

Bi-plot and Procrustes Analysis: Comparing the Configurations by the Economic Changes of ASEAN Members Based on Vision of the ASEAN Economic Community (AEC)

1stYenni Kurniawati
*Mathematics and Science Faculty
Universitas Negeri Padang
Padang, Indonesia
yenni.mathunp@gmail.com*

2nd Luthfia Miranda
*Mathematics and Science Faculty
Universitas Negeri Padang
Padang, Indonesia
mirandaluthfia96@gmail.com*

Abstract—One of the AEC's vision is to support sustainable high economic growth by increasing trade, investment and employment creation; enhancing regional capacity to respond to global challenges. The aim of this paper to describe and explore the impact of the ASEAN Economic Community (AEC). The Method is comparing economic condition of the ASEAN members between both years, 2014 and 2016. Statistical analysis using bi-plot and Procrustes to measure the similarity between both configurations. Bi-plot analysis map the ASEAN members as object and factor influences the economic conditions as variable. The results of this study shows that changes in the economic conditions of ASEAN members are almost the same before the AEC and thereafter. Procrustes analysis shows that the configuration have a 94.85 % similarity

Keywords—AEC, Procrustes analysis, Bi-plot analysis

I. INTRODUCTION

Liberalization trading in ASEAN region begins to be applied with the establishment of ASEAN Economic Community (AEC) in 2015. The aims of the establishment of AEC is to make ASEAN region a competitive place of production as ASEAN products powerful competitive in global markets and increase trade among ASEAN member (*Intra-ASEAN Trade*) (Ministry of Finance RI, 2014). It is liberalization can be seen from efforts to eliminate tariff and non-tariff barriers for countries in the ASEAN region either in the form of employment trade or investment.

The implementation of AEC in 2015 will be able to encourage the creation of production networking networks, strengthen regional integration in the economic sectors as well as to create free movement of educated and insightful business actors. The implementation of the 2015 AEC will also transform ASEAN into a single market in the form of a production base. The single market and ASEAN production base has five pillars of liberalization as in 2015 AEC framework covering liberalization of goods flows, service flows, investment flows, labor market flows, and capital flows (Directorate General of ASEAN Cooperation, 2009).

The liberalization of the goods flow, obviously will affect the flow of exports and imports of goods from each

ASEAN member country. Facing the ASEAN Economic Community (AEC) 2015, each ASEAN member country is emphasized to further improve the production quality of domestic companies in order to increase exports by reducing imports and expected to improve the economic condition of the country so as not to lose competition with the entry of foreign companies will dominate the market.

The liberalization of service flows is also included in 2015 AEC framework a top priority in the liberalization of this service flow is the tourism services sector. The implementation of AEC, can provide great opportunities to ASEAN member countries to increase the visit of foreign tourists to their country.

The implementation of AEC has greatly affected the investment sector as well. Lamsiraroj (2016) [13] states that with the entry of foreign direct investment, there is transfer of capital, technology, science from developed countries to developing countries. The transfers will stimulate productivity and increase national output which will increase economic growth.

The liberalization of labor flows also needs to be addressed in the face of the AEC. The adoption of AEC in 2015, it is certain will open wide job opportunities for ASEAN citizens. The opening of employment opportunities for each ASEAN country will result in an increase in the number of foreign workers in each country. This will have an impact on the number of unemployed in the country so that it will affect things that will harm the country.

In support of the achievement of the AEC, it is also necessary to support a more free flow of capital. One form of this capital flow is portfolio investment (Edwards, 1999). The entry of portfolio investment, the liquidity to meet domestic financial needs will increase and the domestic capital market will increase.

Based on the explanation above, the export, the increasing number of foreign tourists, foreign direct investment, the number of foreign workers and *portfolio* investment, will affect the economy in each ASEAN country after the implementation of AEC. The implementation of AEC can affect economic growth and economic downturn in every ASEAN country. Seeing the

influence of this AEC, each country must have different solutions and readiness in facing the AEC. Differences in the solution facing the AEC that resulted in a country that has decreased in some sectors of the economy but some countries can actually encourage AEC as to improve the economic conditions in the country.

