European Journal of Scientific Research
ISSN 1450-216X Vol.39 No.4 (2010), pp.489-497

http://www.eurojournals.com/ejsr.htm

Classification of the ASEAN+3 Economies Using Fuzzy Clustering Approach

Noer Azam Achsani
Department of Economics and Graduate School of Management and Business
Bogor Agricultural University, Indonesia
E-mail: achsani@yahoo.com (preferred) or achsani@mb.ipb.ac.id
Tel: +62-251-8313813; Fax: +62-251-8318515

Hermanto Siregar
Department of Economics and International Centre for Applied Finance and Economics
Bogor Agricultural University, Indonesia
E-mail: hermansiregar@yahoo.com
Tel: +62-251-8377662; Fax: +62-251-8377896

Abstract

The success story of the EU in establishing a single market in 1999 have motivated ASEAN+3 region to further integrate their economy. It is therefore interesting to assess whether the ASEAN+3 economies may be seen as a single major entity or actually as a number of significantly different clusters.

This study attempts to classify members of ASEAN+3 countries into clusters, employing the Fuzzy Clustering Approach. The results show that the countries can be classified into five clusters. Singapore, Japan, Korea, and China can be seen as the leading economies in the region. Moreover, our analysis using data before, during and after the Asian Financial Crisis seems to be consistent. Therefore, in order for the single market to function effectively, when taking initiatives these countries should consider limitations and bottlenecks faced by other countries within the region.

Keywords: ASEAN+3, economic integration, fuzzy clustering approach.
JEL Classification Codes: C14, F15, F31, F36

1. Introduction

Facing the globalization, many regions tend to integrate their economy in order to have a better bargaining position in compare to other regions, such as the EU, NAFTA and East Asian countries. The history of East Asian Economic integration itself was begun on 8 August 1967, when the Association of Southeast Asian Nations or ASEAN was established in Bangkok, with the aims and purposes to:

1) accelerate the economic growth, social progress and cultural development in the region through joint endeavours in the spirit of equality and partnership in order to strengthen the foundation for a prosperous and peaceful community of Southeast Asian nations, and

2) promote regional peace and stability through abiding respect for justice and the rule of law in the relationship among countries in the region and adherence to the principles of the United Nations Charter.

ASEAN has originally five Member Countries, namely: Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Brunei Darussalam joined on 8 January 1984, Vietnam 28 July 1995, Laos and Myanmar 23 July 1997, and Cambodia 30 April 1999. The Association represents the collective will of the nations to bind themselves together in friendship and cooperation and, through joint efforts and sacrifices, secure for their peoples and for posterity the blessings of peace, freedom, and prosperity (The ASEAN Declaration, Bangkok, 8 August 1967).

When ASEAN was established, trade among the Member Countries was insignificant. Estimates between 1967 and the early 1970s showed that the share of intra-ASEAN trade from the total trade of the Member Countries was between 12 and 15 percent. Thus, some of the earliest economic cooperation schemes of ASEAN were aimed at addressing this situation. One of these was the Preferential Trading Arrangement (PTA) of 1977, which accorded tariff preferences for trade among ASEAN economies. Ten years later, an Enhanced PTA Program was adopted at the Third ASEAN Summit in Manila further increasing intra-ASEAN trade.

The Framework Agreement on Enhancing Economic Cooperation was adopted at the Fourth ASEAN Summit in Singapore in 1992, which included the launching of a scheme toward an ASEAN Free Trade Area or AFTA. The strategic objective of AFTA is to increase the ASEAN region's competitive advantage as a single production unit. The elimination of tariff and non-tariff barriers among the member countries is expected to promote greater economic efficiency, productivity, and competitiveness. The Fifth ASEAN Summit held in Bangkok in 1995 adopted the Agenda for Greater Economic Integration, which included the acceleration of the timetable for the realization of AFTA from the original 15-year timeframe to 10 years.

In 1997, the ASEAN leaders adopted the ASEAN Vision 2020, which called for ASEAN Partnership in Dynamic Development aimed at forging closer economic integration within the region. The vision statement also resolved to create a stable, prosperous and highly competitive ASEAN Economic Region, in which there is a free flow of goods, services, investments, capital, and equitable economic development and reduced poverty and socio-economic disparities. The Hanoi Plan of Action, adopted in 1998, serves as the first in a series of plans of action leading up to the realization of the ASEAN vision.

