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Economic Freedom Index Calculation Using FCM

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ABSTRACT

The Index of Economic Freedom is an annual index and ranking created by The Heritage Foundation and The Wall Street Journal in 1995 to measure the degree of economic freedom in the world's nations. There are many kinds of Economic Freedom Indices depending on variables which many institute or company determine for their research. The aim is to predict countries or regions according to economic parameters. In this study, fuzzy clustering algorithm is proposed for economic freedom ındex calculation. By using degree of memberships founded by FCM, Economic Freedom index will be calculated for regions. Results compared with indices calculated by The Heritage Foundation for the year 2013, 2014, 2015 and 2016. It is showed that FCM is an alternative method for index calculating systems.

Keywords: Fuzzy Clustering Analysis, Economic Freedom, Classification, Freedom Index, FCM

FCM Kullanarak Ekonomik Özgürlük Endeks Hesaplaması

ÖZ

Ekonomik Özgürlük Endeksi, Heritage Foundation ve Wall Street Journal tarafından 1995 yılında dünya uluslarındaki ekonomik özgürlük derecesini ölçmek için oluşturulan yıllık bir endeks ve sıralamadır. Birçok enstitü veya şirketin araştırmaları için belirlediği değişkenlere bağlı olarak Ekonomik Özgürlük Endekslerinin birçok türü vardır. Amaç, ülkeleri veya bölgeleri ekonomik parametrelere göre öngörmektir. Bu çalışmada, ekonomik özgürlük endeksi hesaplaması için bulanık kümeleme algoritması önerilmiştir. Bulanık C-Ortalamalar yardımıyla hesaplanan üyelik derecelerini kullanarak, ülkeler için Ekonomik Özgürlük endeksi hesaplanacaktır. Heritage Foundation tarafından 2013, 2014, 2015 ve 2016 yılları için hesaplanan endekslerle karşılaştırıldığında sonuçlar, BCO'nun endeks hesaplama sistemleri için alternatif bir yöntem olduğunu göstermiştir.

Anahtar Kelimeler: Bulanık Kümeleme Analizi, Ekonomik Özgürlük, Sınıflama, Özgürlük Endeksi, BCO

1. Introduction

In an economically free society, each person controls the fruits of his or her own labor and initiative. Individuals are empowered—indeed, entitled—to pursue their dreams by means of their own free choice (Miller and Kim, 2015b). Economic freedom and democracy affects economic performance by identifying organizational structure. Than, we have to answer these two questions: What is economic freedom and what is it used for?

"Economic freedom" means the degree to which a market economy is in place, where the central components are voluntary exchange, free competition, and protection of persons and property (Gwartney and Lawson, 2002). The goal is to characterize the institutional structure and central parts of economic policy (Berggren, 2003).

Economic freedom is the fundamental right of every human to control his/her own labor and property. In an economically free society, individuals are free to work, produce, consume and invest in any way they please. In an economically free society, governments allow labor, capital and goods to move freely and refrain from coercion or constraint of liberty beyond the extent necessary to protect and maintain liberty itself (www.heritage.org, 2016). The goal of economic freedom is not simply an absence of government coercion or constraint but the creation and maintenance of a mutual sense of liberty for all.

Since Adam Smith's Wealth of Nations, it has been argued that economic freedom is essential to a nation's economic progress. Studies by Dollar (1992) and by Sachs and Warner (1995) concluded that economic growth is faster in countries which are economically more open. It should be noted that economic freedom is not synonymous with political freedom and civil liberty.

Political freedom is concerned with the way in which nations choose their governments and other representatives. On the other hand Civil liberty includes the right of citizens to free assembly (including the right to organize trade unions), freedom of the press, freedom of religion, and due process and equal treatment under the law (Johnson and Lenartowicz, 1998). Some uses of economic freedom can be given below (Miller and Kim, 2015a):

i. Advancing Opportunity: Today's successful economies are not necessarily geographically large or richly blessed with natural resources. Many economies have managed to expand opportunities for their citizens by enhancing their economic dynamism. In general the overarching objective of economic policies must be to create an environment that provides the most opportunity for the widest range of activities that can lead to increased prosperity.

ii. Promoting Prosperity: In many respects, economic freedom is merely shorthand for an openness to entrepreneurial activity that increases opportunity for individuals to succeed in their endeavors.