This economic change is necessary to be considered for each ASEAN member country. Therefore, this study is very important to do to know how the economic conditions before and after the implementation of the AEC, so it can be compared how changes in economic conditions in each - each country. Changes in economic conditions before and after the existence of the AEC can be compared based on these five indicators. Comparison can be done using a technique of statistical analysis, one of which is *multivariate* analysis that is Procrustes analysis.

Procrustes analysis is an analytical technique used compare two configurations through proximity / objective configuration resemblance. Comparison of two object configurations will result in a proximity measure that elicits new data configuration. The new data configuration is compared to the original data to see a direct comparison between the original data and the configuration data. Comparison can be seen and analyzed using bi-plot analysis to see the relative position between the variables and the observed object so that the factors of the variables that influence the object can be known. In Procrustes analysis there are three kinds of transformations namely translation, rotation and dilation.

These three transformations are the adjustment stages of the configuration to be compared so as to achieve the minimum square of squares. The merging of three transforms can be expressed by

$$Z = c\bar{Y}f + 1T$$

Where :

- Z : Transformation matrix
- c : Scala
- \bar{Y} : Centralized Matrix
- f : Rotation Matrix
- 1 : Matrix with value 1
- T : Translation Matrix

Sum of the squares of distances at the point moved corresponding to the configuration made algebraically fixed with

$$M^2 = \text{trace}((X - Z)'(X - Z))$$

After the matrix is obtained, it can be seen the size of similarity between the initial data configuration with the configuration of new data transformed. The similarity sizes of the two configurations illustrate the proximity between two matrix configurations. The higher the value, then the two configurations will be closer. The resemblance size can be formulated as follows:

$$R^2 = 1 - \frac{M_{\min}^2}{JKT}$$

Value R^2 ranging from 0 - 100%, closer to 100%, the closer the two configurations. Matrix Z transformed will be compared with the original data to see a direct comparison

between the original data and the transformed data. Comparison can be seen and analyzed using bi-plot analysis to see the relative position between the variables and the observed object so that it can be known the factors of the variables affecting the object.

Bi-plot is one attempt to describe the data contained in the summary table in the graph two-dimensional. The information provided by bi-plot includes objects and variables in a single image. Bi-plot analysis is descriptive with two dimensions that can present visually as a set of objects and variables in a flat-shaped graph. With this kind of presentation, the characteristics of variables and objects of observation as well as the relative position between observed objects and variables can be analyzed. Based on the view of bi-plot obtained, there are four important things that can be taken, namely the proximity between objects, diversity among variables, correlation between variables and value variable on the object.

II. METHODS

Main sources was adopted to collect the data of the study from <https://data.aseanstats.org>. The data obtained in the form of annual data before and after the implementation of AEC is 2014 and 2016. Data used containing export, investment and the foreign visitor arrival in ASEAN member. The object of this research consisting of 10 ASEAN countries. The variables used in this study are:

X1 = Export

X2 = Foreign Visitor Arrival

X3 = Foreign Domestics Investment

Data analysis in this study was conducted with the help of Software R-2.15.0 with the stage that begins with analysis Procrustes. Analysis Procrustes was performed to see the resemblance of two data configurations, while the analysis Procrustes stages are described as follows:

- 1) Establish matrix (2014 data) and matrix (2016 data) from originating data.
- 2) Standardize data matrix X (2014 data) and data matrix Y (2016 data)
- 3) Perform transformation process on Procrustes analysis beginning with data translation matrix process and calculate the sum of squared distance of M^2 translation. Next is the matrix rotation process and calculate the sum of squares distance M^2 rotation. The matrix transformation is terminated by performing the matrix dilatation and calculating the sum of squares of distance M^2 of dilation.
- 4) Conducting the calculation of the transformation result so as to obtain the Z matrix of transformation and calculate the sum of squares distance of the whole process of transformation.
- 4) Take M^2 minimum of all calculations and use in calculating the similarity measure R2.