In addition to trade and investment liberalization, regional economic integration is being pursued through the development of Trans-ASEAN transportation network consisting of major inter-state highway and railway networks, principal ports and sea lanes for maritime traffic, inland waterway transport, and major civil aviation links. ASEAN is promoting the interoperability and interconnectivity of the national telecommunications equipment and services. Trans-ASEAN energy networks, which consist of the ASEAN Power Grid and the Trans-ASEAN Gas Pipeline Projects, are also being developed.

ASEAN cooperation has resulted in greater regional integration. Within three years from the launching of AFTA, exports among ASEAN countries grew from US$43.26 billion in 1993 to almost US$80 billion in 1996, an average yearly growth rate of 28.3 percent. In the process, the share of intra-regional trade from ASEAN's total trade rose from 20 percent to almost 25 percent. Tourists from ASEAN countries themselves have been representing an increasingly important share of tourism in the region. In 1996, of the 28.6 million tourist arrivals in ASEAN, 11.2 million or almost 40 percent came from within ASEAN itself.

The success story of the EU in establishing a single market in 1999 have motivated ASEAN region to further integrate their economy. During ASEAN Summit in Bali October 2003, all ASEAN members agreed to establish a so-called "ASEAN Economic Community (AEC)" as the realization and end-goal of economic integration as outlined in the ASEAN Vision 2020. It rearticulates its aims to create a stable, prosperous and highly competitive ASEAN economic region in which there is a free flow of goods, services, investment and a freer flow of capital, equitable economic development and reduced poverty and socio-economic disparities. The AEC plans to establish ASEAN as single market and production base, turning the diversity that characterizes the region into opportunities for business complementation making the ASEAN a more dynamic and stronger segment of the global supply chain.

Success in integrating all ASEAN countries (Indonesia, Malaysia, Singapore, Thailand, Philippines, Brunei Darussalam, Vietnam, Myanmar, Cambodia, and Lao's Peoples Democratic Republic) means integrating a region which has a population of about 549 million, a total area of 4.5 million square kilometers, a combined gross domestic product of US$800 billion, and a total trade of US$ 1047 billion (as of year2004). This will have a great impact to the region, not only economically but also the whole aspects.

Furthermore, Mr. Osamu Watanabe (the Director of JETRO Japan) said that the single market should include not only ASEAN countries, but ASEAN+3 (Japan, South Korea and China). So, it would give markedly greater impact, since it will result in a huge market with population more than 3 billion people. Currently, ASEAN has even already closer cooperation with the three countries, i.e. ASEAN-China Free Trade Area, Comprehensive Economic Partnership between ASEAN-Japan, and Korea.

Keeping this development in mind, it is interesting to assess whether the ASEAN+3 economies may be seen as a single major entity or actually as a number of significantly different clusters. When they are still consisting of a number of markedly different clusters, it may reflect that economic conditions, and hence economic interests, are divergent among the economies. Knowing composition of the clusters may therefore be important in identifying common economic interests of groups of the countries. Classifying the ASEAN+3 based on a scientific approach is the objective of this study.

2. Data and Methodology

There are many approaches to classify the ASEAN+3 countries. An approach which has not yet been utilised to do so is the fuzzy clustering approach, which basically minimises the variance or dissimilarity within members of a cluster. We used the macroeconomic data from 10 ASEAN Asian countries (i.e. Indonesia, Malaysia, Singapore, Thailand, the Philippines, Brunei Darussalam, Vietnam, Myanmar, Cambodia, and Lao's Peoples Democratic Republic) plus three other East Asian countries of Japan, China and South Korea.

The data are collected from the official website of ASEAN (www.aseansec.org), covering the period 1990–2006. Using the fuzzy C-Means method, all the countries are classified into some "economic clusters" based on the Maastricht Treaty Criterion of the EU, i.e. Debt/GDP ratio, Budget Deficit/GDP Ratio, Exchange rates stability (against US$), and long term interest rates. In order to see the impact of Asian Crisis 1997 the data are divided into three time periods, before the crisis, i.e., 1990–1996, during the crisis, i.e., 1997–2001, and after the crisis, i.e., 2002–2006.

