δx_2	143	1 – 2	-3.276
	Δx_3	143	1 – 4	-10.128
Korea	Δy	143	1 – 12	-4.977
	Δx_1	143	1 – 5	-2. 598
	Δx_2	143	1 – 12	-3.716
	Δx_3	143	1 – 12	-4.148
Singapore	Δy	143	1 – 7	-4.821
	Δx_1	143	1– 5	-2.598
	Δx_2	143	1 – 6	-3.078
	Δx_3	143	1 – 10	-3.562
Thailand	Δy	131	1 – 12	-2.813
	Δx_1	131	1 – 5	-2.598
	Δx_2	131	1 – 12	-3.417
	Δx_3	131	1 – 3	-8.250

Notes: 1) “Lags” denotes the included augmentation lags in unit root test. 2) ADF is the augmented Dickey-Fuller test. 3) The ADF regression includes only the intercept. 4) The Mckinnon critical value for rejection of hypothesis of a unit root at 1, 5 and 10 percent level is approximately –3.48, –2.88 and –2.57, respectively. 5) The number of lags was determined based on Akaike info criterion and the F-test (the F-test was conducted from 12 lags downward. The larger number of lags is selected if the F-test for 12lags and the minimum Akaike constant rejects the null hypothesis favoring the shorter lags).

<Table 2-2> ADF Unit Root Test for Exports to Japan

Economy/ Country	Variable First Difference	Observations	Lags	ADF Test Statistic
Hong Kong	Δy	143	1 – 9	-3.026
	Δx_1	143	1 – 10	-2.725
	Δx_2	143	1 – 8	-2.938
	Δx_3	143	1 – 7	-6.742*
Korea	Δy	143	1 – 12	-2.796*
	Δx_1	143	1 – 10	-2.725
	Δx_2	143	1 – 9	-3.887
	Δx_3	143	1 – 11	-3.858
Singapore	Δy	143	1 – 11	-3.717
	Δx_1	143	1 – 10	-2.725
	Δx_2	143	1 – 9	-3.658
	Δx_3	143	1 – 11	-7.365*
Thailand	Δy	131	1 – 11	-3.009
	Δx_1	131	1 – 10	-2.725
	Δx_2	131	1 – 12	-3.512
	Δx_3	131	1 – 12	-3.551

Refer to the notes under <Table 2-1>

<TABLE 3-1> JOHANSEN CO-INTEGRATION TESTS FOR EXPORTS TO JAPAN

Economy/ Country	H_0: / H_A:	Trace Statistics				Maximum Eigenvalue			
	H_0:	$r=0$	$r \le 1$	$r \le 2$	$r \le 3$	$r=0$	$r \le 1$	$r \le 2$	$r \le 3$
	H_A:	$r \ge 1$	$r \ge 2$	$r \ge 3$	$r=4$	$r=1$	$r=2$	$r=3$	$r=4$
Hong Kong		47.809*	22.440	6.057	0.062	25.369*	16.382	5.996	0.062
Singapore		51.482*	20.102	6.467	0.045	31.379*	13.635	6.422	0.045
South Korea		70.331*	33.526	16.132	4.377	36.804*	17.394	11.756	4.377
Thailand		68.448*	27.469	11.429	2.317	40.978*	16.040	9.112	2.317
		Critical Values							
Hong Kong	(5%)	53.12	34.91	19.96	9.24	28.14	22.00	15.67	9.24
	(1%)	60.16	41.07	24.60	12.97	33.24	26.81	20.20	12.97
Singapore	(5%)	39.89	24.31	12.53	3.84	23.80	17.89	11.44	3.84
	(1%)	45.58	29.75	16.31	6.51	28.82	22.99	15.69	6.51
South Korea	(5%)	53.12	34.91	19.96	9.24	28.14	22.00	15.67	9.24
	(1%)	60.16	41.07	24.60	12.97	33.24	26.81	20.20	12.97
Thailand	(5%)	53.12	34.91	19.96	9.24	28.14	22.00	15.67	9.24
	(1%)	60.16	41.07	24.60	12.97	33.24	26.81	20.20	12.97

Notes: 1) *r* denotes the number of co-integrating vectors. 2) The asterisks (*) and (**) indicate the rejection of the null hypothesis at the 1% and 5% significance level, respectively.