The next step is bi-plot analysis done to see the factors of the variables affecting the object, while the stages of bi-plot analysis described as follows:

- 1) Conducting the singular value decomposition on matrices \bar{X} and Z, each matrix \bar{X} and Z described into two matrix, ie the matrix G and H.
- 2) Find a two-dimensional matrix which is a best approximation matrix to each matrix \bar{X} and Z to obtain the matrix $G^{(2)}$ and the matrix $H^{(2)}$

3) Prepare the matrix $G^{(2)}$ and matrix $H^{(2)}$ together in one plot so as to obtain bi-plot shape matrix \bar{X} and Z .

4) Interpretation bi-plot form matrix \bar{X} and Z .

Analysis Procrustes is used to see the similarity size of 2 compared configuration. The data matrix prior to the application of the AEC in 2014 (matrix X) is treated as a defined matrix, while the data matrix after the 2016 AEC (Y) is treated as transformed matrix.

III. RESULT AND DISCUSSION

The results of data analysis are described as follows:

1) Form matrix and matrix

$$X = \begin{pmatrix} -0.73691 & -0.21816 & -0.48284 \\ -0.77816 & -0.50726 & -0.42747 \\ 0.15839 & -0.21435 & 2.61961 \\ -0.75366 & -0.29398 & -0.48380 \\ 0.76765 & 2.67474 & 0.03064 \\ -0.68290 & -0.57546 & -0.35291 \\ -0.56731 & -0.77229 & -0.48380 \\ 2.31546 & 0.20614 & 0.59446 \\ 0.62914 & 0.29391 & -0.86807 \\ -0.35170 & -0.59329 & -0.14580 \end{pmatrix}$$

$$Y = \begin{pmatrix} -0.79763 & -0.73899 & -0.84170 \\ -0.80808 & -0.41288 & -0.60236 \\ 0.18755 & -0.13660 & 2.34062 \\ -0.78754 & -0.25626 & -0.75268 \\ 0.84761 & 2.54210 & -0.17264 \\ -0.73326 & -0.69259 & -0.24386 \\ -0.58062 & -0.68299 & -0.63729 \\ 2.16745 & 0.20823 & 1.15761 \\ 0.81664 & 0.69031 & -0.21750 \\ -0.31211 & -0.52034 & -0.03020 \end{pmatrix}$$

2) Conducting the process of matrix transformation

Procrustes analysis is solved by using R-2.15.0 software, based on stages of Procrustes analysis performed three types of transformation, namely:

a) *Translation matrix*

Based on the calculation generated translation matrix X^* namely:

$$X^* (-9.657385e - 07 \quad 9.674809e - 07 \quad 2.168319e - 06)$$

b) *Rotation of the matrix*

Next is the rotation process that produces the rotation matrix

$$R = \begin{pmatrix} 0.9908395649 & 0.005882122 & -0.13491611 \\ -0.0007700283 & 0.999280791 & 0.03791183 \\ 0.1350420809 & -0.037460653 & 0.99013147 \end{pmatrix}$$

c) *The dilatation of the matrix*

The dilation process is performed to determine the scale used when magnification or distance reduction of each point in configuration against its center. Based on the calculation we get the scale value $c = 0.97$ with the sum of squared distance $M = 1.390489$.