Fuzzy Clustering

Ruspini (1969) introduced a notion of fuzzy partition to describe the cluster structure of a data set and suggested an algorithm to compute the optimum fuzzy partition. Dunn (1973) generalized the minimum-variance clustering procedure and Bezdek (1981) generalized Dunn's approach to obtain an infinite family of algorithms known as Fuzzy C-Means (FCM). He generalized the fuzzy objective function by introducing the weighting exponent *m*, $1 \le m < \infty$;

$$J_m(U,V) = \sum_{k=1}^{n}\sum_{i=1}^{c}(u_{ik})^m d^2(x_k, v_i),$$

where $X = \{x_1, x_2, ..., x_n\} \subset R^p$ is a subset of the real *p*-dimensional vector space R^p consisted of n observations. U is a randomly fuzzy partition matrix of X into *c* parts, v_i is the cluster centres in R^p,

$d(x_k, v_i) = \|x_k - v_i\| = \sqrt{(x_k - v_i)^T (x_k - v_i)}$ is an inner product induced norm on R^p, u_{ik} is referred to as the grade of membership or belonging of x_t to the cluster *i*. The grade of memberships satisfies the following constraints:

$$0 \le u_{ik} \le 1, \text{ for } 1 \le i \le c, 1 \le k \le n,$$

$$0 < \sum_{k=1}^{n} u_{ik} < n, \text{ for } 1 \le i \le c,$$

$$\sum_{i=1}^{c} u_{ik} = 1, \text{ for } 1 \le k \le n.$$

The FCM uses an iterative optimization of the objective function, based on the weighted similarity measure between x_t and the cluster centre v_i. The FCM algorithm computes partition matrix U and the clusters prototypes in order to derive fuzzy models from these matrices. Steps of fuzzy C-means algorithm can be found for example in Hellendorn and Driankov (1997).

3. Empirical Results

The fuzzy classification results are presented in Figures 1 and 2 as well as Table 1 and 2. The graphs and the tables show the "memberships values" of each country corresponding to each cluster. Empirical observations lead us to classify the countries into 3 or 4 clusters, both before, during, and after the crisis. Table 3 gives summary of the classifications.

The 3-cluster fuzzy classification result shows that before the crisis, Indonesia, Philippines, Lao's, and Myanmar tend to be in Cluster I with the membership values lie between 0.69 and 0.82. Malaysia, Thailand, Singapore, Vietnam, Cambodia, Japan, China, and South Korea are in Cluster III, meanwhile Brunei Darussalam is the only country with a unique economy characteristic. But, during the crisis period, Malaysia, Thailand, and Vietnam have tendencies to be in Cluster I along with Indonesia and Philippines, meanwhile Singapore, Japan, China, and South Korea remain in the same cluster. This fact indicates that the aforementioned countries have a robust economic fundamental. After the crisis, i.e., during the period of 2002–2006, there is no significant position shifting. The only shifting we can see is that, in the period, Malaysia has been properly recovering from the crisis. Therefore Malaysia reverts to be a leading economic country, like Singapore, Japan, China, and South Korea.

The 4-cluster results show a relatively similar situation. Malaysia, Thailand, and Vietnam, which belong to the leading economic cluster during the pre-crisis period, together with Singapore, Japan, China, and South Korea, shifted to other cluster during the crisis, alongside Indonesia and Philippines.

Figure 1: Membership values of the fuzzy clustering in three clusters, before (top), during (mid), and after (bottom) the Asian crisis.

Figure 2: Membership values of the fuzzy clustering in four clusters, before (top), during (mid), and after (bottom) the Asian crisis.