iii. Antidote to Poverty: By a great many measures, the past two decades during which the Index has been charting the advance of economic freedom have been the most prosperous in the history of humankind. Those countries that have adopted some version of free market capitalism, with economies

supported by efficient regulations and open to the free flow of goods, services, and capital, have participated in an era of globalization and economic integration in which solutions to many of the world's development problems have taken hold and generated real improvements in living standards.

iv. Societal development and democratic progress: Growing economic freedom is unequivocally about more than financial success. Achieving greater overall prosperity that goes beyond materialistic and monetary dimensions of well-being is equally important. The societal benefits of economic freedom extend far beyond higher incomes or reductions in poverty. Countries with higher levels of economic freedom enjoy higher levels of overall human development as measured by the United Nations Human Development Index, which measures life expectancy, literacy, education, and the standard of living in countries worldwide

v. The Key to Upward Mobility and Greater Social Progress: The massive improvements in global indicators of income and quality of life largely reflect a paradigm shift in the debate over how societies should be structured to achieve the most optimal outcome. Over the past two decades, this debate has largely been won by capitalism. However, fears that the immediate benefits of capitalism are fading has brought to the forefront concerns about economic mobility and economic freedom.

As we summarize benefits of economic freedom, we can say that economic freedom increases in income per capita and most low-income group income, amplify life expectancy and play a key role in the development of society.

2. Economic Freedom Index

The Index of Economic Freedom is an annual index and ranking created by The Heritage Foundation and The Wall Street Journal in 1995 to measure the degree of economic freedom in the world's nations. For over twenty years the Index has delivered thoughtful analysis in a clear, friendly, and straight-forward format. With new resources for users and a website tailored for research and education, the Index of Economic Freedom is poised to help readers track over two decades of the advancement in economic freedom, prosperity, and opportunity and promote these ideas in their homes, schools, and communities. With the help economic freedom index, we simply analyses the country's economic freedom levels or categorizes them in to similar groups.

2.1. Selected Literature for Freedom Indices:

Bengoa and Robles (2003), explores the interplay between economic freedom, foreign direct investment (FDI) and economic growth using panel data analysis for a sample of 18 Latin American countries for 1970–1999.

Haan and Sturm (2000), compared various indicators for economic freedom. The robustness of the relationship between freedom and growth is also examined in the paper. The conclusion is that greater economic freedom fosters economic growth but the level of economic freedom is not related to growth.

Carlsson and Lundström (2002), investigate what specific types of economic freedom measures are important for growth. The results shows that economic freedom does matter for growth. They found only variables in the economic freedom index that have positive and robust relations to GDP growth are Legal structure and Private Ownership, and Freedom to Use Alternative Currency.

Gwartney et all. (1999), examines the importance of economic freedom by using an index that measures economic freedom in four basic areas: Money and inflation, economic structure, takings and discriminatory taxation, and international trade. The empirical results show that economic freedom is a significant determinant of economic growth, even when human and physical capital, and demographics are taken into account.

Johnson and Lenartowicz (1998) presented a framework for examining the relationship among cultural values, economic freedom and economic growth. Also they found two important results: Firstly, evidence of strong positive association both between economic freedom and economic growth and weak uncertainty between economic freedom and individualautonomy.

Ayal and Karras (1998), examined the relationship between economic growth and economic freedom. Their results are very supportive of the proposition that aggregate "economic freedom" enhances growth both via increasing total factor productivity and via enhancing capital accumulation.

Stroup (2006) examines the interaction of economic freedom and democracy on measures of health, education, and disease prevention in society. He has found that greater economic freedom consistently enhances these welfare measures, even among more democratic countries. Democracy has a smaller positive influence that disappears for many welfare measures in countries with more economic freedoms.

Heckelman (2000) investigates casuality between economic freedom and economic growth. As for the results; growth may precede one of the component indexes and no relationship is found to exist between growth and two of the indexes.

Esposto and Zaleski (1999) attempt to bridge this gap by analyzing the effect of economic freedom on the quality of life. Taking advantage of newly developed measures of economic freedom, we analyze the impact of economic freedom on life expectancy and literacy rates. They also found that greater economic freedom enhances the quality of life both across nations and increases the improvements in the quality of life over time.

Shen and Williamson (2005) searched structural equation-based analysis of data for 91 nations includes several important determinants of cross-national variation in perceived levels of corruption. The analyses yield four major findings: 1) democracy, as measured by indicators of political rights, civil liberties, and press freedom, has a positive effect on perceived level of corruption control; 2) state strength has a positive direct effect; 3) openness of the economy, as measured by economic freedom, has a positive effect; and 4) ethnolinguistic fractionalization has both direct and indirect negative effects.

Berggren (2003) analyses benefits of economic freedom as a survey. He explains the concept and importance of economic freedom by giving examples. He utilize

economic freedom with economic growth and income equality. At the end he gives a short summary of implications for economic policy.

3. Fuzzy Clustering Analysis

Clustering analysis is a statistical classification technique for discovering whether the individuals of a population fall into different groups by making quantitative comparisons of multiple characteristics. The objective of cluster analysis is the classification of objects according to similarities among them and organizing of data into groups (Balasko et all., 2005).

Fuzzy Clustering Analysis comes into the picture as an appropriate method when the clusters cannot be separated from each other distinctly or when some units are uncertain about membership. Membership grades are assigned to each of the data points. These membership grades indicate the degree to which data points belong to each cluster. Thus, points on the edge of a cluster, with lower membership grades, may be in the cluster to a lesser degree than points in the center of cluster. Fuzzy clusters are functions modifying each unit between 0 and 1 which is defined as the membership of the unit in the cluster. The units which are very similar to each other hold their places in the same cluster according to their membership degree. Similar to other clustering methods, fuzzy clustering is based on distance measurements as well. The structure of the cluster and the algorithm used to specify which of these distance criteria will be used. Some of the convenient characteristics of fuzzy clustering can be given as follows (Naes and Mevik, 1999):

i. It provides membership values which are convenient to comment on.

ii. It is flexible on the usage of distance.

iii. When some of the membership values are known, they can be combined with numeric optimization.

The advantage of fuzzy clustering over classical clustering methods is that it provides more detailed information on the data. Since there will be too much output when there are too many individuals and clusters, it is difficult to summarize and classify the data. Moreover, fuzzy clustering algorithms, which are used when there is uncertainty, are generally complicated (Oliveira and Pedrycz, 2007).

3.1. Fuzzy C-Means (FCM) Algorithm

Fuzzy C-Means algorithm forms the basis of all clustering techniques that depend on objective function. It was developed by Bezdek (1974a and 1974b). When the FCM algorithm comes to a conclusion, the dots in the p dimension space become a sphere-shaped figure. It is assumed that these clusters are approximately the same size. Cluster centers represent each cluster and they are called prototypes. Euclidean distance d_{ik} between the data and the cluster center is used as the distance measurement and can be calculated by formula given in Equation.1.

$$d_{ik} = \left(x_i - v_k\right) = \left\|x_i - v_k\right\| = \left[\sum_{v=1}^{p}\left(x_{ji} - v_{jk}\right)^2\right]^{1/2} \quad (1)$$

where x_k represents the position observation value in the coordinated system, and v_i represents the cluster center. It is necessary to know the number of clusters and the membership degrees of the individuals beforehand to be able to put this technique into practice. Since it is difficult to know these parameters before the application, it is possible to find these values through the method of trial and error or through some techniques developed.

The objective function used for this clustering method is as follows:

$$J(u,v)=\sum_{j=1}^{n}\sum_{t=1}^{c}u_{jk}^{m}\left\|x_{ji}-v_{jk}\right\|^{2} \tag{2}$$

This function is the weighted least square function. *n* parameter represents the number of observations, and *c* represents the number of clusters. u_{jk}^{m} is the membership of x_j in *k*-th cluster, $J(u,v)$ value is a measure of the total of all weighted error sum of squares. If the $J(u,v)$ function is minimized for each value of *c*, in other words if it is derived from the 1st degree according to v_j's and made equal to 0, the prototype of FCM algorithm can be given in Equation.3:

$$v_{jk}=\frac{\sum_{j=1}^{n}u_{jk}^{m}x_{ik}}{\sum_{j=1}^{n}u_{jk}^{m}} \tag{3}$$

In equation.3, it symbolizes; the number of cluster with c, fuzziness index with m, process ending criteria with ε and membership degrees matrix with U of FCM algorithm generate cluster prototypes at random. By taking means of these values, membership degrees matrix is calculated as given in Equation.4: (Sintas et all., 1999).

$$u_{ik}=\left[\sum_{j=1}^{c}\left(\frac{d_{ji}}{d_{jk}}\right)^{\frac{2}{m-1}}\right]^{-1} \tag{4}$$

U cluster prototypes are updated in all iteration and the processes are repeated until $\left\|U^{(t)}-U^{(t-1)}\right\|$ value reach to previously determined error term. After FCM algorithms is implemented membership degrees are used in other to decide which individual will participate in which cluster. For each individual; the highest cluster membership is observed and this individual is added to that cluster. However each individual can participate in other clusters with a certain membership degree (Sintas et all., 1999).

3.2. Fuzzy Clustering Validity Index

A good clustering method will produce high quality clusters with high intra-class similarity and low inter-class similarity. The quality of a clustering result depends on both the similarity measure used by the method and its implementation. The quality of a clustering method is also measured by its ability to discover some or all of the hidden patterns.

Aim of clustering analysis is to put similar objects into same groups. In many clustering algorithms, it is hard to know the actual num¬ber of cluster before the

application. In studies based on real data, if the researchers do not have preliminary information about the number of cluster, it cannot be known whether the number of cluster which calculated is more or less than the real num¬ber of cluster. Determination processes of the opti¬mal number of clusters are generally called as Cluster Validity. So, after clustering processes are carried out the validity of the number of cluster which calculated can be determined (Halkidi et all, 2001, Erilli et all, 2011).

Many fuzzy clustering analysis validity indexes are used in literature (Bezdek, 1974a and 1981; Rezaee et all., 1998; Kwon, 1998; Xie and Beni, 1991). Conveni¬ent clustering validity analyses are used depending on data structure and the number of variables. In this study, Artificial Neural Networks Based Cluster Valid¬ity Index was used for the optimum number of cluster detection.

3.3. Artificial Neural Networks Based Cluster Validity Index

This method was proposed by Erilli et all. (2011). Optimum number of cluster is decided by artificial neural network. In this method at first the lowest and the highest number of cluster which are convenient to data are decided. The most convenient determined number of cluster will be in this interval. Let the optimal number of cluster is c_{opt}, maximum number of the cluster is c_{maks} and minimum number of the cluster is $c_{\min}$, are defined. The relation between them will be like that; $c_{\min} \leq c_{opt} \leq c_{maks}$. Then, feed-forward artificial neural networks are implemented for each possible numbers of clusters in the manner that its output will be data matrix and its target value will be the number of cluster to which each data is appointed as a result of fuzzy clustering. The median of RMSE (root-mean-square error) value which is obtained through artificial neural networks according to several hidden layer unit number are calculated for each number of clusters. The graph or obtained median values of each number of clusters or classification error is drawn and the first jumping (where median value of RMSE overgrows for the first time) is observed. Then pre-jumping value is determined as the most convenient number of cluster (Erilli et all., 2011).

4. Application

4.1. The Data

There are many institutions which measures and calculates economic freedom. Some of the organizations are; Heritage, Fraser Institute, Free the world, Cato Institute, Buck Eye Institute, Ratio Institute etc. In this article, it has been used heritage data for calculation indices with FCM method. Heritage organization uses 10 measured aspects of economic freedom which can be grouped into four broad categories (Miller and Kim, 2015b):

i. Rule of Law (Property Rights, Freedom from corruption)

ii. Government Size (Fiscal Freedom, Government Spending)

iii. Regulatory Efficiency (Business Freedom, Labor Freedom, Monetary Freedom)

iv. Market Openness (Trade Freedom, Investment Freedom, Financial Freedom)

Each of 10 economic freedoms within these categories is graded on a scale of 0 to 100. A country's overall score is derived by averaging these 10 economic freedoms with equal weights being given to each.

There are also 11 variables given in Heritage reports. These are; 5 important subject about tax (Tariff Rate %, Income Tax Rate %, Corporate Tax Rate %, Tax Burden % of GDP and Gov't Expenditure % of GDP) and 6 important subject of economy (Population (Millions), GDP Growth Rate (%), 5 Year GDP Growth Rate (%), Unemployment (%), Inflation (%) and Public Debt (% of GDP)).

The data includes 185 countries. But 8 countries variables are mostly missing (Afghanistan, Iraq, Kosovo, Libya, Liechtenstein, Sudan, Syria, Somalia), so we analyze application for 177 countries for the year 2013, and 178 countries for the years 2014, 2015 and 2016 (Brunei Darussalam is added).

Fuzzy clustering analyses are used to categorize the countries with these 21 variables. After FCM administration to the data, degree of membership for each country can be calculated. With the help of membership degrees, ranking for countries is calculated and compared with the list of Heritage Foundation for the year 2013, 2014, 2015 and 2016. Correlation coefficient and significant level summarize the power of proposed method for calculating economic freedom index. Analysis is performed with Matlab.2009b and SPSS.21 package programs.

4.2. Classification Results

For the data 2013, it has been calculated 6 clusters as well. Separation of cluster centers can be seen easily in Figure.1.

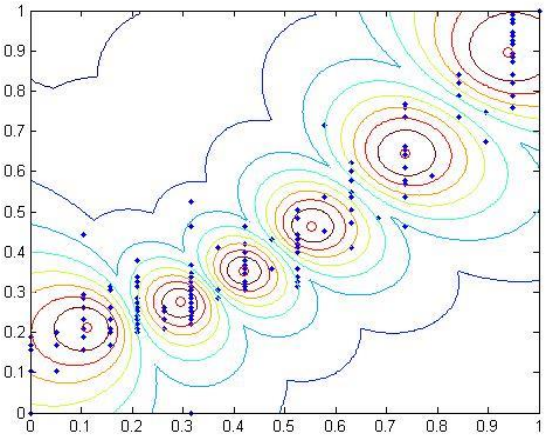

Figure.1. Cluster Separation for the Data 2013

Countries have to belong to the clusters with membership degrees with a coefficient between 0 and 1. Whichever is greater from a country's coefficient, the country will be assigned to that cluster. Every observation is ranked from big to small within the cluster they belong to according to their membership degrees. In addition, the focal point of each cluster is calculated and these are also ranked according to their sizes. Thus, the whole series is separately ranked from big to small and the ranking calculation is completed.

In Table.1, it is given first 20 countries arranged in order for the data 2013.

FCM	Countries		Heritage
1	Luxembourg	Hong Kong	1
2	Hong Kong	Singapore	2
3	Canada	Australia	3
4	Iceland	New Zealand	4
5	Australia	Switzerland	5
6	Switzerland	Canada	6
7	Netherlands	Chile	7
8	Norway	Mauritius	8
9	Germany	Denmark	9
10	Singapore	United States	10
11	Sweden	Ireland	11
12	Denmark	Bahrain	12
13	Finland	Estonia	13
14	Austria	United Kingdom	14
15	United Kingdom	Luxembourg	15
16	New Zealand	Finland	16
17	Ireland	Netherlands	17
18	Japan	Sweden	18
19	Chile	Germany	19
20	Barbados	Taiwan	20

Table.1. 2013 Ranking Results of FCM and Heritage for the first 20 Countries

As we look to the Table.1, 15 of 20 countries are take part in both list. Harmony of two lists compared with Spearman Rank Correlation coefficient. Spearman's rho between FCM and Heritage for the whole data is given in Table.2. The calculated coefficient is calculated as 0,748 and it is significant at level 0,01 (p=0,000).

			FCM	Heritage
Spearman's rho	FCM	Correlation Coefficient	1,000	,748(**)
		Sig. (2-tailed)	.	,000
		N	177	177
	Heritage	Correlation Coefficient	,748(**)	1,000
		Sig. (2-tailed)	,000	.
		N	177	177

** Correlation is significant at the 0.01 level (2-tailed).

Table.2. Spearman Rank Correlation Results for Data 2013

For the data 2014, it is performed 5 clusters. Separation of cluster centers can be seen easily in Figure.2.

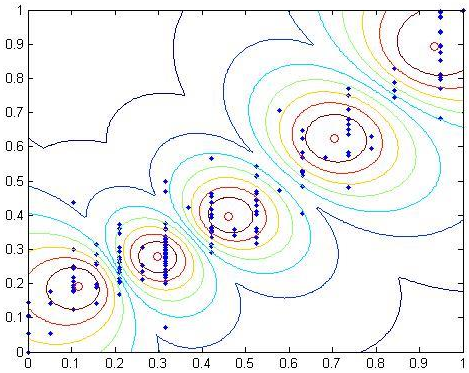

Figure.2. Cluster Separation for the Data 2014

In Table.3, it is given first 20 countries arranged in order for the data 2014. Table.3 shows that 15 of 20 countries are take part in both list.

Heritage	Countries		FCM
1	Hong Kong SAR	Iceland	1
2	Singapore	Luxembourg	2
3	Australia	Hong Kong SAR	3
4	Switzerland	Australia	4
5	New Zealand	Canada	5
6	Canada	Netherlands	6
7	Chile	Norway	7
8	Mauritius	Switzerland	8
9	Ireland	Germany	9
10	Denmark	Singapore	10
11	Estonia	Sweden	11
12	United States	Finland	12
13	Bahrain	Denmark	13
14	United Kingdom	United Kingdom	14
15	Netherlands	New Zealand	15
16	Luxembourg	Austria	16
17	Taiwan	Ireland	17
18	Germany	Chile	18
19	Finland	Japan	19
20	Sweden	Belgium	20

Table.3. 2014 Ranking Results of FCM and Heritage for the first 20 Countries

Spearman's rho coefficient between FCM and Heritage is given in Table.4. Correlation coefficient calculated as 0,829 and it is significant at level 0,01 (p=0,000).

			FCM	Heritage
Spearman's rho	FCM	Correlation Coefficient	1,000	,829(**)
		Sig. (2-tailed)	.	,000
		N	178	178
	Heritage	Correlation Coefficient	,829(**)	1,000
		Sig. (2-tailed)	,000	.
		N	178	178

** Correlation is significant at the 0.01 level (2-tailed).

Table.4. Spearman Rank Correlation Results for Data 2014

For the data 2015, it is performed 5 clusters. Separation of cluster centers can be seen in Figure.3.

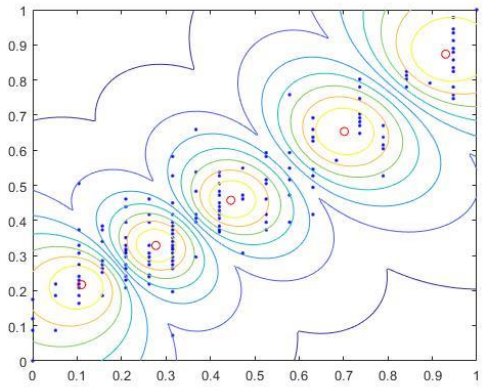

Figure.3. Cluster Separation for the Data 2015

As for the results given in Table.5 it can be seen for the first 20 countries, 13 of 20 countries are take part in both list.

Heritage	Countries			FCM
1	Hong Kong SAR		Luxembourg	1
2	Singapore		Australia	2
3	New Zealand		Canada	3
4	Australia		Germany	4
5	Switzerland		Iceland	5
6	Canada		Netherlands	6
7	Chile		United Kingdom	7
8	Estonia		Switzerland	8
9	Ireland		Hong Kong SAR	9
10	Mauritius		Norway	10
11	Denmark		Singapore	11
12	United States		Finland	12
13	United Kingdom		Sweden	13
14	Taiwan		Denmark	14
15	Lithuania		New Zealand	15
16	Germany		Chile	16
17	Netherlands		Ireland	17
18	Bahrain		Austria	18
19	Finland		Barbados	19
20	Japan		Belgium	20

Table.5. 2015 Ranking Results of FCM and Heritage for the first 20 Countries

Spearman's rho between FCM and Heritage is found 0,772 for Data 2015 given in Table.6 and it is significant at level 0,01 (p=0,000).

			FCM	Heritage
Spearman's rho	FCM	Correlation Coefficient	1,000	,772(**)
		Sig. (2-tailed)	.	,000
		N	178	178
	Heritage	Correlation Coefficient	,772(**)	1,000
		Sig. (2-tailed)	,000	.
		N	178	178

** Correlation is significant at the 0.01 level (2-tailed).

Table.6. Spearman Rank Correlation Results for Data 2015

For the data 2016, it is also performed 5 clusters.

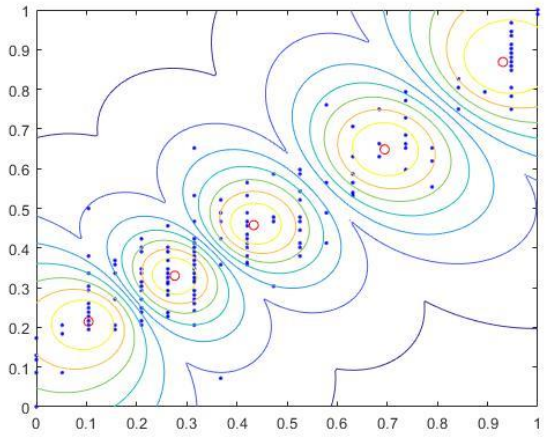

Figure.4. Cluster Separation for the Data 2016

As we look for the first 20 countries in Table.7, 13 of 20 countries are take part in both list.

Heritage	Countries			FCM
1	Hong Kong SAR		Netherlands	1
2	Singapore		Germany	2
3	New Zealand		United Kingdom	3
4	Switzerland		Luxembourg	4
5	Australia		Estonia	5
6	Canada		Ireland	6
7	Chile		Iceland	7
8	Ireland		Canada	8
9	Estonia		Australia	9
10	United Kingdom		Switzerland	10
11	United States		Finland	11
12	Denmark		Chile	12
13	Lithuania		Denmark	13
14	Taiwan		Singapore	14
15	Mauritius		Hong Kong SAR	15
16	Netherlands		Sweden	16
17	Germany		New Zealand	17
18	Bahrain		Austria	18
19	Luxembourg		Norway	19
20	Iceland		United States	20

Table.7. 2016 Ranking Results of FCM and Heritage for the first 20 Countries

Spearman's rho between FCM and Heritage is 0,934 (highest against all years) and is significant at level 0,01 given in Table.8 (p=0,000).

			FCM	Heritage
Spearman's rho	FCM	Correlation Coefficient	1,000	,934(**)
		Sig. (2-tailed)	.	,000
		N	177	177
	Heritage	Correlation Coefficient	,934(**)	1,000
		Sig. (2-tailed)	,000	.
		N	177	177

** Correlation is significant at the 0.01 level (2-tailed).

Table.8. Spearman Rank Correlation Results for Data 2016

Finally, in Table.9, the first three grades resulting from the last 4 analyzes are summarized. In all Heritage result, first 2 countries are all same: Hong Kong and Singapore. Third palce is repeated by Australia and New Zealand. There are only 4 different countries in 12 steps. But in FCM results, there 9 different countries in 12 steps. Also there are 3 different leaders in whole FCM results.

Heritage			FCM	
Hong Kong	1	1	Luxembourg	2013
Singapore	2	2	Hong Kong	
Australia	3	3	Canada	
Hong Kong SAR	1	1	Iceland	2014
Singapore	2	2	Luxembourg	
Australia	3	3	Hong Kong SAR	
Hong Kong SAR	1	1	Luxembourg	2015
Singapore	2	2	Australia	
New Zealand	3	3	Canada	
Hong Kong SAR	1	1	Netherlands	2016
Singapore	2	2	Germany	
New Zealand	3	3	United Kingdom	

Table.9. First 3 Countries for 4 Data Sets

The correlation coefficient used in the comparison of FCM-Heritage sequences shows that all the results are in the same direction and highly correlated. Moreover, all the coefficients were found to be statistically significant. These results also show that althought the analysis methods are different but results are similar to those used by large organizations such as Heritage or Fraser. It has been proved that successful results can be obtained when using alternative methods in these types of comparisons.

5. Conclusion

Economic freedom is the key to greater opportunity and an improved quality of life. Economic freedom index is one of the way to calculate economic freedoms and levels. While a simple concept, it is an engine that drives prosperity in the world and is the difference between why some societies thrive while others do not. The goal of economic freedom is to characterize the institutional structure and central parts of economic policy (Berggren, 2003). Also it is not simply an absence of government constraint but the creation and maintenance of a mutual sense of liberty for all.

The Index of Economic Freedom is an annual index and ranking created by The Heritage Foundation and The Wall Street Journal in 1995 to measure the degree of economic freedom in the world's nations. For over twenty years the Index has delivered thoughtful analysis in a clear, friendly, and straight-forward format. There are many institutions which measures and calculates economic freedom. All they are using different types of variables and different methods. Most methods based on mathematical calculations. In this study, it is used Fuzzy Clustering Analysis to determine Economic Freedom Index. Analysis is applied for 4 different Data sets. Data sets for the years 2013, 2014, 2015 and 2016 is taken from Heritage web site.

Correlation coefficients between FCM and Heritage takes place 0,748 and 0,934 and all they are significant at level 0,01. Overall correlation coefficient is 0,881 and it is clearly high level. The high correlation coefficients between the suggested index rankings and the Heritage rankings also indicate the strength of the study results. The fact that the coefficients are statistically significant also indicates that there is not much difference between the calculations.

Fuzzy clustering and FCM algorithm increased its popularity recently. It can give better results when the number of data or the number of variables increases. