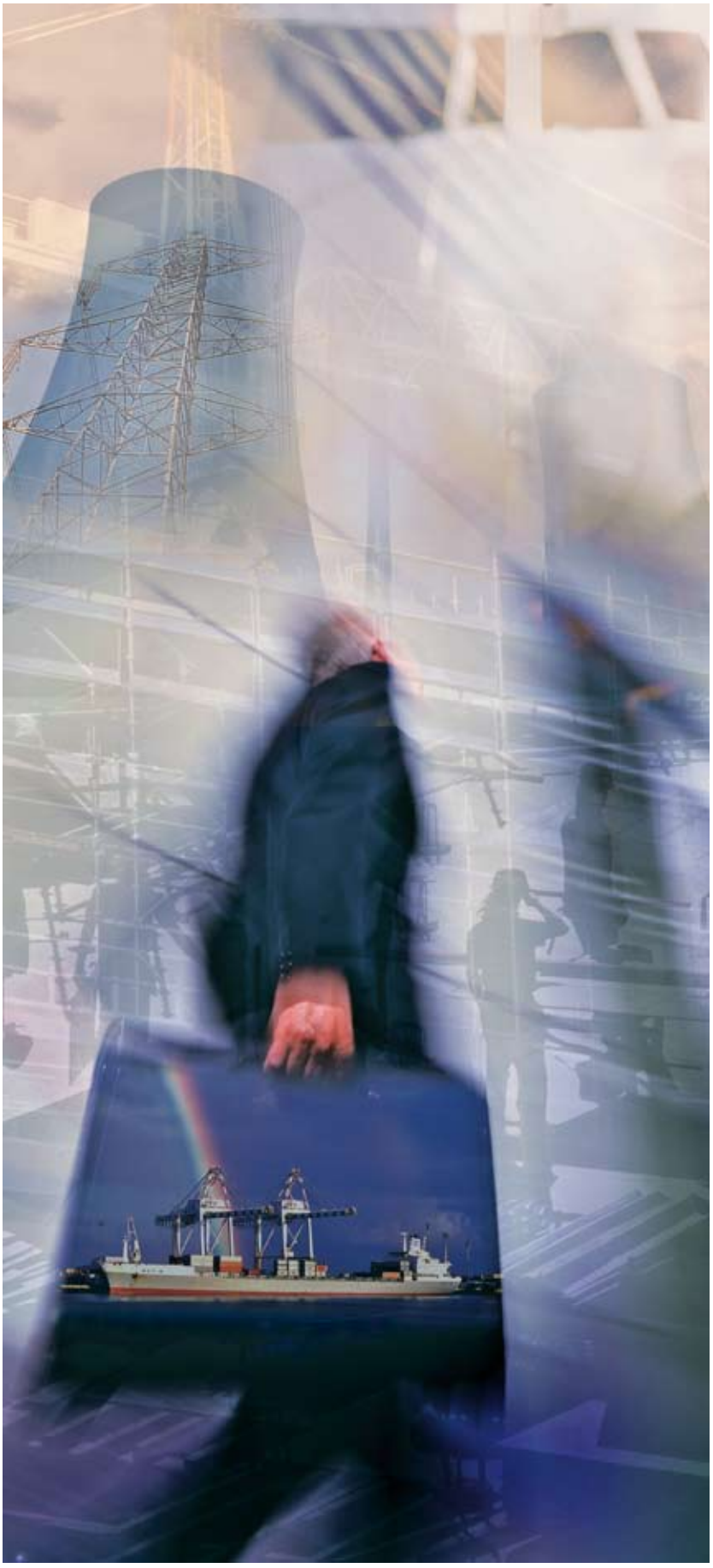

Queensland

The Economic Society of Australia Inc.

Proceedings of the 37th Australian Conference of Economists

Papers delivered at ACE 08

30th September to 4th October 2008

Gold Coast Queensland Australia

ISBN 978-0-9591806-4-0

Welcome

The Economic Society of Australia warmly welcomes you to the Gold Coast, Queensland, Australia for the 37th Australian Conference of Economists.

The Society was formed 83 years ago in 1925. At the time, the Society was opposed to declarations of policy and instead focused on open discussions and encouraging economic debate. Nothing has changed today, with the Society and the conference being at the forefront of encouraging debate.

This year we have a large number of papers dealing with Infrastructure, Central Banking and Trade.

Matters of the greatest global importance invariably boil down to be economic problems. Recent times have seen an explosion of infrastructure spending, after world-wide population growth has seen demand outpace aging supply. The world has become more globalised than at any time since World War I but the benefits of this (and the impact on our climate) has been questioned by some.

At the time of preparing for this conference we could not have known that it would have been held during the largest credit crisis since the Great Depression. The general public and politicians both look to central banks for the answers.

We are also very pleased to see a wide selection of papers ranging from applied economics to welfare economics. An A – Z of economics (well, almost).

Another feature of this conference is that we have gone out of our way to bring together economists from all walks of life, in particular from academia, government and the private sector. We are grateful to all of our sponsors, who are as diverse as the speakers.

The Organising Committee

James Dick
Khorshed Alam (Programme Chair)
Michael Knox
Greg Hall
Allan Layton
Rimu Nelson
Gudrun Meyer-Boehm
Jay Bandaralage
Paula Knight

Published November 2008

GPO Box 1170
Brisbane Queensland Australia
ecosocqld@optushome.com.au

Our Gold Sponsors

QIC

Queensland Treasury Corporation

Reserve Bank of Australia

Queensland Government
Department of Infrastructure and Planning

Keynote Sponsors

Australian Government
Productivity Commission

Australian Government
The Treasury

Queensland University of Technology
Faculty of Business
School of Economics and Finance

The University Of Queensland
AUSTRALIA

Goldman Sachs JBWere

The University Of Queensland
AUSTRALIA

NCER National Centre for Econometric Research

Central Council

Special Session Sponsors

Griffith UNIVERSITY

The Higher Education Academy Economics Network

Unless we have specifically been requested to do otherwise, all the papers presented at the conference are published in the proceedings in full. A small number of papers will have versions that have also been made available for special editions of Journals, Economic Analysis and Policy, and the Economic Record. Authors will retain the right to seek additional publication for papers presented at the conference so long as it differs in some meaningful way from those published here.

The opinions expressed in the papers included in the proceedings are those of the author(s) and no responsibility can be accepted by the Economic Society of Australia Inc, Economic Society of Australia (Queensland) Inc, the publisher for any damages resulting from usage or dissemination of this work.

The Paper following forms part of - *Proceedings of the 37th Australian Conference of Economists*
ISBN 978-0-9591806-4-0

The Suitability of a Monetary Union in East Asia: What does the Cointegration Approach Tell?

Kiyotaka Sato[*]
Yokohama National University

Zhaoyong Zhang
Edith Cowan University

David Allen
Edith Cowan University

June 2008

[*] Corresponding author: Kiyotaka Sato, Faculty of Economics, Yokohama National University, 79-3 Tokiwadai, Hodogaya-ku, Yokohama, 240-8501, Japan. Tel: +81-45-339-3551, Fax: +81-45-339-3518, Email: sato@ynu.ac.jp (Sato); zhaoyong.zhang@ecu.edu.au (Zhang); d.allen@ecu.edu.au (Allen).

The Suitability of a Monetary Union in East Asia: What does the Cointegration Approach Tell?

Abstract

The suitability of forming a monetary union in East Asia remains a hot issue in the study of the East Asian economies. Most of the existing studies focus on the symmetric issue of the fundamental shocks and the extent of correlation by applying the Blanchard and Quah [5] structural vector autoregression (VAR) technique, which includes the first-differenced variables in the model and examines only the bilateral relationship. However, the shock symmetry does not necessarily mean the co-movements of the real output variables between the countries concerned. The present paper employs the Johansen [11] cointegration test to check the long-run co-movements of real outputs among the East Asian countries, Japan and the United States to infer implication of forming a monetary union in the region. The results suggest that some groups of Asian NIEs plus the United States will be a potential candidate to form a monetary union. Mainland China is not suggested to be a member country of a monetary union with any of the grouped economies. More interestingly, the ASEAN countries alone are not feasible to form a monetary union unless when Japan is included, which has important implications for the role of Japan towards a regional monetary union.

JEL classification: E32; F36; F41
Keywords: Monetary union; Cointegration; Real output co-movements; East Asia

1. Introduction

In recent years, feasibility of forming a monetary union and establishing a regional (common) monetary unit in East Asia has been lively debated in industrial, governmental and academic arena. The post-crisis experience has provoked calls among politicians for further monetary integration and alternative regional exchange rate arrangements in East Asia to enhance stability and credibility of the exchange rate system. In 2000 ASEAN plus China, Japan and Korea (Known as ASEAN +3) agreed to establish a currency-swap network and to help avert future crisis,[1] and again in 2003 decided to establish an ASEAN Economic Community (AEC) by 2020. At the ADB 39th annual meeting in 2006, ASEAN+3 finance ministers agreed to take over the ADB's controversial plan to launch an Asian Currency Unit (ACU) with the hope to make it the region's legal currency in the future.

According to the seminal work of Mundell [19] and McKinnon [18], the incentive for two economies to peg their bilateral exchange rates rises with the bilateral intensity of trade, flexibility of factor markets, and symmetry of underlying shocks. By doing so, both will be able to forsake nominal exchange rate changes as an instrument of adjustment and to reap the reduction in transactions costs associated with a common currency. In general, the identified preconditions for forming a monetary union include: (i) the openness and goods market integration; (ii) factor market integration; (iii) similarity in economic structure and symmetry in (real) shocks; (iv) financial market integration; and (v) policy

[1] In the ASEAN + 3 (China, Japan and Korea) Finance Ministers Meeting on 6 May 2000 at Chiang Mai, participating countries agreed to establish a regional financing arrangement to supplement the existing international facilities through the "Chiang Mai Initiative". The Initiative involves an expanded ASEAN Swap Arrangement that would include all ASEAN countries, and a network of bilateral swap and repurchase agreement facilities among ASEAN countries, China, Japan and the Republic of Korea.

coordination.[2] , Most of the existing studies focus on the symmetric nature of the fundamental (real) shocks as it is important in terms of cost consideration when the member countries have to renounce the monetary policy autonomy after the union. If shocks to respective economies are symmetric, the cost of relinquishing the discretionary monetary policy is likely to be outweighed by the benefits of establishing a common currency. In contrast, if shocks are asymmetric, it will be more costly to give up the autonomous monetary policy and, hence, to establish a monetary union.

To investigate the symmetry in fundamental shocks, most of the existing studies generally use the Blanchard and Quah [5] structural vector autoregression (VAR) technique to identify fundamental shocks and conduct a correlation analysis between the identified shocks.[3] However, this approach has several weaknesses. First, a correlation analysis of shocks identified by the structural VAR is inherently a bivariate method, whereas it is obvious that an analysis of OCA must be based on a multi-country framework. More specifically, the bivariate approach reveals just country-to-country correlations without taking into account the relationship with other possible partner countries. A multi-country approach will thus be more appropriate to examine the monetary arrangement within a particular group of countries.

Second, it is important to distinguish between the short- and the long-run dynamics in consideration of a monetary union.[4] If real output variables are not cointegrated among the countries concerned, each output variable wonders randomly over

[2] For a good survey of the theory of OCA, see Kawai [15], Tavlas [23], De Grauwe [7] and Sato [21].

[3] See, for instance, Bayoumi and Eichengreen [2], Bayoumi, Eichengree and Mauro [3], Zhang, Sato and McAleer [25], and Zhang and Sato [24] for an application of the Blanchard and Quah technique to the East Asian region.

[4] Beine, Candelon and Hecq [4] make a similar discussion of this point.

time, which may lead to a different growth path for each country. Since nominal exchange rate changes as well as other macroeconomic policies have only transitory effects to stabilize the economy, the long-run economic divergence among the economies can be an obstacle to forming a monetary union. The structural VAR approach generally employs a bivariate VAR model including the first-differenced variables and imposes a restriction to allow only supply shock to affect the real output series in the long run, a result of which will be likely to remove any information about the long-run equilibrium relationship.

Recently, Cheung and Yuen [6] assess the level of integration among the three Greater China economies (the Mainland, Hong Kong and Taiwan) by using the cointegration technique. Sato and Zhang [22] apply a similar approach to the 9 East Asian economies plus Japan and the United States to explore whether real outputs are co-moved among these economies. Although Sato and Zhang [22] investigate the whole East Asian economies for an analysis of common business cycles, they employ a bivariate VAR of real output series for possible pairs of countries still within a two-country framework.

In contrast to the previous studies, the novelty of this paper is two-hold. First, the present paper is to investigate whether a *group* of East Asian countries share a common business cycles as well as a common stochastic trend of real outputs by using a multivariate VAR framework.[5] Second, we attempt to investigate *sixty* groups of countries to detect possible regional currency areas, which is far more comprehensive than the previous literature.[6] We include in this study Japan and the United States in addition to nine East Asian economies including three Asian NIEs (Korea, Taiwan and Hong Kong),

[5] There have so far been surprisingly a few studies that apply the cointegration technique to the analysis of a monetary union in East Asia. A few exceptions are Kawasaki and Ogawa [16] and Ogawa and Kawasaki [20] that apply the cointegration technique to the Generalized PPP model to assess the viability of an optimum currency area in East Asian region.

[6] Sato and Zhang [22] deal with 54 pairs of countries for the cointegration and common cycle tests, but theirs are just a bivariate analysis.

ASEAN5 (Singapore, Malaysia, Indonesia, Thailand and the Philippines), and Mainland China to investigate the co-movements of the real output variables spanning a period from 1978Q1 to 2006Q4. Based on a multivariate cointegration approach, this study will provide important implications for cost effectiveness in establishing a regional monetary union.

The rest of the paper is structured as follows. In section 2 we discuss the analytical framework for this study. Section 3 describes the data and presents the results of empirical examination. Finally, Section 4 concludes the paper.

2. Analytical Framework

To investigate the existence of a stable linear steady-state relationship between the variables, we need to conduct unit-root and cointegration tests to determine whether a time-series variable is stationary, and whether there is a long-run (cointegrating) relationship between the variables if all the variables are found non-stationary (i.e., have unit roots). If all variables studied are I(1) non-stationary, we proceed to the Johansen maximum likelihood (ML) method (Johansen [11]; Johansen and Juselius [14]) to test whether these variables are cointegrated. The Johansen approach allows testing of the long run relationship between variables in a multivariate framework, and considers the error structure of the data processes and the interactions in the determination of the relevant economic variables. If the variables are cointegrated, the real output series have a common stochastic trend, implying synchronous long-run movements of the real outputs among the economies.

The Johansen cointegration technique is based on the maximum likelihood estimation of the vector error-correction model.[7] Let X_t be an $(n \times 1)$ vector of I(1)

[7] For conducting the Johansen cointegration test, we use CATS in RATS, Version 2.

variables. Then, it is possible to specify the following unrestricted vector autoregression (VAR) involving up to *k*-lags of X_t:

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

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:

$$\Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \varepsilon_t, \qquad (2)$$

where $\Pi = \sum_{i=1}^{k} A_i - I_n$ and $\Gamma_i = -\sum_{i=i+1}^{k} A_i$. 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 $\beta' X_{t-1}$ represents up to $(n-1)$ cointegration relationship in the multivariate model. Thus, the test for cointegration is to determine how many $r \leq (n-1)$ cointegration vectors exist in β, which amounts to testing whether $\Pi = \alpha\beta'$ has reduced rank.

We use in this paper the trace statistic by which the null hypothesis that there are at most *r* cointegrating vectors ($0 \leq r \leq n$) can be tested:[8]

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i), \qquad (3)$$

[8] We do not consider the maximum eigenvalue test in this paper. Doornik, Hendry and Nielsen [9] recommend not the maximum eigenvalue test but the trace test because the former lacks the consistency of the rank-selection procedure.

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. Rejection of this hypothesis suggests the existence of the maximum r cointegrating vectors. To avoid the finite-sample bias toward over-rejection of the no cointegration hypothesis, we employ the small sample correction of the trace test provided by CATS in RATS, Version 2, which is based on Johansen [12] and [13].

3. Empirical Results

3.1. Data

We use the quarterly series of real GDP for cointegration analysis of real outputs among the concerned economies. All data are expressed in natural logarithms and seasonally adjusted using the Census X-12 method. The eleven economies taken up in this paper include the three Asian NIEs (Korea, Taiwan and Hong Kong), ASEAN5 (Singapore, Malaysia, Indonesia, Thailand and the Philippines), China, Japan and the United States. The sample period covers 1978Q1 through 2006Q4 for all economies. The data on real GDP is obtained from Abeysinghe and Gulasekaran [1], the CEIC Asia Database, and the web sites of the Japanese METI (Ministry of Economy, Trade and Industry) and the FRB (Federal Reserve Board).

We first check the stationarity of the real GDP series using the ADF (Augmented Dickey-Fuller) test and DFGLS test (Dickey-Fuller test with GLS detrending) proposed by Elliott, Rothenberg and Stock [10][9] and then proceed to the cointegration analysis in the following section. 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

[9] We use EViews 6.0 for the unit-root tests.

difference of the variables reject the null hypothesis. These findings suggest that each series contains one unit root and is thus I(1) process (the results are not reported in the paper but available upon request).

3.2. Results of Cointegration Tests

We conduct the multivariate analysis of real output co-movements among the East Asian countries, Japan and the United States. The Johansen cointegration test is employed to test whether the I(1) output series move together in the long-run. In conducting the Johansen test, we initially estimate vector autoregressions (VAR) with four lags and then conduct the lag reduction tests based on the χ^2-distributed Likelihood Ratio (LR) tests. Once the common lag length is determined, we perform the test for reduced rank.[10] We also include impulse dummies in a VAR model since the Johansen cointegration test is very sensitive to the assumption that errors are independently normal.[11] The inclusion of impulse dummy variables is necessary in this study particularly because our sample includes the currency crisis period in 1997-98. Following Doornik, Hendry and Nielsen [9], we initially make a preliminary VAR estimation without dummies to investigate the histogram of the standardized residuals. Then, in the presence of extreme outliers, we include the impulse dummies and re-conduct the VAR estimation.[12]

---

[10] 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 [9] and Dennis, Hansen, Johansen and Juselius [8]. We use CATS in RATS Version 2 for the Johansen cointegration test.

[11] See, for instance, Maddala and Kim [17], Ch.5. Doornik, Hendry and Nielsen [9] argue that impulse dummies should be included unrestrictedly based on their Monte Carlo study to allow for the outliers so that the VAR residuals may be normally distributed.

[12] More specifically, we attempted much closer inspection of the estimated residuals than the visual investigation of the residual graph. If finding large residuals with absolute value larger than the threshold (2.576), we included impulse dummies and re-estimate a VAR. The dummies are included when the following economies are in the VAR (the dates of dummies are listed in parenthesis): Korea (1980Q4, 1988Q1), Taiwan (1999Q2, 2003Q2), Hong Kong (1984Q4-1985Q2, 2003Q2), Singapore

[Insert Table 1 about here]
[Insert Table 2 about here]
[Insert Table 3 about here]

We performed the Johansen cointegration test for sixty groups of countries with different combinations and the results are reported in Tables 1, 2 and 3.[13] Whereas there are a large number of possible combinations (sub-groups) among the 9 East Asian economies plus Japan as well as the United States, we categorize the groupings in the following ways: the East Asian countries are grouped as the whole East Asia, the Northeast Asia/NIEs and the ASEAN; and we then perform the tests without the inclusion of Japan and the U.S. and with the inclusions the latter.

Table 1 reports the cointegration test results for the East Asian countries only without the inclusion of Japan and/or the U.S., and Tables 2 and 3 report the results with the inclusion of Japan and the U.S., respectively. As it can be seen in Table 1, the hypothesis of no cointegration is rejected in 8 out of 20 cases (groups) mostly in the cases of the whole East Asia and also in the northeast Asia/NIEs. In contrast, no cointegrating relationships are found in the case of the ASEAN groups. When Japan is included in the group, the results become very different. As it can be seen in Table 2, there are 7 out of 20 cases (groups) that show at least one cointegrating relationship and mostly within the Japan and ASEAN groups. In contrast, the inclusion of Japan reduces the number of

---

(1985Q2, 2003Q2), Malaysia (1984Q4, 1998Q1), Indonesia (1993Q1, 1998Q1, 1998Q2), Thailand (1980Q2, 1997Q4), the Philippines (1979Q4, 1984Q3, 1987Q4), China (1986Q1, 1989Q1, 1989Q3), Japan (1993Q2) and the United States (1981Q2, 1981Q4, 1982Q1). In conducting the VAR estimation, we tried to scrutinize the existence of large residuals carefully and to include as small number of dummies as possible. Hence, all the dummies above were not used at the same time for estimation.

[13] In Tables 1, 2 and 3, the results for the null hypothesis of at most 6 cointegrating vectors or more are not reported due to the space limitation. As will be seen, however, we could find maximum 3 cointegrating vectors.

cointegrating relationship in Northeast Asia/NIEs groups. When the United States is included, the number of cointegrating relationship improves substantially: 15 out of 20 groups are found to share the long-run output co-movements (Table 3). Thus, the inclusion of Japan and/or the United States in a group considerably changes the pattern and the number of possible combinations of countries that exhibit cointegrating relationship of real outputs.

[Insert Table 4 about here]

Once a cointegrating relationship is found, we then test the significance of cointegrating vectors. The LR test is conducted for each coefficient in the cointegrating relationship and the null hypothesis is set such that the coefficient is equal to zero. If we cannot reject the zero restriction on one of β-coefficients, it implies that the variable corresponding to zero-restricted coefficients will be excluded from the cointegrating relationship. The zero-restriction is tested for each cointegrating vector one by one, and the results are reported in Table 4 where the figures in square brackets denote the *p*-value for the LR test. The insignificant *p*-value indicates that the corresponding country needs to be excluded from the system and, hence, a group that includes the country with insignificant β-coefficients will not be considered as a possible candidate of forming a monetary union. As it can be seen in Table 4, interestingly only 6 out of 25 groups reject the zero-restrictions in all the coefficients of the cointegrating vectors; otherwise, at least one coefficient in the long-run cointegrating vectors cannot reject the zero-restriction. As a consequence, there are just 6 groups of countries found to exhibit long-term real output co-movements.

[Insert Table 5 about here]

The results of cointegration test and the LR test for cointegrating vectors are summarized in Table 5. As it can be seen in Table 5, the number and patterns of cointegrating groups of countries are greatly affected with the inclusion of Japan or the United States as a member country in the study. First, the results indicate that for whole East Asian countries it seems to be inappropriate to form a monetary union. Second, the results support the formation of a monetary union among the Asian NIEs (Korea, Taiwan, Hong Kong and Singapore) as at least one cointegration relationship is found and the zero restriction on each β-coefficient is rejected in the cointegration system. It is interesting to note that the United States could become a member country of a monetary union with Taiwan, Hong Kong and Singapore, while, in contrast, China were not supported to be a member country with any of the grouped economies. Lastly and probably more importantly, ASEAN5 economies are found not to share the long-run output co-movements unless with the inclusion of Japan. Since the long-run real output co-movements are considered as one of the most important preconditions for forming an optimum currency area, we may postulate that a monetary union would be viewed feasible in the group of the above 6 countries as they share synchronous long-run output co-movements.

4. Concluding Remarks

This study adopts a multivariate cointegration approach to evaluate the feasibility of a monetary union in the East Asian region. The results suggest that some groups of Asian NIEs plus the United States and ASEAN5 plus Japan will be a potential candidate to form a monetary union as these grouped economies share the long-run real output co-movements. Interestingly, Mainland China is not suggested to be a member country of a

monetary union with any of the grouped economies. Furthermore, the results indicate that the ASEAN countries alone are not feasible to form a monetary union unless when Japan is included. This finding has important implications for the role of Japan in the region and when drives towards a regional monetary union.

However, our analysis has some limitations and further extension will be necessary. First, we need to conduct a robust test to check the sensitivity of the results to the formation of other possible groups as our analysis deals with only sixty groups of countries. Second, our analysis may not be able to fully catch the marked development of recent regional integration process and the growing presence of the Chinese economy in the last decade or so, as our sample covers the output variable only for about 30 years from 1978 to 2006. Third, our analysis is limited to the long-run co-movements of real outputs among the regional countries. However, even if a cointegrating relationship is found, the countries may still have different responses to shocks in the short-run or may not share synchronous common business cycles. These aspects are not counted in the current study, but reward a further consideration in the future study of a regional monetary union.

Acknowledgements:

The authors would like to thank Michael McAleer, Colin McKenzie, Kentaro Kawasaki, Mica Panić, Masanaga Kumakura, Tze Haw Chan and Craig Parsons for their insightful comments on the earlier version of the paper. The study is financially supported by Japan Society for the Promotion of Science through the Grant-in-Aid for Scientific Research (B), 116330059. The last two authors wish to acknowledge the financial support of a Strategic Research Grant at ECU.

References

[1] T. Abeysinghe, R. Gulasekaran, Quarterly Real GDP Estimates for China and ASEAN4 with a Forecast Evaluation, *Journal of Forecasting*, 23 (2004), 431-447.

[2] T. Bayoumi, B. Eichengreen, 1994, One Money or Many? Analyzing the Prospects for Monetary Unification in Various Parts of the World, *Princeton Studies in International Finance*, 16 (1994), International Finance Section, Princeton University.

[3] T. Bayoumi, B. Eichengreen, P. Mauro, On Regional Monetary Arrangements for ASEAN, *Journal of the Japanese and International Economies*, 14 (2000), 121-148.

[4] M. Beine, B. Candelon, A. Hecq, Assessing a Perfect European Optimum Currency Area: A Common Cycles Approach, *Empirica*, 27 (2000), 115-132.

[5] O.J. Blanchard, D. Quah, The Dynamic Effects of Aggregate Demand and Supply Disturbances, *American Economic Review*, 79 (1989), 655-673.

[6] Y.W. Cheung, J. Yuen, The Suitability of a Greater China Currency Union, *Pacific Economic Review*, 10 (2005), 83-103.

[7] P. De Grauwe, *Economics of Monetary Union*, Sixth Edition, Oxford, Oxford University Press, 2005.

[8] J.G. Dennis, H. Hansen, S. Johansen, K. Juselius, *CATS in RATS, Cointegration Analysis of Time Series, Version 2*, Evanston, Illinois: Estima, 2006.

[9] J.A. Doornik, D.F. Hendry, 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.

[10] G. Elliot, T. J. Rothenberg, J. H, Stock, Efficient Tests for an Autoregressive Unit Root, *Econometrica*, 64(1996), 813-836.

[11] S. Johansen, Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control,* 12 (1988), 231-254.

[12] S. Johansen, A Bartlett Correction Factor for Tests on the Cointegrating Relations, *Econometric Theory*, 16 (2000), 740-778.

[13] S. Johansen, A Small Sample Correction of the Test for Cointegrating Rank in the Vector Autoregressive Model, *Econometrica*, 70 (2002), 1929-1961.

[14] S. Johansen, K. Juselius, "Maximum Likelihood Estimation and Inference on Cointegration – With Application to the Demand for Money," *Oxford Bulletin of Economics and Statistics*, 52 (1990), 169-210.

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

[16] K. Kawasaki, E. Ogawa, What Should the Weights of the Three Major Currencies be in a Common Currency Basket in East Asia? *Asian Economic Journal*, 20 (2006), 75-94.

[17] G.S. Maddala, I.-M. Kim, *Unit Roots, Cointegration, and Structural Change*, Cambridge: Cambridge University Press, 1998.

[18] R.I. McKinnon, Optimum Currency Areas, *American Economic Review*, 53 (1963), 717-725.

[19] R.A. Mundell, A Theory of Optimum Currency Areas, *American Economic Review*, 51 (1961), 657-665.

[20] E. Ogawa, K. Kawasaki, Adopting a Common Currency Basket Arrangement into the 'ASEAN plus Three', paper presented at the 17th NBER Annual East Asian Seminar on Economics, Hawaii, June 22-24, 2006.

[21] K. Sato, East Asian Monetary Integration: An Empirical Assessment of the Optimum Currency Area Criteria, in H. Mitsuo, ed., *New Developments of the Exchange Rate Regimes in Developing Countries*, UK: Palgrave Macmillan, 159-185, 2007.

[22] K. Sato, Z.Y. Zhang, Real Output Co-movements in East Asia: Any Evidence for a Monetary Union? *The World Economy*, 29 (2006), 1671-1689.

[23] G.S., Tavlas, The 'New' Theory of Optimum Currency Areas," *The World Economy*, 16 (1993), 663-685.

[24] Z.Y. Zhang, K. Sato, Whither A Currency Union in Greater China? *Open Economies Review*, 19 (2008), 355-370.

[25] Z.Y. Zhang, K. Sato, M. McAleer, Is a Monetary Union Feasible for East Asia? *Applied Economics*, 36 (2004), 1031-1043.

Table 1: Results for Cointegration Rank Tests

Groups (Country Name)	Number of lags:	*Trace test:* $H_0: r = 0$	$H_0: r \leq 1$	$H_0: r \leq 2$	$H_0: r \leq 3$	$H_0: r \leq 4$	$H_0: r \leq 5$
a) East Asia (EA)							
(A01) EA9	4	287.22 **	215.61 **	153.83 *	108.45	73.97	48.51
		[0.000]	[0.000]	[0.012]	[0.100]	[0.273]	[0.418]
(A02) EA8	4	220.36 **	159.12 **	114.96 #	67.20	43.06	32.85
		[0.000]	[0.014]	[0.072]	[0.618]	[0.734]	[0.349]
b) Northeast Asia/NIEs							
(A03) NIEs4 (Kr,Tw,Hk,Sg) + Ch	4	65.48	34.64	16.65	4.16	1.02	-
		[0.599]	[0.939]	[0.986]	[1.000]	[0.994]	
(A04) NIEs3 (Kr,Tw,Hk) + Ch	4	66.83 *	34.96	18.14	4.00	-	-
		[0.016]	[0.212]	[0.306]	[0.725]		
(A05) Greater China (Tw,HK,Ch)	4	40.56 #	20.63	6.56	-	-	-
		[0.060]	[0.183]	[0.386]			
(A06) NIEs4 (Kr,Tw,Hk,Sg)	3	62.22 #	28.07	9.28	1.56	-	-
		[0.051]	[0.572]	[0.934]	[0.975]		
(A07) NIEs3 (Kr,Tw,Hk)	3	48.21 **	21.22	4.42	-	-	-
		[0.009]	[0.137]	[0.666]			
(A08) Kr, Tw, Sg	2	28.42	8.29	0.81	-	-	-
		[0.555]	[0.966]	[0.997]			
(A09) Kr, Hk, Sg	3	44.76 *	11.43	1.84	-	-	-
		[0.025]	[0.814]	[0.959]			
(A10) Tw, Hk, Sg	3	45.26 *	15.94	2.43	-	-	-
		[0.021]	[0.472]	[0.918]			
c) ASEAN							
(A11) ASEAN5 + Ch	4	101.76	39.95	24.86	11.73	12.44	2.33
		[0.212]	[0.999]	[0.999]	[1.000]	[0.734]	[0.918]
(A12) ASEAN5 (Sg,My,Id,Th,Ph)	2	55.61	25.87	17.60	7.19	1.36	-
		[0.902]	[0.999]	[0.977]	[0.985]	[0.982]	
(A13) ASEAN4 (My,Id,Th,Ph)	2	40.49	14.44	4.97	1.27	-	-
		[0.776]	[0.996]	[0.999]	[0.988]		
(A14) Sg, Id, Th, Ph	4	43.04	16.73	7.03	1.37	-	-
		[0.665]	[0.986]	[0.986]	[0.985]		
(A15) Sg, My, Th, Ph	2	44.51	18.75	8.69	2.42	-	-
		[0.599]	[0.962]	[0.949]	[0.906]		
(A16) Sg, My, Id, Ph	2	24.01	9.49	2.78	0.76	-	-
		[0.999]	[1.000]	[1.000]	[0.997]		
(A17) Sg, My, Id, Th	2	45.10	16.02	10.80	0.80	-	-
		[0.573]	[0.993]	[0.863]	[0.997]		
(A18) Sg, My, Id	2	16.77	5.29	0.73	-	-	-
		[0.988]	[0.998]	[0.998]			
(A19) Sg, My, Th	2	31.15	7.70	2.83	-	-	-
		[0.388]	[0.977]	[0.858]			
(A20) My, Id, Th	3	38.24	5.09	1.20	-	-	-
		[0.110]	[0.999]	[0.990]			

Note: Sample period is 1978Q1-2006Q4. "Trend" indicates that a VAR is estimated with a linear trend restricted to the cointegration space. Abbreviation of the country name: Kr (Korea), Tw (Taiwan), HK (Hong Kong), Sg (Singapore), My (Malaysia), Id (Indonesia), Th (Thailand), Ph (Philippines), Ch (China), EA9 (all 9 East Asian economies), and EA8 (all East Asian economies excluding China). Double asterisks (**), a single asterisk (*) and a sharp (#) denote the 1 percent, 5 percent and 10 percent significance, respectively. Figures in brackets indicate *p*-value.

Table 2: Results for Cointegration Rank Tests

Groups (Country Name)	Number of lag:	*Trace test:* $H_0: r = 0$	$H_0: r \leq 1$	$H_0: r \leq 2$	$H_0: r \leq 3$	$H_0: r \leq 4$	$H_0: r \leq 5$
a) Japan plus East Asia (EA)							
(B01) EA9 + Jp	4	350.41 **	250.22 **	189.09 *	137.70	100.94	63.79
		[0.000]	[0.000]	[0.013]	[0.125]	[0.253]	[0.645]
(B02) EA8 + Jp	4	293.21 **	199.90 **	144.41 *	95.93	54.56	30.32
		[0.000]	[0.002]	[0.047]	[0.369]	[0.913]	[0.983]
b) Japan plus Northeast Asia/NIEs							
(B03) Jp + NIEs4 + Ch	3	91.45	52.63	25.55	12.98	4.37	1.63
		[0.540]	[0.950]	[0.999]	[0.999]	[1.000]	[0.973]
(B04) Jp + NIEs3 (Kr,Tw,Hk) + C	3	69.49	39.76	16.54	5.64	2.54	-
		[0.424]	[0.805]	[0.990]	[0.997]	[0.894]	
(B05) Jp + Greater China	4	56.68	33.77	12.24	2.17	-	-
		[0.135]	[0.245]	[0.758]	[0.940]		
(B06) Jp + NIEs4	3	78.21	41.00	15.19	4.92	1.14	-
		[0.161]	[0.757]	[0.995]	[0.999]	[0.992]	
(B07) Jp + NIEs3 (Kr,Tw,Hk)	3	54.36	26.49	6.94	2.51	-	-
		[0.186]	[0.677]	[0.987]	[0.913]		
(B08) Jp, Kr, Tw, Sg	2	39.11	15.36	6.33	0.59	-	-
		[0.834]	[0.993]	[0.993]	[0.998]		
(B09) Jp, Kr, Hk, Sg	3	61.19 #	21.82	6.51	1.48	-	-
		[0.058]	[0.890]	[0.991]	[0.978]		
(B10) Jp, Tw, Hk, Sg	3	56.52	24.37	8.47	0.88	-	-
		[0.137]	[0.780]	[0.958]	[0.995]		
c) Japan plus ASEAN							
(B11) Jp + ASEAN5 + Ch	3	119.07	53.52	36.93	18.10	13.49	5.57
		[0.553]	[1.000]	[1.000]	[1.000]	[0.998]	[0.997]
(B12) Jp + ASEAN5	4	114.84 *	42.46	19.44	11.67	3.85	1.52
		[0.041]	[0.998]	[1.000]	[1.000]	[1.000]	[0.977]
(B13) Jp + ASEAN4	4	93.87 *	36.84	17.03	7.26	0.99	-
		[0.011]	[0.891]	[0.986]	[0.985]	[0.993]	
(B14) Jp, Sg, Id, Th, Ph	4	69.26	32.30	14.12	5.29	2.11	-
		[0.431]	[0.968]	[0.997]	[0.998]	[0.934]	
(B15) Jp, Sg, My, Th, Ph	4	93.14 *	27.57	8.20	5.27	1.39	-
		[0.014]	[0.996]	[1.000]	[0.998]	[0.980]	
(B16) Jp, Sg, My, Id, Ph	4	45.40	17.07	7.59	2.56	0.66	-
		[0.994]	[1.000]	[1.000]	[1.000]	[0.998]	
(B17) Jp, Sg, My, Id, Th	4	88.40 *	22.07	15.17	4.44	0.53	-
		[0.034]	[1.000]	[0.995]	[0.999]	[0.999]	
(B18) Jp, Sg, My, Id	4	34.88	12.46	4.03	1.39	-	-
		[0.958]	[1.000]	[1.000]	[0.985]		
(B19) Jp, Sg, My, Th	4	77.37 **	26.24	7.76	3.01	-	-
		[0.001]	[0.678]	[0.975]	[0.845]		
(B20) Jp, My, Id, Th	4	68.76 *	13.03	4.74	0.39	-	-
		[0.010]	[0.999]	[0.999]	[1.000]		

Note: Sample period is 1978Q1-2006Q4. "Trend" indicates that a VAR is estimated with a linear trend restricted to the cointegration space. Abbreviation of the country name: Kr (Korea), Tw (Taiwan), HK (Hong Kong), Sg (Singapore), My (Malaysia), Id (Indonesia), Th (Thailand), Ph (Philippines), Ch (China), EA9 (all 9 East Asian economies), EA8 (all East Asian economies excluding China), and Jp (Japan). Double asterisks (**), a single asterisk (*) and a sharp (#) denote the 1 percent, 5 percent and 10 percent significance, respectively. Figures in brackets indicate *p*-value.

Table 3: Results for Cointegration Rank Tests

Groups (Country Name)	Number of lag:	*Trace test:* $H_0: r = 0$	$H_0: r \leq 1$	$H_0: r \leq 2$	$H_0: r \leq 3$	$H_0: r \leq 4$	$H_0: r \leq 5$
a) United States plus East Asia (EA)							
(C01) US + EA9	4	355.50 **	275.11 **	206.34 **	139.39	107.92	70.69
		[0.000]	[0.000]	[0.001]	[0.100]	[0.108]	[0.392]
(C02) US + EA8	4	286.93 **	214.98 **	155.01 **	86.76	62.46	30.02
		[0.000]	[0.000]	[0.009]	[0.684]	[0.683]	[0.986]
b) United States plus Northeast Asia/NIEs							
(C03) US + NIEs4 + Ch	3	133.58 **	86.33 *	53.36	22.09	7.69	3.08
		[0.001]	[0.046]	[0.219]	[0.864]	[0.973]	[0.829]
(C04) US + NIEs3 (Kr,Tw,Hk) + (	3	105.99 **	59.99 #	36.89	10.70	2.09	-
		[0.000]	[0.065]	[0.137]	[0.852]	[0.942]	
(C05) US + Greater China	4	62.73 *	37.10	20.93	5.60	-	-
		[0.037]	[0.130]	[0.158]	[0.496]		
(C06) US + NIEs4	3	100.11 **	65.77 *	35.62	9.73	2.30	-
		[0.003]	[0.022]	[0.173]	[0.911]	[0.922]	
(C07) US + NIEs3 (Kr,Tw,Hk)	3	79.87 **	48.35 **	21.36	3.58	-	-
		[0.000]	[0.008]	[0.140]	[0.778]		
(C08) US, Kr, Tw, Sg	3	71.01 **	37.85	11.07	2.71	-	-
		[0.007]	[0.118]	[0.841]	[0.889]		
(C09) US, Kr, Hk, Sg	3	76.21 **	38.10	17.60	4.68	-	-
		[0.001]	[0.114]	[0.335]	[0.623]		
(C10) US, Tw, Hk, Sg	3	82.75 **	48.35 #	20.04	4.61	-	-
		[0.000]	[0.008]	[0.185]	[0.600]		
c) United States plus ASEAN							
(C11) US + ASEAN5 + Ch	4	155.66 **	99.20	25.48	33.83	15.66	9.16
		[0.008]	[0.259]	[1.000]	[0.947]	[0.993]	[0.932]
(C12) US + ASEAN5	4	109.08 #	61.41	10.35	15.78	2.85	0.14
		[0.085]	[0.713]	[1.000]	[0.992]	[1.000]	[1.000]
(C13) US + ASEAN4	4	92.28 *	44.49	12.93	2.62	0.03	-
		[0.016]	[0.600]	[0.999]	[1.000]	[1.000]	
(C14) US, Sg, Id, Th, Ph	4	71.77	34.71	13.48	3.34	0.41	-
		[0.343]	[0.939]	[0.999]	[1.000]	[1.000]	
(C15) US, Sg, My, Th, Ph	3	81.89 #	47.97	10.79	6.85	0.05	-
		[0.093]	[0.411]	[1.000]	[0.988]	[1.000]	
(C16) US, Sg, My, Id, Ph	2	43.78	17.40	7.07	1.76	0.04	-
		[0.996]	[1.000]	[1.000]	[1.000]	[1.000]	
(C17) US, Sg, My, Id, Th	3	74.42	30.27	13.77	9.43	1.30	-
		[0.258]	[0.988]	[0.998]	[0.250]	[0.986]	
(C18) US, Sg, My, Id	2	29.22	13.70	4.07	0.80	-	-
		[0.990]	[0.998]	[1.000]	[0.996]		
(C19) US, Sg, My, Th	2	48.60	18.52	8.08	3.03	-	-
		[0.393]	[0.961]	[0.965]	[0.835]		
(C20) US, My, Id, Th	4	61.94 *	17.87	7.00	0.86	-	-
		[0.048]	[0.977]	[0.986]	[0.995]		

Note: Sample period is 1978Q1-2006Q4. "Trend" indicates that a VAR is estimated with a linear trend restricted to the cointegration space. Abbreviation of the country name: Kr (Korea), Tw (Taiwan), HK (Hong Kong), Sg (Singapore), My (Malaysia), Id (Indonesia), Th (Thailand), Ph (Philippines), Ch (China), EA9 (all 9 East Asian economies), EA8 (all East Asian economies excluding China), and US (the United States). Double asterisks (**), a single asterisk (*) and a sharp (#) denote the 1 percent, 5 percent and 10 percent significance, respectively. Figures in brackets indicate *p*-value.

Table 4: Cointegrating Vectors and Test of Exclusion

	Long-run Cointegrating Vectors:											
Country Groups:	Kr	Tw	HK	Sg	My	Id	Th	Ph	Ch	Jp	US	Trend
(A01) EA9	0.060 +	-0.408	-0.331	1.000	-0.969	0.413	-0.041 +	-0.336	-0.015	-	-	0.006
	0.085 +	-0.582	0.812	-0.310	1.000	-0.490	-0.136 +	-0.393	-0.104			0.000
	-0.002 +	0.018	-0.329	1.000	-0.563	0.498	-0.248 +	-0.095	-0.470	-	-	0.005
	[0.751]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.111]	[0.000]	[0.019]			[0.001]
(A02) EA8	0.038 +	-0.491	-0.277	1.000	-0.986	0.285	0.079 +	-0.347	-	-	-	0.007
	0.381 +	-0.586	-0.027	1.000	-0.445	0.464	-0.313 +	-0.090				-0.007
	-0.117 +	-0.118	0.967	-0.889	1.000	-0.749	0.075 +	-0.051	-	-	-	-0.001
	[0.226]	[0.000]	[0.003]	[0.000]	[0.000]	[0.024]	[0.335]	[0.000]				[0.000]
(A04) NIEs3 (Kr,Tw,Hk) + Ch	1.000	-0.592 +	-0.955	-	-	-	-	-	-0.314 +	-	-	0.0130 +
	[0.017]	[0.202]	[0.001]						[0.464]			[0.124]
(A05) Greater China (Tw,HK,Ch)	-	-0.572	0.522 +	-	-	-	-	-	1.000	-	-	-0.0210
		[0.040]	[0.154]						[0.052]			[0.030]
(A06) NIEs4 (Kr,Tw,Hk,Sg)	-0.480 +	-0.075 +	1.000	0.369 +	-	-	-	-	-	-	-	-0.0100
	[0.287]	[0.884]	[0.002]	[0.143]								[0.003]
(A07) NIEs3 (Kr,Tw,Hk)	1.000	-0.671 +	-0.918	-	-	-	-	-	-	-	-	0.0060
	[0.062]	[0.257]	[0.018]									[0.053]
(A09) Kr, Hk, Sg	-0.687	-	1.000	0.606	-	-	-	-	-	-	-	-0.0110
	[0.006]		[0.000]	[0.012]								[0.001]
(A10) Tw, Hk, Sg	-	-0.661	1.000	0.614	-	-	-	-	-	-	-	-0.013
		[0.027]	[0.002]	[0.045]								[0.001]
(B01) Jp + EA9	-0.156 +	1.000	-0.318	-0.656	0.294	-0.049	0.118	0.749	-0.023 +	-0.049	-	-0.008
	-0.014 +	0.059	0.544	-0.834	1.000	-0.519	0.067	-0.011	-0.095 +	-0.118	-	-0.001
	0.029 +	-0.721	0.106	0.308	0.676	-0.064	-0.554	-0.237	0.128 +	1.000	-	-0.004
	[0.573]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.241]	[0.000]		[0.026]
(B02) Jp + EA8	-0.076 +	0.250	0.192	-0.674	1.000	-0.334	-0.149	0.283	-	0.326	-	-0.007
	0.156 +	-0.844	-0.240	1.000	-0.276	0.301	-0.424	-0.385	-	0.732	-	0.003
	-0.046 +	-0.082	0.619	-0.690	1.000	-0.452	-0.148	-0.012	-	0.237	-	-0.004
	[0.146]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]		[0.000]

Table 4: Cointegrating Vectors and Test of Exclusion (cont'd)

	Long-run Cointegrating Vectors:											
Country Groups:	Kr	Tw	HK	Sg	My	Id	Th	Ph	Ch	Jp	US	Trend
(B09) Jp, Kr, Hk, Sg	-0.936	-	0.878	1.000	-	-	-	-	-	0.183 +	-	-0.0130
	[0.022]		[0.012]	[0.000]						[0.769]		[0.005]
(B12) Jp + ASEAN5	-	-	-	-0.309	1.000	-0.050 +	-0.453	0.115	-	0.619	-	-0.0070
				[0.024]	[0.000]	[0.669]	[0.012]	[0.021]		[0.005]		[0.000]
(B13) Jp + ASEAN4	-	-	-	-	1.000	0.009 +	-0.617	0.231	-	0.734	-	-0.0120
					[0.000]	[0.959]	[0.014]	[0.006]		[0.007]		[0.000]
(B15) Jp, Sg, My, Th, Ph	-	-	-	-0.342	1.000	-	-0.479	0.117	-	0.649	-	-0.007
				[0.004]	[0.000]		[0.000]	[0.011]		[0.000]		[0.000]
(B17) Jp, Sg, My, Id, Th	-	-	-	-0.301	1.000	-0.173	-0.331	-	-	0.434	-	-0.006
				[0.038]	[0.000]	[0.092]	[0.037]			[0.026]		[0.000]
(B19) Jp, Sg, My, Th	-	-	-	-0.438	1.000	-	-0.448	-	-	0.554	-	-0.004
				[0.000]	[0.000]		[0.000]			[0.001]		[0.000]
(B20) Jp, My, Id, Th	-	-	-	-	1.000	-0.372	-0.178 +	-	-	0.151 +	-	-0.009
					[0.000]	[0.052]	[0.469]			[0.567]		[0.000]
(C01) US + EA9	-0.014 +	-0.062	0.454	-0.930	1.000	-0.616	0.195	0.163	0.302	-	0.249	-0.010
	0.112 +	-0.770	-0.113	1.000	-0.900	0.163	0.037	-0.526	0.304	-	-0.209	0.005
	0.005 +	-0.470	0.685	-0.163	1.000	-0.161	-0.288	-0.346	-0.424	-	0.695	-0.001
	[0.819]	[0.004]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.034]	[0.000]
(C02) US + EA8	0.000 +	-0.180	0.446	-0.754	1.000	-0.409	0.106	0.110	-	-	0.910	-0.010
	0.107 +	-0.713	-0.237	1.000	-0.897	0.314	0.046	-0.473	-	-	0.315	0.006
	-0.092 +	-0.076	0.852	-0.449	1.000	-0.309	-0.338	-0.115	-	-	0.235	-0.008
	[0.718]	[0.003]	[0.002]	[0.001]	[0.000]	[0.001]	[0.066]	[0.000]			[0.000]	[0.000]
(C03) US + NIEs4 + Ch	0.240	-0.301	0.016 +	0.124	-	-	-	-	-0.199	-	1.000	-0.004
	-0.564	0.059	0.325 +	0.512	-	-	-	-	-0.065	-	1.000	-0.010
	[0.001]	[0.012]	[0.220]	[0.001]					[0.023]		[0.000]	[0.001]
(C04) US + NIEs3 (Kr,Tw,Hk) + Ch	0.452	-0.388	-0.030 +	-	-	-	-	-	-0.250	-	1.000	-0.003 +
	-0.394	0.345	0.371 +	-	-	-	-	-	-0.179	-	1.000	-0.007 +
	[0.000]	[0.002]	[0.296]						[0.030]		[0.000]	[0.151]

Table 4: Cointegrating Vectors and Test of Exclusion (cont'd)

	Long-run Cointegrating Vectors:											
Country Groups:	Kr	Tw	HK	Sg	My	Id	Th	Ph	Ch	Jp	US	Trend
(C05) US + Greater China	-	-0.719	0.641 +	-	-	-	-	-	0.845 +	-	1.000 +	-0.025
		[0.047]	[0.125]						[0.215]		[0.511]	[0.050]
(C06) US + NIEs4	1.000	-0.530 +	-0.437 +	-0.569 +	-	-	-	-	-	-	-0.350 +	0.009 +
	-0.008	-0.076 +	-0.193 +	0.187 +	-	-	-	-	-	-	1.000 +	-0.006 +
	[0.038]	[0.602]	[0.367]	[0.113]							[0.586]	[0.474]
(C07) US + NIEs3 (Kr,Tw,Hk)	-0.965	1.000	0.190 +	-	-	-	-	-	-	-	-0.916 +	0.005 +
	0.251	-0.556	0.667 +	-	-	-	-	-	-	-	1.000 +	-0.012 +
	[0.004]	[0.010]	[0.114]								[0.145]	[0.184]
(C08) US, Kr, Tw, Sg	0.507	-0.531	-	0.111 +	-	-	-	-	-	-	1.000	-0.009
	[0.018]	[0.005]		[0.445]							[0.006]	[0.008]
(C09) US, Kr, Hk, Sg	-0.985	-	1.000	0.783	-	-	-	-	-	-	-0.119 +	-0.009 +
	[0.000]		[0.000]	[0.001]							[0.863]	[0.210]
(C10) US, Tw, Hk, Sg	-	-0.281	0.177	0.359	-	-	-	-	-	-	1.000	-0.011
	-	-0.634	1.000	0.432	-	-	-	-	-	-	-0.416	-0.008
		[0.034]	[0.019]	[0.004]							[0.001]	[0.000]
(C11) US + ASEAN5 + Ch	-	-	-	-0.340	-0.047 +	-0.431	0.242	0.200	1.000	-	-0.234 +	-0.015
				[0.036]	[0.832]	[0.011]	[0.033]	[0.038]	[0.000]		[0.490]	[0.000]
(C12) US + ASEAN5	-	-	-	-0.265 +	-0.673 +	-0.017 +	0.266 +	-0.239 +	-	-	1.000 +	0.005 +
				[0.504]	[0.191]	[0.965]	[0.375]	[0.187]			[0.164]	[0.497]
(C13) US + ASEAN4	-	-	-	-	1.000	0.065 +	-0.322 +	0.226 +	-	-	-0.746 +	-0.007 +
					[0.002]	[0.867]	[0.312]	[0.219]			[0.202]	[0.292]
(C15) US, Sg, My, Th, Ph	-	-	-	-0.299 +	0.288 +	-	0.001 +	-0.056 +	-	-	1.000	-0.006 +
				[0.117]	[0.326]		[0.990]	[0.592]			[0.016]	[0.126]
(C20) US, My, Id, Th	-	-	-	-	1.000	-0.359 +	-0.131 +	-	-	-	0.010 +	-0.009
					[0.000]	[0.281]	[0.587]				[0.980]	[0.042]

Note: The likelihood ratio test is conducted by imposing zero restrictions on β for each variable. If the null hypothesis of zero coefficients is not rejected, the corresponding variable will be excluded from the cointegrating relationship. A plus (+) sign indicates that the null is not rejected at the 10 percent level.

Table 5: Summary Result: Cointegration Rank Test and Zero-Restrictions on β

Groups (Country Name)	(A) East Asia Only	(B) Including Japan	(C) Including USA
a) East Asia (EA)			
(01) EA9	No	No	No
(02) EA8	No	No	No
b) Northeast Asia/NIEs			
(03) NIEs4 (Kr,Tw,Hk,Sg) + Ch	-	-	No
(04) NIEs3 (Kr,Tw,Hk) + Ch	No	-	No
(05) Greater China (Tw,HK,Ch)	No	-	No
(06) NIEs4 (Kr,Tw,Hk,Sg)	No	-	No
(07) NIEs3 (Kr,Tw,Hk)	No	-	No
(08) Kr, Tw, Sg	-	-	No
(09) Kr, Hk, Sg	**Yes**	No	No
(10) Tw, Hk, Sg	**Yes**	-	**Yes**
c) ASEAN			
(11) ASEAN5 + Ch	-	-	No
(12) ASEAN5 (Sg,My,Id,Th,Ph)	-	No	No
(13) ASEAN4 (My,Id,Th,Ph)	-	No	No
(14) Sg, Id, Th, Ph	-	-	-
(15) Sg, My, Th, Ph	-	**Yes**	No
(16) Sg, My, Id, Ph	-	-	-
(17) Sg, My, Id, Th	-	**Yes**	-
(18) Sg, My, Id	-	-	-
(19) Sg, My, Th	-	**Yes**	-
(20) My, Id, Th	-	No	No

Note: Column A represents the case of forming a monetary union involving East Asian economies only. Columns B and C indicate respectively the candidate economies of East Asia for a monetary union with the inclusion of Japan and the United States. "Yes" denotes that at least one cointegration relationship is found, and the zero restriction on each β-coefficient is rejected in the cointegration system. "No" indicates that at least one cointegrating relationship is found, but the zero restriction on some β-coefficients cannot be rejected.