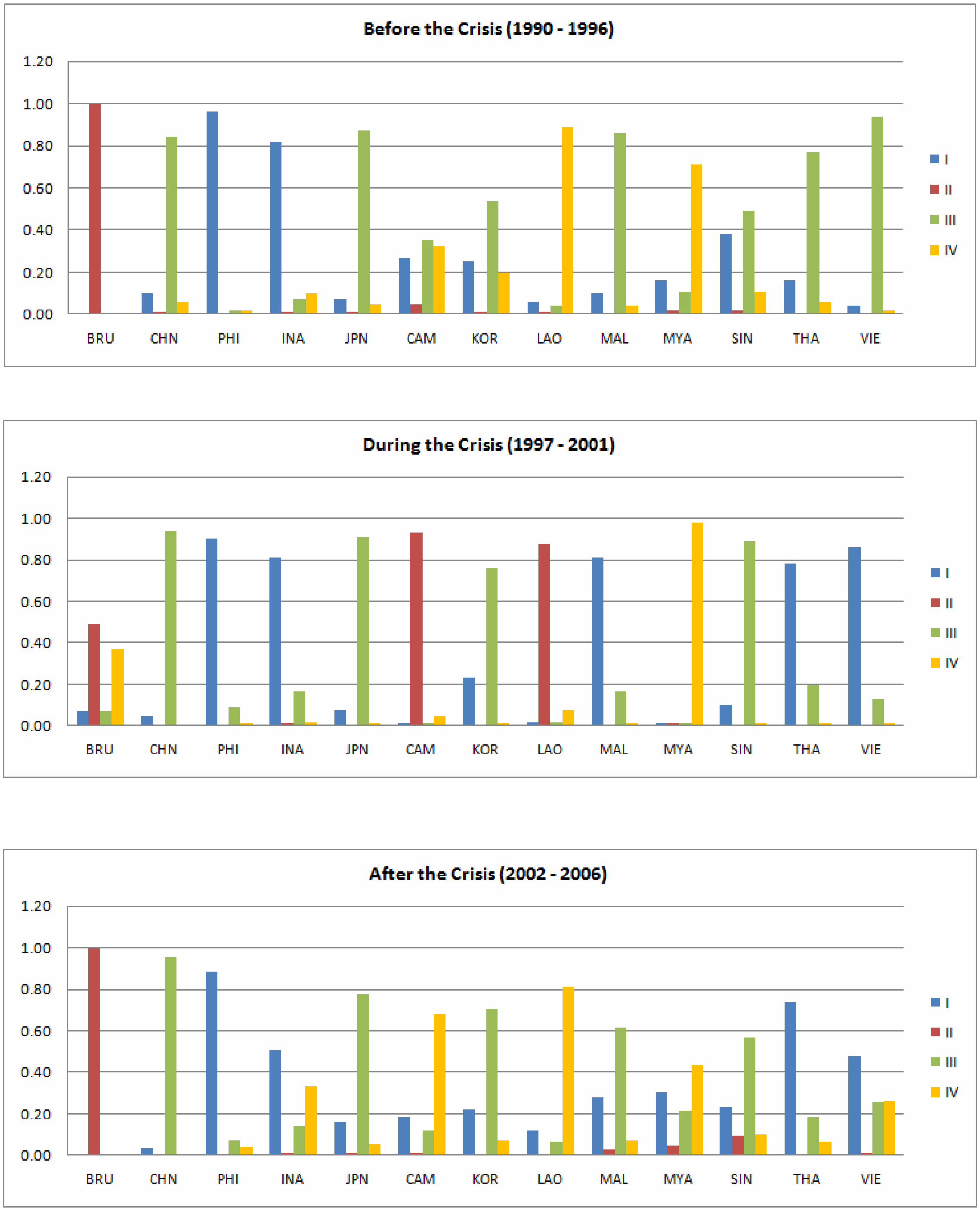

Table 1: Membership values of each country as the result of fuzzy classification into three clusters.

Country	Before the crisis			During the crisis			After the crisis		
	I	II	III	I	II	III	I	II	III
Brunei	0.00	**1.00**	0.00	0.07	**0.85**	0.07	0.00	**1.00**	0.00
China	0.11	0.01	**0.89**	0.06	0.00	**0.94**	0.03	0.00	**0.97**
Philippines	**0.69**	0.01	0.30	**0.89**	0.00	0.11	0.40	0.02	**0.57**
Indonesia	**0.76**	0.02	0.22	**0.83**	0.01	0.16	**0.84**	0.01	0.15
Japan	0.09	0.01	**0.90**	0.11	0.00	**0.89**	0.10	0.02	**0.88**
Cambodia	0.45	0.07	**0.49**	0.00	**0.99**	0.00	**0.78**	0.02	0.20
S. Korea	0.36	0.01	**0.63**	0.17	0.00	**0.82**	0.13	0.01	**0.86**
Lao’s	**0.82**	0.03	0.15	0.04	**0.92**	0.04	**0.81**	0.02	0.17
Malaysia	0.07	0.00	**0.92**	**0.78**	0.00	0.21	0.13	0.04	**0.83**
Myanmar	**0.77**	0.03	0.21	0.30	**0.43**	0.27	**0.65**	0.06	0.28
Singapore	0.25	0.02	**0.73**	0.13	0.00	**0.87**	0.19	0.14	**0.67**
Thailand	0.11	0.00	**0.88**	**0.75**	0.01	0.25	0.24	0.02	**0.74**
Vietnam	0.04	0.00	**0.96**	**0.87**	0.00	0.13	**0.58**	0.01	0.40

Note: Bold are the highest membership values for the corresponding countries.

Table 2: Membership values of each country as the result of fuzzy classification into four clusters.

Negara	Before the crisis				During the crisis				After the crisis			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Brunei	0.00	**1.00**	0.00	0.00	0.07	**0.49**	0.07	0.37	0.00	**1.00**	0.00	0.00
China	0.10	0.01	**0.84**	0.06	0.05	0.00	**0.94**	0.00	0.04	0.00	**0.95**	0.01
Philippines	**0.96**	0.00	0.02	0.02	**0.90**	0.00	0.09	0.01	**0.88**	0.00	0.07	0.04
Indonesia	**0.82**	0.01	0.07	0.10	**0.81**	0.01	0.17	0.02	**0.51**	0.01	0.14	0.34
Japan	0.07	0.01	**0.87**	0.05	0.08	0.00	**0.91**	0.01	0.16	0.01	**0.78**	0.05
Cambodia	0.27	0.05	**0.35**	0.32	0.01	**0.93**	0.01	0.05	0.18	0.01	0.12	**0.68**
S. Korea	0.25	0.01	**0.54**	0.20	0.23	0.00	**0.76**	0.01	0.22	0.01	**0.70**	0.07
Lao’s	0.06	0.01	0.04	**0.89**	0.02	**0.88**	0.02	0.08	0.12	0.01	0.06	**0.81**
Malaysia	0.10	0.00	**0.86**	0.04	**0.81**	0.00	0.17	0.01	0.28	0.03	**0.61**	0.07
Myanmar	0.16	0.02	0.11	**0.71**	0.01	0.01	0.01	**0.98**	0.30	0.05	0.21	**0.44**
Singapore	0.38	0.02	**0.49**	0.11	0.10	0.00	**0.89**	0.01	0.23	0.10	**0.57**	0.10
Thailand	0.16	0.00	**0.77**	0.06	**0.78**	0.00	0.20	0.01	**0.74**	0.01	0.19	0.06
Vietnam	0.04	0.00	**0.94**	0.02	**0.86**	0.00	0.13	0.01	**0.47**	0.01	0.25	0.26

Note: Bold are the highest membership values for the corresponding countries.

Table 3: Summary of the classification.

Country	3-cluster			4-cluster		
	Before the crisis	During the crisis	After the crisis	Before the crisis	During the crisis	After the crisis
Indonesia	1	1	1	1	1	1
Malaysia	3	1	3	3	1	3
Thailand	3	1	3	3	1	1
Philippines	1	1	3	1	1	1
Singapore	3	3	3	3	3	3
Brunei	2	2	2	2	2	2
Vietnam	3	1	1	3	1	1
Lao’s	1	2	1	4	2	4
Cambodia	1 (3)	2	1	3 (4)	2	4
Myanmar	1	2	1	4	4	4
Japan	3	3	3	3	3	3
China	3	3	3	3	3	3
S. Korea	3	3	3	3	3	3

Table 3 comprehensively shows the inter-cluster shifting among the ASEAN+3 countries for all periods of crisis. It can be seen from the figures and table that there is a relatively consistent classification as follows:

I : Singapore, Jepang, Korea dan China.
II : Malaysia-Vietnam-Thailand.
III : Indonesia-Filipina.
IV : Myanmar, Cambodia, Lao's Peoples Democratic Republic.
V : Brunei Darussalam.

This classification seems to be consistent over time (before, during, and after the crisis), and also similar with the real economic situation in the region during the last 17 years. Cluster I is the "big-economy" in the region, consisting of Singapore, Japan, South Korea, and China. Singapore, Japan, and South Korea are the richest countries in the region, which may function as investment source for the region. As for China, though not as rich as these countries, it is the most promising country in the world. China has a consistent economic development during the last decade and got the highest foreign direct investment.