3) Form a matrix of results of Procrustes analysis

From the three transformation processes obtained value matrix as follows:

$$Z = \begin{pmatrix} -0.3317561 & 0.0385801809 \\ -0.2618414 & 0.0544617708 \\ 0.2998010 & -0.6409559414 \\ -0.2564602 & 0.1312066651 \\ 0.4502867 & 0.6578607238 \\ -0.2418774 & -0.1055748014 \\ -0.2633525 & -0.0002993372 \\ 0.5294389 & -0.2425133550 \\ 0.1990206 & 0.2253959207 \\ -0.1232579 & -0.1181645833 \\ 2.9655382 & -0.2436870004 \\ 2.0644878 & 1.9398791007 \\ 1.6941035 & -1.9374221097 \end{pmatrix}$$

4) Specifies the matrix similarity size of

Value M^2 of the whole process of transformation, there is value M^2 minimum the value M^2 dilatation $M^2 = 1.390489$ and the value of $JKT = 26,99999$. Calculation which performed the following values:

$$R^2 = 1 - \frac{1,390489}{26,99999} = 0,9485 = 94,85\%$$

It is indicates that both data configurations have a similarity of 94.85%. Configuration difference of AEC to 5.15%. This difference is caused by the relative position of the object with the variable before and after the application of AEC. In some changes in economic indicators, there are differences in values before and after the implementation of the AEC. Configuration differences are also caused by differences in correlation between variables and proximity between objects as before and after the application of the AEC.

Bi-plot analysis is used for viewing characteristics of and the variables that influence it. Bi-plot analysis, the data display used is \bar{X} and Z matrix. After the decomposition is obtained bi-plot output as follows:

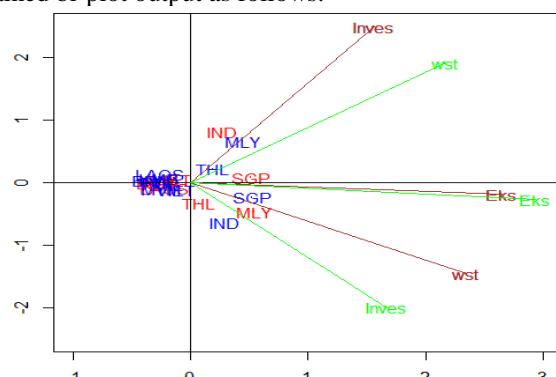


Figure 1 (i). Bi-plot Data Procrustes Analysis

5) Bi-plot Interpretation

From Figure 1 (i) there are some countries whose positions are so tight that they cannot be seen positions before and after the application of the AEC. These countries include Brunei Darussalam, Myanmar, Laos PDR, Philippine, Cambodia and Vietnam. In order to be able to

see the changes of these six countries, it is done to scale back again so as to facilitate in interpreting the results.

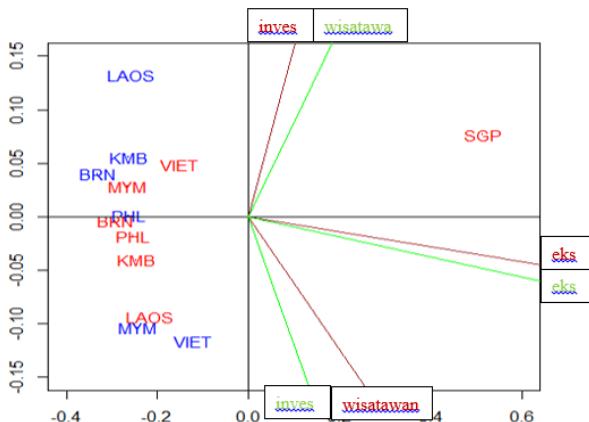


Figure 1 (ii). Bi-plot Data Procrustes Analysis

Based on the picture above can be seen that changes in export value, the number of foreign tourists and investment before and after the implementation of the AEC is not apparent. When compared to the average value of each indicator, these six countries (Brunei Darussalam, Cambodia, Laos, Vietnam, Myanmar and the Philippines) have the value of each indicator below the average. The country of Singapore has an above average value on every indicator. Malaysia and Thailand, indicators that have above average value are the number of foreign tourists and exports. While the Indonesian country indicators that have above average value are exports and investments both before and after the implementation of the AEC. If seen from the diversity between variables can be seen that before and after the implementation of the longest vector AEC is export. This is evident in figure 4. However, seen in Figure 4 the length of the export vector after the application of the AEC is longer than before the application of the AEC. This indicates that ASEAN's export value is more diverse at the time after the implementation of the AEC. While the length of vector number of foreign tourists and investment before and after the application of the AEC looks almost the same length.