< TABLE 3-2> JOHANSEN CO-INTEGRATION TEST FOR EXPORTS TO THE U.S.

Economy/ Country	H_0: / H_A:	Trace Statistics				Maximum Eigenvalue			
	H_0:	$r=0$	$r \le 1$	$r \le 2$	$r \le 3$	$r=0$	$r \le 1$	$r \le 2$	$r \le 3$
	H_A:	$r \ge 1$	$r \ge 2$	$r \ge 3$	$r=4$	$r=1$	$r=2$	$r=3$	$r=4$
Hong Kong		71.414*	40.872**	21.856**	8.341	30.542**	19.016	13.515	8.341
Singapore		67.306*	33.123	18.514	5.798	34.183*	14.608	12.717	5.798
South Korea		72.490*	37.573	17.705	6.003	34.917**	19.869	11.702	6.003
Thailand		71.590*	32.679	15.419	3.850	38.911*	17.260	11.569	3.850
		Critical Values							
Hong Kong	(5%)	38.89	24.31	12.53	3.84	23.80	17.89	11.44	3.84
	(1%)	45.58	29.75	16.31	6.51	28.82	22.99	15.69	6.51
Singapore	(5%)	53.12	34.91	19.96	9.24	28.14	22.00	15.67	9.24
	(1%)	60.16	41.07	24.60	12.97	33.24	26.81	20.20	12.97
South Korea	(5%)	62.99	42.44	25.32	12.25	31.46	25.54	18.96	12.25
	(1%)	70.05	48.45	30.45	16.26	36.65	30.34	23.65	16.26
Thailand	(5%)	62.99	42.44	25.32	12.25	31.46	25.54	18.96	12.25
	(1%)	70.05	48.45	30.45	16.26	36.65	30.34	23.65	16.26

Refer to the notes under <Table 3-1>

<Table 4-1> Estimates of the contegrating vectors for exports to Japan

Country	Normalized cointegrating equation Constant	i_t	p_t	σ_t
Hong Kong		**4.904**	**-0.103**	**2.934**
		(1.498)	(1.219)	(0.916)
Singapore		**4.725**	**2.545**	**1.215**
		(0.864)	(0.823)	(0.172)
South Korea	**-104.869**	**19.568**	**8.781**	**-1.509**
	(17.384)	(3.254)	(1.396)	(0.346)
Thailand	**-23.758**	**6.352**	**3.193**	**-0.290**
	(5.249)	(1.133)	(0.433)	(0.090)

Notes :
(1) Numbers in the parentheses are standard errors.

<Table 4-2> Estimates of the contegrating vectors for exports to the U.S.

Country	Normalized cointegrating equation Constant	@trend	i_t	p_t	σ_t
Hong Kong	**-18.395**		**3.517**	**2.874**	**0.272**
	(7.918)		(1.263)	(1.333)	(0.225)
Singapore	**-10.191**		**2.414**	**-0.816**	**-0.051**
	(0.501)		(0.112)	(0.181)	(0.028)
South Korea		**-0.013**	**6.485**	**1.278**	**-0.218**
		(0.004)	(1.126)	(0.286)	(0.057)
Thailand		**-0.013**	**0.064**	**8.086**	**-0.361**
		(0.025)	(6.547)	(1.544)	(0.192)

Notes :
(1) Numbers in the parentheses are standard errors.

<Table 5-1> Regression Results for Error-Correction Models for Export to Japan

Variables	Hong Kong	Singapore	South Korea	Thailand
C	0.141***	0.007	-0.004	0.009**
	(0.040)	(0.006)	(0.012)	(0.005)
@trend	-0.001***		0.000**	
	(0.000)		(0.000)	
EC_{t-1}	0.022	-0.103***	0.019**	0.018
	(0.019)	(0.019)	(0.009)	(0.019)
ΔY_{t-1}	-0.950***	-0.471***	-0.601***	-0.753***
	(0.065)	(0.081)	(0.100)	(0.097)
ΔY_{t-2}		-0.269***	-0.506***	-0.327***
		(0.091)	(0.112)	(0.091)
ΔY_{t-3}	-0.166	-0.223**	-0.306**	
	(0.110)	(0.092)	(0.123)	
ΔY_{t-4}	-1.224***	-0.159*	-0.176	-0.181**
	(0.135)	(0.092)	(0.113)	(0.091)
ΔY_{t-5}	-1.091***	-0.179**	-0.115	-0.222**
	(0.144)	(0.085)	(0.104)	(0.089)
ΔY_{t-6}	-0.586**			
	(0.230)			
ΔY_{t-7}			0.153*	0.167*
			(0.080)	(0.091)
ΔY_{t-8}	-0.414	-0.083		0.150
	(0.252)	(0.070)		(0.091)
ΔY_{t-9}	-0.375			
	(0.248)			
ΔY_{t-12}		-0.233***		
		(0.076)		
Δi_{t}		1.099***	1.386***	0.625**
		(0.334)	(0.333)	(0.288)
Δi_{t-1}	2.835***		0.437	
	(0.967)		0.381	
Δi_{t-2}	2.196**		0.535	-0.770**
	(0.997)		(0.385)	(0.306)
Δi_{t-3}		0.382	0.697*	-0.785**
		(0.367)	(0.394)	(0.328)
Δi_{t-4}			0.806**	-0.685**
			(0.406)	(0.300)
Δi_{t-5}	2.973***	0.542	0.861**	
	(0.900)	(0.374)	(0.412)	
Δi_{t-6}			0.626*	0.859***
			(0.363)	(0.302)
Δi_{t-7}				0.823***
				(0.304)
Δi_{t-9}	2.641***			
	(0.953)			
Δi_{t-12}		0.823**		-0.917***
		(0.371)		(0.304)
Δi_{t-13}				-0.522*
				(0.306)
Δp_{t-1}	-1.403**	0.574**	0.660***	0.258*
	(0.623)	(0.277)	(0.192)	(0.140)
Δp_{t-2}	1.533**	-0.796***		0.441***
	(0.644)	(0.298)		(0.149)
Δp_{t-3}			0.439**	
			(0.197)	

Δp_{t-4}			0.226 (0.180)	
Δp_{t-5}				0.144 (0.139)
Δp_{t-6}	0.923 (0.644)		0.099 (0.158)	
Δp_{t-7}	1.527** (0.650)	-0.902*** (0.289)		
Δp_{t-8}				0.358** (0.155)
Δp_{t-9}			0.265 (0.180)	0.411** (0.162)
Δp_{t-11}	1.293** (0.613)		0.340* (0.177)	0.337** (0.142)
Δp_{t-12}		-0.713** (0.296)	0.159 (0.185)	0.281* (0.143)
Δp_{t-13}		0.602** (0.280)		
Δp_{t-14}			0.168 (0.152)	-0.454*** (0.135)
Δp_{t-15}			0.367** (0.148)	
$\Delta \sigma_{t-1}$	0.099** (0.051)	-0.112*** (0.025)	-0.035** (0.017)	
$\Delta \sigma_{t-2}$	0.067* (0.040)	-0.104*** (0.024)	-0.028 (0.018)	
$\Delta \sigma_{t-3}$		-0.059*** (0.022)	-0.035** (0.018)	
$\Delta \sigma_{t-4}$	0.045 (0.038)	-0.072*** (0.019)	-0.019 (0.017)	
$\Delta \sigma_{t-5}$	0.052 (0.037)	-0.072*** (0.018)	-0.028* (0.017)	
$\Delta \sigma_{t-6}$		-0.038** (0.015)	-0.026** (0.012)	-0.047*** (0.010)
$\Delta \sigma_{t-7}$	-0.055 (0.035)			-0.039*** (0.013)
$\Delta \sigma_{t-8}$			-0.022* (0.011)	-0.043*** (0.013)
$\Delta \sigma_{t-9}$			-0.009 (0.014)	-0.035*** (0.013)
$\Delta \sigma_{t-10}$	-0.053 (0.033)		-0.020 (0.016)	-0.036*** (0.013)
$\Delta \sigma_{t-11}$			-0.040** (0.019)	-0.052*** (0.013)
$\Delta \sigma_{t-12}$			-0.038* (0.019)	-0.027** (0.011)**
$\Delta \sigma_{t-13}$			-0.022 (0.019)	
$\Delta \sigma_{t-14}$		0.015 (0.013)	-0.035** (0.017)	
$\Delta \sigma_{t-15}$		0.032** (0.013)	-0.027** (0.013)	-0.017** (0.008)
$\Delta \sigma_{t-17}$			-0.016 (0.011)	
Adjusted R^2	0.771	0.458	0.504	0.515
DW	2.111	1.997	2.086	1.886

Notes: Figures in parentheses are standard errors

<Table 5-2> Regression Results for Error-Correction Models for Export to the U.S.

Variables	Hong Kong	Singapore	South Korea	Thailand
C	0.350***	0.047***		-0.034**
	(0.086)	(0.017)		(0.015)
@trend	-0.004***	-0.001***	0.000***	0.000**
	(0.001)	(0.000)	(0.000)	(0.000)
EC_{t-1}	-0.242***	0.017		
	(0.077)	(0.090)		
EC_{t-5}				-0.036***
				(0.010)
EC_{t-7}			-0.329***	
			(0.058)	
ΔY_{t-1}	-0.929***	-0.764***	-0.684***	-0.878***
	(0.115)	(0.112)	(0.085)	(0.091)
ΔY_{t-2}	-0.299*	-0.296***	-0.423***	-0.426***
	(0.152)	(0.090)	(0.095)	(0.089)
ΔY_{t-3}	-0.407**		-0.390***	
	(0.169)		(0.092)	
ΔY_{t-4}	-1.170***		-0.514***	
	(0.171)		(0.096)	
ΔY_{t-5}	-1.379***	-0.223**	-0.501***	-0.128
	(0.187)	(0.094)	(0.106)	(0.093)
ΔY_{t-6}	-0.659***	-0.286**	-0.457***	-0.079
	(0.203)	(0.114)	(0.111)	(0.093)
ΔY_{t-7}		-0.236**	-0.179*	
		(0.110)	(0.091)	
ΔY_{t-8}	-0.312	-0.224**	-0.259***	
	(0.249)	(0.108)	(0.090)	
ΔY_{t-9}	-0.948***	-0.267**	-0.246***	
	(0.311)	(0.107)	(0.093)	
ΔY_{t-10}	-1.202***	-0.329***	-0.283***	-0.196**
	(0.340)	(0.108)	(0.088)	(0.078)
ΔY_{t-11}	-0.721**	-0.231**	-0.296***	
	(0.345)	(0.105)	(0.087)	
ΔY_{t-12}	-0.812**	-0.207**	-0.453***	
	(0.331)	(0.101)	(0.086)	
ΔY_{t-13}	-0.912**	-0.149	-0.391***	-0.137
	(0.347)	(0.091)	(0.076)	(0.095)
ΔY_{t-14}	-0.495*			-0.214*
	(0.294)			(0.113)
ΔY_{t-15}	-0.570**			-0.109
	(0.224)			(0.091)
Δi_{t}	8.778**	2.743**	2.731**	2.785**
	(3.433)	(1.258)	(1.162)	(1.185)
Δi_{t-1}			-3.559***	
			(1.131)	
Δi_{t-2}		-1.962		
		(1.243)		
Δi_{t-3}		-2.378**		5.047***
		(1.155)		(1.230)
Δi_{t-4}				2.102*
				(1.209)

Δi_{t-5}	11.905*** (3.474)	6.310*** (1.264)	2.401** (1.153)	
Δi_{t-6}	4.864 (3.345)		3.308*** (1.206)	
Δi_{t-7}			-2.399** (1.128)	
Δi_{t-8}	10.940*** (3.636)			2.167* (1.215)
Δi_{t-9}	5.588 (3.402)			
Δi_{t-10}	8.227** (3.575)			-3.061*** (1.145)
Δi_{t-11}				
Δi_{t-12}				0.979 (1.147)
Δi_{t-13}	10.060** (3.917)	1.969 (1.216)		
Δp_{t}	12.548*** (2.913)	0.484 (0.392)	0.197 (0.149)	-0.489*** (0.171)
Δp_{t-1}				
Δp_{t-2}			0.372* (0.193)	0.607*** (0.169)
Δp_{t-3}	5.241 (3.177)			
Δp_{t-4}			0.444** (0.206)	
Δp_{t-5}				
Δp_{t-6}	-5.742* (3.013)		0.914*** (0.201)	
Δp_{t-7}			-0.271 (0.207)	-0.743*** (0.199)
Δp_{t-8}	1.702 (3.190)	-0.530 (0.426)	-0.365* (0.217)	-0.212 (0.162)
Δp_{t-9}	2.786 (3.219)		0.357* (0.209)	
Δp_{t-10}	4.068 (3.282)		-0.369** (0.166)	-0.198 (0.159)
Δp_{t-11}	-4.918 (3.285)	0.762* (0.412)		-0.278* (0.156)
Δp_{t-12}		-0.505 (0.419)		-0.161 (0.152)
Δp_{t-13}		0.442 (0.385)		-0.350** (0.148)
Δp_{t-14}		-1.213*** (0.379)		-0.255 (0.156)
$\Delta \sigma_{t}$		-0.025*** (0.009)		
$\Delta \sigma_{t-1}$	-0.096*** (0.028)	-0.015 (0.009)		
$\Delta \sigma_{t-2}$	-0.100*** (0.030)		-0.026** (0.011)	0.010 (0.007)
$\Delta \sigma_{t-3}$	-0.062* (0.036)		-0.030** (0.013)	
$\Delta \sigma_{t-4}$	-0.111*** (0.038)	-0.017* (0.009)	-0.050*** (0.015)	

$\Delta\sigma_{t-5}$	-0.088** (0.037)	-0.022** (0.009)	-0.041*** (0.015)	0.022** (0.009)
$\Delta\sigma_{t-6}$	-0.090*** (0.034)		-0.058*** (0.016)	0.039*** (0.010)
$\Delta\sigma_{t-7}$	-0.078*** (0.027)	0.017 (0.010)	0.021* (0.010)	0.018* (0.009)
$\Delta\sigma_{t-8}$	-0.038 (0.024)	0.024** (0.011)		0.024** (0.010)
$\Delta\sigma_{t-9}$		0.033*** (0.010)		
$\Delta\sigma_{t-10}$				0.012 (0.010)
$\Delta\sigma_{t-11}$				0.018* (0.010)
$\Delta\sigma_{t-12}$		-0.026** (0.010)		0.023** (0.011)
$\Delta\sigma_{t-13}$		-0.037*** (0.012)	0.012 (0.008)	0.020* (0.012)
$\Delta\sigma_{t-14}$		-0.032*** (0.011)		0.029** (0.012)
$\Delta\sigma_{t-15}$				0.025*** (0.009)
Adjusted R^2	0.777	0.483	0.521	0.566
DW	2.194	1.908	1.889	1.956

Notes: Figures in parentheses are standard errors