Real Output Co-movements in East Asia: A Cointegration Approach

[1]Sato, K. and [2]Z.Y. Zhang

[1]Yokohama National University (sato@ynu.ac.jp) [2]NUCB and Edith Cowan University (zhaoyong.zhang@ecu.edu.au)

Keywords: *Monetary union; Cointegration; Common feature business cycle; East Asia.*

EXTENDED ABSTRACT

The East Asian region has experienced astonishing economic growth and was widely cited as an exemplar of sustained economic growth over the past few decades. Compared to the European experience, regional integration in East Asia has occurred in the absence of a formal institutional framework, and is more market-driven. Such a trend towards spontaneous regional integration is a result of progressive outward orientation of individual economies' trade and investment policies, and the unilateral liberalization of goods and capital markets. High degree of integration in the East Asian region would greatly shape the economic structure of each individual economy and has direct implications for the effectiveness of domestic stabilization policy and policy coordination. It is therefore the major objective of this paper to empirically examine the feasibility of forming a monetary union in East Asia by assessing the real output co-movements among these economies. As suggested by the optimum currency area theory (OCA) that losing monetary independence would be the major cost for adopting a common currency, it would be less costly for the economies to form a monetary union if the business cycles are synchronized across countries.

In recent years, there has been a number of studies empirically assessing the feasibility of forming a monetary union in the East Asian region from a symmetric shock perspective (see Bayoumi and Eichengreen, 1994; Bayoumi, Eichengreen and Mauro, 2000; Zhang, Sato and McAleer, 2004). In contrast to the previous studies, the present paper adopts the Johansen (1991) maximum-likelihood procedure to examine the co-movements of real outputs among the East Asian economies during the period 1978-2004. In particular, we perform the bivariate cointegration test for each pair of the East Asian economies to determine the long-run (cointegrating) relationship of the real output variables, and estimate the short-run dynamics of this relationship as well as analyze the contemporaneous output correlation and cyclical co-movement. Following Vahid and Engle (1993), we finally conduct a common feature test to detect the presence of common business cycles among the paired economies.

The results suggest that the long-run synchronous movements of real outputs are perceived in the North East Asian area including Japan and China as well as the ASEAN economies. The test results from conducting the Vahid and Engle (1993) common serial correlation cycle tests provide further evidence in support the finding of the output co-movements in these areas. Both suggest that the high degree of integration through the flows of trade and capital in the East Asian region has greatly shaped the economic structure of each individual economy and contributed to the business cycle synchronization and co-movements of real output variables in both the short run and the long run. This has important implications for the economies in terms of adjustment costs when considering the adoption of a monetary union.

1. INTRODUCTION

Over the past three decades, at least well before the Asian financial crisis in 1997, the East Asian region has recorded astonishing economic growth and was widely cited as an exemplar of sustained economic growth. Accompanying and fostering the region's remarkable economic dynamism have been the outward looking, export-oriented development strategy and its spontaneous and rapid regional integration. However, compared to the European experience, regional integration in East Asia has occurred in the absence of a formal institutional framework, and is more market-driven. It is the international firms that are creating linkages across borders in their search for profitable opportunities through trade, foreign direct investment (FDI), technology contracts, and other arrangements in accordance with changes in comparative advantage and industrial upgrading in these economies. Such a trend towards spontaneous regional integration is a result of progressive outward orientation of individual economies' trade and investment policies, and the unilateral liberalization of goods and capital markets (Dobson 1997, Zhang 2003).

It is believed that high degree of integration in the East Asian region would greatly shape the economic structure of each individual economy and has direct implications for the effectiveness of domestic stabilization policy and policy coordination. It is indeed true that, for the purpose of establishing a well-coordinated economic and financial monitoring system in the region, monetary co-operation and foreign exchange arrangements among the East Asian economies have been often conducted since 1977 when the ASEAN Swap Arrangement was established. The more recent calls among politicians for greater monetary integration and regional exchange rate stability in East Asia following the 1997 financial crisis have attracted the attention of academics to empirically study the feasibility of establishing a currency union in the region.

It is therefore the objective of the present paper to empirically analyze how the business cycle co-movements are affected by the process of the East Asian economic integration and how feasible to establish a monetary union in this region. Co-movements of the real output reflect the degree of similarity in the economic structure and/or symmetry of the fundamental shocks among the concerned countries. Assessing the business cycle co-movements will allow us to evaluate the costs and benefits of forming an optimum currency area (OCA) when a member country has to give up its monetary independence (see Kawai, 1987; Tavlas, 1993; De Grauwe, 2003).

In recent years, there has been a number of studies empirically assessing the feasibility of forming a monetary union in the East Asian region from a symmetric shock perspective (see Bayoumi and Eichengreen, 1994; Bayoumi, Eichengreen and Mauro, 2000; Zhang, Sato and McAleer, 2004). In contrast to the previous studies, the present paper adopts the Johansen (1991) maximum-likelihood procedure to examine the co-movements of real outputs among the East Asian economies from 1978Q1 through 2004Q4. [1] In particular, we perform the bivariate cointegration test for each pair of the East Asian economies to determine the long-run (cointegrating) relationship of the real output variables, and then estimate the short-run dynamics of this relationship as well as analyze the contemporaneous output correlation and cyclical co-movement. Following Vahid and Engle (1993) who extend the Engle and Kozicki (1993) test for the common serial correlation cycles in the presence of cointegrating relationship, we conduct a common feature test to detect the presence of common business cycles among the paired economies.

The remainder of this paper is organized as follows. Section 2 presents the analytical framework. Section 3 describes the data and the result of preliminary analysis. Section 4 discusses the results of estimations. Section 5 concludes the paper.

2. ANALYTICAL FRAMEWORK

To investigate whether there exists a stable linear steady-state relationship between the interested variables, we need to conduct unit-root and cointegration tests for the variables. Unit-root tests show if a time-series variable is stationary. Cointegration analysis determines the long-run (cointegrating) relationship between the variables when all the variables are found non-stationary (i.e., have unit roots). If all variables studied are I(1), we then use the Johansen maximum likelihood (ML) method (Johansen, 1988; Johansen and Juselius, 1990) to test whether these variables are cointegrated. If they are cointegrated, the real output series share synchronous long-run

[1] By far few studies have applied this method to studying the co-movements of the real output in East Asia. Cheung and Yuen (2003) examine the cointegrating relationship of real outputs among China, Japan and Korea using the quarterly series of real per capita GDP ranging from 1993Q4 to 2001Q4.

movements, implying the feasibility of forming a monetary union.

The Johansen cointegration technique is based on the maximum likelihood estimation of the vector error-correction model. Let X_t be a $(n \times 1)$ vector of I(1) variables. Then, it is possible to specify the following unrestricted vector autoregression (VAR) involving up to *k*-lags of X_t:

$$X_t = \mu + A_1 X_{t-1} + ... + A_k X_{t-k} + \varepsilon_t ,$$

where A_i is an $(n \times n)$ matrix of parameters and ε_t are a Gaussian error term. The above equation can be expressed as a vector error-correction form:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \varepsilon_t ,$$

where $\Gamma_1 = -(I - A_1 - ... - A_i)$, (i = 1, … , $k-1$), and $\Pi = -(I - A_1 - ... - A_k)$. Our major interest is in the matrix $\Pi = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium, while β is a matrix of long-run coefficients such that the term $\beta' X_{t-k}$ represents up to $(n-1)$ cointegration relationship in the multivariate model. Thus, the test for cointegration is to determine how many $r \le (n-1)$ cointegration vectors exist in β , which amounts to testing whether $\Pi = \alpha\beta'$ has reduced rank.

We use the trace statistic and the maximum eigenvalue statistic. The null hypothesis that there are at most *r* cointegrating vectors ($0 \le r \le n$) can be tested by the trace statistic:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) ,$$

where $\hat{\lambda}_i$'s are the $(n-r)$ smallest squared canonical correlations of X_{t-1} with respect to ΔX_t corrected for lagged differences and *T* is the sample size used for estimation. Another test of the significance of the largest λ_r is to use the maximum eigenvalue statistic:

$$\lambda_{\max} = -T \ln(1 - \hat{\lambda}_{r+1}) ,$$

This is to test that there are *r* cointegrating vectors against the alternative that *r* + 1 exist. Rejection of this hypothesis suggests the existence of the maximum *r* cointegrating vectors. Asymptotic critical values are shown in Osterwald-Lenum (1992).

Even though cointegrating relationship in real output is found among the economies, short-run output fluctuations might not be synchronous. Such an asynchronous business cycle will have to be attended by an individual monetary policy, which would suggest a low feasibility for forming a monetary union.

Test for common business cycles will be a test for a serial correlation common feature in the difference of the variables. Engle and Kozicki (1993) devise the test for a serial correlation common feature for stationary variables based on two-stage least square regression using the lagged value of all variables as the instruments. If there exists a linear combination of variables that eliminates all correlation with the past and is not correlated with past information set, we then conclude that the set of variables shares a common cycles. Vahid and Engle (1993) extend the Engle and Kozicki test to propose test procedure for common serial correlation cycles given the presence of cointegration. The test procedure is to find a sample canonical correlation between ΔX_t and $W(p) \equiv (\Delta X'_{t-1}, ..., \Delta X'_{t-p}, Z'_{t-1})'$ where Z_{t-1} is the error-correction term. Under the null hypothesis that there exist *s* linearly independent common feature vectors, the test statistic is given by:

$$C(p,s) = -(T - p - 1) \sum_{j=1}^{s} \ln(1 - \lambda_j^2) ,$$

where λ_j^2 (j = 1,…, s) is the *s* smallest squared canonical correlations between ΔX_t and $W(p)$. Under the null hypothesis, the statistic $C(p,s)$ has a χ^2 distribution with ($s^2 + snp + sr - sn$) degrees of freedom, where *n* is the number of endogenous variables, *p* is the lag order of the differenced variables in the error-correction model, and *r* is the number of cointegrating vectors.

3. DATA AND PRELIMINARY ANALYSIS

We use real GDP series as a proxy for real outputs. All data are quarterly, expressed in natural logarithms and seasonally adjusted using the Census X-12. Eleven economies are taken up in this paper, including the four Asian NIEs (Korea, Taiwan, Hong Kong and Singapore), ASEAN4 (Malaysia, Indonesia, Thailand and the

Philippines), China, the United States and Japan. The sample period covers 1978Q1-2004Q4 for all economies. The data for real GDP are obtained from the web sites of the statistic authorities in the respective economies and the NUS ESU databank.

We first check the stationarity of the real GDP series using the ADF (Augmented Dickey-Fuller) tests. The test statistics show that for the levels of all the series, the null hypothesis that a unit root exists cannot be rejected. The unit root tests of the first difference of the variables reject the null hypothesis. These findings suggest that each series contains one unit root and thus I(1) (the results are not reported in the paper but available upon request). Then we proceed to the cointegration analysis in the next section.

4. EMPIRICAL RESULTS

4.1. Bivariate Cointegration Test

We investigate the bivariate relations of real output co-movements between East Asian economies, Japan and the United States. The Johansen (1991) cointegration test is employed to test whether the I(1) non-stationary output series move together in the long-run. In conducting the Johansen test, we follow the Hendry approach of general-to-specific modeling. We initially estimate vector autoregressions (VAR) with eight lags and then reduce the longest lag if none is specifically significant for the *F*-test of the overall significance in the system of each regressor.[2] Once the common lag length is determined, we perform the test for reduced rank.

The result of the Johansen test is very sensitive to the assumption that errors are independently normal (Maddala and Kim (1998), Chapter 5). Doornik, Hendry and Nielsen (1999) propose to include impulse dummies that take account of outliers in the data so that residuals from a VAR estimation may be normally distributed, even though the including of a dummy-type variable may affect the underlying distribution of the test statistics. [3] Including dummies appears to be necessary to allow for an impact of the Asian currency crisis. In our VAR estimations, we have checked the distribution of VAR residuals and allowed for extreme outliers by including impulse dummies.[4]

We conducted the Johansen cointegration test for fifty-four pairs of economies and the results are not reported due to the space limitation but available upon request. The results show that the hypothesis of no cointegration is rejected by either trace or maximum eigenvalue test at least at the 10% level in six out of nine cases between the East Asian economies and the United States, in four out of nine cases between the East Asian economies and Japan, and in twelve out of thirty-six cases among the East Asian economies. The null hypothesis of at most one cointegrating relationship is not rejected in all cases.

For the country pairs with one cointegrating relationship, we impose certain restrictions on the cointegrating vectors to determine the unique cointegration relations. We first conduct the likelihood ratio (LR) test for restrictions that each cointegrating vector is zero, i.e., H0: $\beta_k = 0$ where $k = i, j$. It is interesting to note that, for the pairs between East Asian economies and the United States, only the coefficient of the US real output is statistically significant, which implies that the US real output series are individually stationary. As with an insignificant coefficient the cointegrating relationship between two real output series is unlikely to occur, we then proceed to the error-correction estimations with the pair-countries where they have a statistically significant estimate of the real output.[5] Next, we perform the LR test for the restrictions that two cointegrating vectors are equal, i.e., H0: $\beta_i - \beta_j = 0$. The results show that the hypothesis is accepted for only three pairs, i.e., Hong Kong-Japan, Taiwan-Korea and Singapore-Indonesia pairs, implying the real outputs tend to move together over time.

---

[2] We estimate a VAR with a linear trend restricted to the cointegration space and an unrestricted constant, which is proposed by Doornik, Hendry and Nielsen (1999). The trend is excluded if the *F*-test shows it is insignificant in the system. We use PcGive version 10.1 for the Johansen cointegration test.

[3] Doornik, Hendry and Nielsen (1999) argue that impulse dummies should be included unrestrictedly based on their Monte Carlo study.

[4] We attempted to minimize the number of impulse dummies included in VAR estimation. The dummies are included when the following economies are included in the VAR: Japan (1993Q2), Korea (1980Q4, 1981Q1, 1988Q1, 1998Q1), Taiwan (2003Q3), Malaysia (1985Q1, 1998Q1), Indonesia (1998Q1, 1998Q2), Thailand (1994Q4, 1997Q4).

[5] As for the pairs of the Philippines with Japan, Taiwan, Hong Kong and Singapore, the estimated β coefficients indicate that real outputs move in the opposite direction. Hence, these four pairs are also disregarded in the analysis of error-correction estimation.

Table 1 reports the summary of the estimated bilateral cointegrating relationship for the concerned economies. It is interesting to note that the cointegration relationship of the real output variables tends to be "cluster" based, related to the development level of an economy. Among the Asian NIEs and Japan with the exclusion of Singapore, real output variables are found to be cointegrated, and the same for the ASEAN countries as well as between China and Hong Kong. These results contrast with Bayoumi, Eichengreen and Mauro (2000) and Zhang, Sato and McAleer (2004), where a significant correlation in supply shocks is normally found between the pair countries of Singapore-Malaysia, Malaysia-Indonesia and Taiwan-Hong Kong, and supply shocks are less correlated between Japan and the Asian NIEs.

Table 1. Summary Result of Bilateral Cointegrating Relationship: 1978Q1-2004Q4

	US	Jp	Kr	Tw	HK	Si	Ml	Id	Th	Ph	Ch
United States											
Japan	-										
Korea	β=0	**Coint+**									
Taiwan	β=0	**Coint+**	**Coint+**								
Hong Kong	β=0	**Coint+**	**Coint+**	β=0							
Singapore	No	No	No	No	No						
Malaysia	No	No	No	No	No	No					
Indonesia	β=0	No	No	No	No	**Coint+**	No				
Thailand	No	No	No	No	**Coint+**	**Coint+**	**Coint+**	No			
Philippines	β=0	Coint-	No	Coint-	Coint-	Coint-	No	No	No		
China	β=0	No	No	β=0	**Coint+**	No	No	No	No	No	

Note: "Coint" indicates that there is a cointegration relationship. "No" denotes that there is no cointegration relationship. $\beta = 0$ shows that a cointegration relationship is found but either (or both) of cointegrating vectors is not significantly different from zero. Positive (+) sign indicates the long-run co-movement of real outputs for the pair of countries. Negative (-) shows that real outputs of the countries move in opposite directions.

Table 2. Restrictions on Short-run Dynamics

Country pair (*i* & *j*)	Error-correction term (Dependent variable) Δy(*i*)	Δy(*j*)	Granger causality test Δy(i) □Δy(*j*)	Δy(j) □Δy(*i*)
Panel A: North East Asian Group				
Kr - Jp	-0.117 **		5.89 #	9.26 **
	(0.031)		[0.053]	[0.010]
Tw - Jp	-0.031 **		12.65 **	1.94
	(0.009)		[0.002]	[0.379]
HK - Jp	-0.194 **	0.072 **	7.88 *	8.91 *
	(0.063)	(0.027)	[0.049]	[0.031]
Tw - Kr		0.092 **	25.76 **	12.18 *
		(0.025)	[0.000]	[0.016]
HK - Kr	-0.243 **	0.156 **	49.66 **	24.30 **
	(0.078)	(0.039)	[0.000]	[0.001]
HK - Ch		0.049 **	3.37	5.68
		(0.014)	[0.849]	[0.578]
Panel B: ASEAN plus Hong Kong				
Si - Id	-0.127 **		9.19	11.23 #
	(0.033)		[0.163]	[0.081]
Si - Th	-0.198 **	-0.094 *	16.87 *	20.23 **
	(0.048)	(0.038)	[0.018]	[0.005]
Ml - Th		-0.150 **	29.95 **	15.07 *
		(0.035)	[0.000]	[0.020]
HK - Th	-0.138 *	0.089 **	13.02 *	9.81 *
	(0.053)	(0.033)	[0.011]	[0.044]

Note: The figures reported in the second and third columns are the coefficient of the error-correction term. Figures in parenthesis are standard errors. Those reported in the forth and fifth columns are the *F*-statistics for the null hypothesis that the lagged Δy(*i*) do not Granger-cause Δy(*j*) (Δy(*i*) →Δy(*j*)) or that the lagged Δy(*j*) do not Granger-cause Δy(*i*) (Δy(*j*) →Δy(*i*)). Double asterisks (**), a single asterisk (*) and a sharp (#) denote the 1%, 5% and 10% significance, respectively. Figures in brackets indicate *p*-value.

4.2. Error-Correction Estimation

Once the cointegrating relationship of the variables is identified, we then perform the error-correction estimation to investigate the short-run interactions of the real output variations. In estimating the error-correction model, we first conduct the weakly exogenous test, i.e., the LR test for the significance of the α coefficients. If the null hypothesis of $\alpha_k = 0$ is not rejected where k represents the country i or j, we condition on the weakly exogenous variable and its short-run behavior is not modeled. It is found that, in six out of twenty cases in our estimations, the hypothesis of $\alpha_k = 0$ is not rejected, which implies that this variable can enter on the right-hand side of the vector error-correction model (the results are available upon request).

Based on the results of the weakly exogenous tests, we estimated the error-correction model. Table 2 reports a part of the results of the error-correction model estimations. First, for the North East Asian group (Panel A of Table 2), all error-correction terms take correct signs, showing that the economies concerned in the second and third columns adjust to deviations from the long-run relationship of real output. In Panel B, however, the error-correction terms do not show the correct sign in the real output growth equations for the pair-country of Singapore-Thailand and Malaysia-Thailand. Second, the coefficient estimates of the (lagged) real output growth in the error-correction estimation provide us with the information on whether the short-run output interactions are positive or negative (the results are available upon request). However, we cannot observe any clear patterns of short-run interactions, which motivate us to pursue the test for common serial correlation cycles in the next sub-section. We also implement the Granger-causality test on the joint significance of the lagged output growth variables for each pair country. Table 2 reports that the null hypothesis that the lagged real output growth of one country does not Granger-cause the output growth of the other country is not rejected only in four out of twenty cases. In addition, the two-way Granger causality is found in seven out of ten pairs, which implies the existence of short-run interactions of output growth between the countries.

Table 3. Common Feature Test Results

Country pair: (i & j)		Degrees of Freedom	Squared Canonical Stat. (λs)	Common Feature Stat. C(p,s)		Critical Value (5% level)
Kr - Jp	S = 1	4	0.12	12.96	*	9.49
	S = 2	10	0.46	75.00	*	18.31
Tw - Jp	S = 1	4	0.08	8.24		9.49
	S = 2	10	0.75	150.22	*	18.31
HK - Jp	S = 1	6	0.17	19.00	*	12.59
	S = 2	14	0.38	66.26	*	23.68
Tw - Kr	S = 1	8	0.15	15.73	*	15.51
	S = 2	18	0.66	121.92	*	28.87
HK - Kr	S = 1	14	0.10	9.34		23.68
	S = 2	30	0.63	100.14	*	43.77
HK - Ch	S = 1	14	0.06	5.53		23.68
	S = 2	30	0.92	236.18	*	43.77
Si - Id	S = 1	12	0.10	10.05		21.03
	S = 2	26	0.65	109.30	*	38.89
Si - Th	S = 1	14	0.15	14.55		23.68
	S = 2	30	0.79	159.35	*	43.77
Ml - Th	S = 1	12	0.20	21.37	*	21.03
	S = 2	26	0.81	177.00	*	38.89
HK - Th	S = 1	8	0.09	9.23		15.51
	S = 2	18	0.66	114.94	*	28.87

Note: "S" denotes the number of common features. Under the null hypothesis, the common feature statistics, *C(p,s)* has an asymptotic chi-square distribution with ($s^2 + snp + sr - sn$) degrees of freedom, where n is the number of endogenous variables, p is the lag order of the system in differences, and r is the number of cointegration vectors. A single asterisk (*) indicates the 5% significance level.

4.3. Test for Common Feature Business Cycle

Synchronous long-term co-movement per se does not necessarily guarantee a monetary union, especially when the short-run business cycles are found asynchronous. To incorporate this issue in the analysis, we conducted the Vahid and Engle (1993) procedure to test for common serial correlation business cycles in the presence of cointegrating relationship.[6] The results are reported in Table 3. The hypothesis that $s = 1$ is not rejected in six out of ten pairs while the null that $s = 2$ is rejected in all pairs. The evidence for the presence of one common feature vector implies a potential source of real output synchronization both in short- and long-run, which has important implications for forming a monetary union in North East Asian region consisting of Japan, Korea, Taiwan and Hong Kong and some pairs of ASEAN economies. In particular, Hong Kong, Thailand and Singapore will be better suited for a monetary union as the economies share common short-run business cycles.

5. CONCLUDING REMARKS

This paper examines the feasibility of forming a monetary union in East Asia by applying the Johansen approach to assessing the real output co-movements among these economies. The results show that the long-run synchronous movements of real outputs are perceived in the North East Asian area including Japan and China as well as the ASEAN economies. This finding is supported by the results from the Vahid and Engle (1993) common serial correlation cycle tests, which shows that some sub-groups of the economies share common short-run business cycles as well. These results suggest that the high degree of integration through the flows of trade and capital in the East Asian region has greatly shaped the economic structure of each individual economy and contributed to the business cycle synchronization and co-movements of real output variables in both the short run and the long run.

[6] Cheung and Yuen (2003) employs the Vahid and Engle (1993) test to examine the prospect of creating a currency union in the North East Asian region that consists of China, Japan and Korea.

This has important implications for the economies when considering the adoption of a monetary union. As the losing of monetary independence would be the major cost for adopting a common currency, it is therefore less costly for the economies to form a monetary union when the business cycles are synchronized across countries.

This paper focuses on the bivariate cointegration tests in determining the long-run (cointegrating) relationship of the real output variables. It is still possible to conduct a multivariate cointegration test, although the three-variable system or more is inherently atheoretical. We have assessed the impacts of the recent financial crisis on the co-movements of output by including the dummy variables in the empirical study. Some further measures would be necessary to deal with possible structural break especially when we adopt a longer time span. These certainly reward a further study.

Acknowledgments

The earlier version of the paper was presented at the Western Economic Association International 2005 in San Francisco. We wish to thank Richard Cohen for insightful comments. The study is financially supported by Japan Society for the Promotion of Science through the Grant-in-Aid for Scientific Research (B), 116330059.

6. REFERENCES

Bayoumi, T. and B. Eichengreen, "One Money or Many? Analyzing the Prospects for Monetary Unification in Various Parts of the World," *Princeton Studies in International Finance*, No.16, 1994.

Bayoumi, T., B. Eichengreen and P. Mauro, "On Regional Monetary Arrangements for ASEAN," *Journal of the Japanese and International Economies*, 14, pp.121-148, 2000.

Blanchard, O.J. and D. Quah, "The Dynamic Effects of Aggregate Demand and Supply Disturbances," *American Economic Review*, 79, pp.655-673, 1989.

Cheung, Y.-W. and J. Yuen, "A Currency Union in Asia: An Output Perspective," manuscript, 2003.

De Grauwe, P., *Economics of Monetary Union*, Fifth Edition, Oxford and New York: Oxford University Press, 2003.

Dobson, W., "East Asian integration: synergies between firm strategies and government policies," in W. Dobson and Chia S.Y. eds., *Multinationals and East Asian Integration*. IDRC Books and ISEAS Publishers, pp.3-27, 1997.

Doornik, J.A., D.F. Hendry and B. Nielsen, "Inference in Cointegrated Models: UK M1 Revisited," in M. McAleer and L. Oxley, eds., *Practical Issues in Cointegration Analysis*, Oxford: Blackwell Publishers, 1999.

Engle, R.F. and S. Kozicki, "Testing for Common Features," *Journal of Business & Economic Statistics*, 11(4), pp.369-380, 1993.

Johansen, S., "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models," *Econometrica* 59, pp.1551-1581, 1991.

Kawai, M., "Optimum Currency Areas," in J. Eatwell, M. Milgate, and P. Newman, eds., *The New Palgrave: A Dictionary of Economics*, London: Macmillan Press, Ltd., pp. 740-743, 1987.

Maddala, G. S. and In-Moo Kim, *Unit Roots, Cointegration, and Structural Change*, UK: Cambridge University Press, 1998.

Osterwald-Lenum, M., "A Note with Quantiles of the Asymptotic Distribution of the ML Cointegration Rank Test Statistics," *Oxford Bulletin of Economics and Statistics* 54, pp.461-72, 1992.

Tavlas, G.S., "The 'New' Theory of Optimum Currency Areas," *The World Economy*, Vol.16, No.6, pp.663-685, 1993.

Vahid, F. and R.F. Engle, "Common Trends and Common Cycles," *Journal of Applied Econometrics*, 8, pp.341-360, 1993.

Zhang, Z.Y., "Open Regionalism and Trade Expansion in the Asia Pacific Region", *Papers in Regional Science*, Springer-Verlag, vol. 82, no. 3, pp.303-307, 2003.

Zhang, Z.Y. and K. Sato, "Whither Currency Union in Greater China?" CITS Working Paper 2005-01, Center for International Trade Studies, Faculty of Economics, Yokohama National University, 2005.

Zhang, Z.Y., K. Sato and M. McAleer, "Is a Monetary Union Feasible for East Asia?" *Applied Economics*, 36, pp.1031-1043, 2004.