Characteristics of economic indicators from 6 ASEAN member countries (Myanmar, Brunei Darussalam, Cambodia, Philippines, Vietnam and Lao PDR) can be said the same. Characteristics of economic indicators of the six countries are no variables that characterize it because the six countries are located opposite the direction of the vector. This means that the value in every indicator in the country is still low.

Characteristics of Malaysian and Thai countries before or after the introduction of the AEC are characterized by the variable number of foreign tourists who have a high number of tourists. While the state of Indonesia is characterized by investment variables which have high investment value. Thereafter, the state of Singapore is characterized by an export variable because it has a high export value either before the introduction of the AEC or before the implementation of the AEC.

IV. CONCLUSION

Based on the results of research and discussion then obtained:

1. Configuration of economic indicators before and after the implementation of the AEC looks almost the same, with a size similarity of 94.85%. This indicates that the state of the economic indicators both before and after the application of the AEC can be said to be similar. This suggests that changes that occurred before and after the application of the AEC experienced relatively little change. However, it is sufficient to change in every ASEAN member country either increase or decrease value after application of AEC.
2. The diversity of economic indicators before and after the implementation of the AEC is still mixed. The greatest diversity is the export variable. This means that each ASEAN member country has diverse export values both before and after the implementation of the AEC.
3. The relationship between each economic indicator is positively correlated with each variable. Relationship between variables as follows:
 - a. Export with investment

The higher the value of exports in each country then the value of investment will also increase well before or after the application of the AEC. Both of these variables have a stronger relationship after the application of the AEC than before the application of the AEC.
 - b. Export by the number of foreign tourists

The higher the value of exports the number of foreign tourists will increase and vice versa. After the application of AEC these two variables also have a stronger relationship.
 - c. Number of foreign tourists and investment

The higher the number of foreign tourists the investment value will increase. the relationship between these two variables is stronger after the application of the AEC.
4. In this case the founders of each ASEAN country are:
 - a. Factors that characterize Malaysia and Thailand countries before and after the implementation of the AEC is an indicator of the number of foreign tourists and exports. Thus, the number of foreign tourists and export value in both countries is high both before and after the application of AEC.
 - b. Factors that characterize the countries of Singapore and Indonesia, before and after the implementation of the AEC are exports, the number of foreign tourists and investment. Thus, the value of these three variables in both countries is also high both before and after the application of the AEC.
 - c. Laos and Cambodia are characterized by indicators of foreign tourists both before and after the introduction of the AEC. This indicates that the number of foreign tourists in both countries is high both before and after the implementation of the AEC.
 - d. Vietnam and Myanmar before and after the implementation of the AEC, the indicator of the identifier is an investment indicator. This shows that the investment value of both countries is high both before and after the implementation of AEC.

- e. Brunei Darussalam before the implementation of AEC, indicator of the founder does not exist. But after the application of the AEC, the indicator of the identities of this country is the number of foreign tourists. This indicates that the number of foreign tourists in this country after the application of a high AEC.

While the Philippine state no one characterizes the country either before or after the application of the AEC. This shows that the value of each economic indicator in these six countries is still low.