Cluster II consists of Thailand, Malaysia and Vietnam. Thailand and Malaysia are two of the so-called the new industrialized countries. Their economies are relatively stable during the last decade, and also got only a small impact from the Asian crisis. Only in a few years, both of them, especially Malaysia, recovered successfully from the crisis. On the other hand, Vietnam is not as developed as Thailand and Malaysia, but has also a consistent economic progress during this period. The Asian crisis has only a little impact on its economy, and it becomes a major foreign direct investment destination next to China in the region (UNCTAD, 2003).

Cluster III consists of Indonesia and the Philippines. Both countries were actually also included in the "new Asian tiger". After the onset of the crisis, however, these countries face many problems in their economy, including persistent poverty, high unemployment rate, and infrastructure bottleneck. These economies are not yet recovered well until now.

Cluster IV consists of the "less-developed countries" in the region, i.e. Myanmar, Cambodia, and Lao's People Democratic Republic. All of them are the newest member of the ASEAN. Cluster V has only one member, i.e. Brunei Darussalam. Brunei is a very small in terms of area or population but rich country, so that it has only a little economic impact in the region. Brunei may be compared to the Luxemburg in the EU.

4. Summary and Policy Implication

The above classification can be related to some economic phenomena occurring in the last two years. First, there is a phenomenon that many investors, which mainly of Japanese, closed their investment in Indonesia (e.g. Sony, Nike, Aiwa), and move to Vietnam, Malaysia, and China. This movement across clusters (from cluster III to cluster II and I) may have affected individual economy's performance (e.g. slow export growth in Indonesia relative to that in Vietnam, Malaysia, and China) but might not be affecting the region's economic performance. Being bounded in the ASEAN+3 agreement, this would force Indonesia to undertake economic reform seriously, including to overcome for infrastructure or supply side bottlenecks, in order to attract investors' interest and to increase competitiveness of its export products. More detail unilateral measures, such as relaxed limitations on foreign equity ownership, liberalised sectoral restrictions, streamlined approval procedures, granted incentives and investment guarantees, seem to be important for Indonesia as well as the Philippines and members of cluster IV.

Second, Mr. Goh Cok Tong (member of cluster I) and Mr Thaksin Sinawatra (member of cluster II) suggested that the ASEAN single market should be developed soon. In line with this, Mr Watanabe suggested that Japan, South Korea and China (the other members of cluster I) should also be included in the single market. These five countries may be seen as "leaders" in the region's economy. In order for the ASEAN+3 to function effectively, their initiatives should consider problems faced by the other economies. As warned by YAMAZAWA (1992) among others, the benefits of such development would not be evenly distributed among members, but accrued mainly to the most advanced members in the group. One way to avoid this is to provide a kind of investment assistance, for instance by assigning some industries to each member nation, or to simply help the lagging countries (members of clusters III and IV) to develop the aforementioned unilateral measures.

References

[1] Achsani, N.A. and H. Siregar, 2005, Toward East Asian Economic Integration: Classification of ASEAN+3 Economies using Fuzzy Clustering Approach, Paper was presented at the International Conference "EU-ASEAN Facing Economic Globalization" at the Center for European Studies, Chulalongkorn University, Thailand. July 20-22, 2005.

[2] Achsani, N.A. and H. Siregar, 2007, Financial and Economic Integration: Experience of the EU and Future Prospect of ASEAN+3, In Dong, L and G. Heiduk (Eds), *The EU's Experience in Integration: A Model for ASEAN+3?*, Peter Lang, Bern - Switzerland.

[3] Ruspini, E. H. (1969), A New Approach to Clustering, *Information Control* 15: 22-32

[4] Bezdek, J.C. (1981), Pattern Recognition with Fuzzy Objective Function Algorithms, New York: Plenum Press.

[5] Dunn, J.C. (1973), A Fuzzy Relative of ISODATA Process and Its Use in Detecting Compact Well-Separated Clusters, *Journal of Cybernetics* 3:32-57.

[6] Hellendorn, H. and Driankov, D. (1997). *Fuzzy: Model Identification*, Heidelberg: Springer.

[7] UNCTAD (2003). World Investment Report – FDI Policies for Development: National and International Perspectives, United Nations, New York.

[8] Yamazawa, I. (1992), On Pacific Economic Integration, *Economic Journal* 102: 1519-1529.