REFERENCES

- [1] Anton, Howard. *Elementary Linier Algebra* (Terjemahan Suminto, H.). Pennsylvania: Drexel University, 1999. Buku asli diterbitkan tahun 1987.
- [2] Arifin, S., Djaafara, R. A., & Budi, A. S. Masyarakat Ekonomi ASEAN (MEA) 2015 Memperkuat Sinergi ASEAN di Tengah Kompetisi Global. Jakarta: Gramedia, 2008.
- [3] Badan Pusat Statistik Indonesia. Berbagai tahun publikasi. *Statistic Indonesia*. Jakarta: Badan Pusat Statistik
- [4] Bank Indonesia. *Masyarakat Ekonomi ASEAN 2015*. PT. Gramedia :Jakarta, 2008.
- [5] Departemen Keuangan. 2014. *ASEAN Free Trade Area (AFTA)*. [diunduh 2017 September 13] : <http://www.tarif.depkeu.go.id/Others/hi=AFTA>
- [6] Direktorat Jenderal Kerjasama ASEAN.2009. *ASEAN Economic Community Blueprint*. [diunduh 2017 September 23]: <http://aeccenter.kemendag.go.id/media/176978/cetak-biru-komunitas-ekonomi-asean.pdf>
- [7] Forrest, Edward. Internet Marketing Research : Resources and Techniques. McGraw Hill, Australia, 1999.
- [8] Ilham, Moch, dan Suparyati, Agustina. Analisis Pengaruh Kausalitas Antara Ekspor, Impor dan Pertumbuhan Ekonomi di Indonesia dan Thailand dengan Menggunakan Pendekatan VAR Periode 1980-2013. *Jurnal Ekonomi Pembangunan*. Vol.1. No.1. Hal. 21-36.2014
- [9] Johnson, Richard A and Wichern, Dean W. *Applied Multivariate Statistical Analysis*. New Jersey: Prentice Hall Inc, 1998.
- [10] Kurniawati, Y. "Penerapan Analisis Procrustes Dalam Dinamika Financial Distress Pasca Kenaikan Harga BBM (Studi Kasus pada Perusahaan Publik di Bursa Efek Indonesia)". UNP, 2012.
- [11] Kurniawati, Y, "Penerapan Analisis Procrustes Untuk Mengkaji Transisi Kondisi Keuangan Perusahaan Pasca Kenaikan Harga BBM" Jurnal Biastatistics Departemen Statistika FMIPA Universitas Padjajaran, 7 (2), 1- 11, 2013.
- [12] Kurniawati, Y."Penggunaan Bahasa R Pada Analisis Biplot Dan Analisis Procrustes." *Jurnal JMAP UNJ* (Nomor 2 tahun 2016). Hlm. 1-10,2014.
- [13] Lamsiraroj, Sasi. 2016. *The Foreign Direct Investment-Economic Growth Nexus. International Review of Economics and Finance*. Vol. 42 hlm 116-133.
- [14] Mattjik, A. A., & Sumertajaya, I. M. *Sidik Peubah Ganda dengan Menggunakan Aplikasi SAS*. Bogor: IPB Press, 2011.
- [15] Myers, Raymond H. *A first Course Theory Linier Statistical Models*. The Mc Graw-Hill Companies Inc,1998.
- [16] Rasulong, Wahyuni S. Asean Tourism Forum Dan Peningkatan Pariwisata Indonesia, Thailand Dan Brunei Darussalam, 2014.
- [17] Sadono, Sukirno. Makroekonomi. Teori Pengantar. Edisi Ketiga. Jakarta: PT. Raja Grasindo Perseda, 2010.
- [18] Sartono, dkk. *Analisis Peubah Ganda*. Jurusan Statistika FMIPA IPB. Bogor, 2003.
- [19] Siswadi. 1997. Analisis Eksplorasi Data Peubah Ganda. Jurusan Matematika FMIPA IPB. Bogor.
- [20] Sukirno, Sadono,. Mikro Ekonomi Teori Pengantar, Edisi Ketiga, Jakarta:Raja Grafindo Persada,2005.
- [21] Supramono & Utami I, Desain Proposal Penelitian Akutansi & Keuangan, Edisi Pertama, Yogyakarta: Penerbit Andi, 2004.
- [22] Suprapto, J. *Analisis Multivariat Arti dan Interpretasi*. Jakarta: Rineka Cipta,2004.
- [23] Suryanto. *Metode Statistika Multivariat*. Jakarta: Departemen Pendidikan dan Kebudayaan, 1998.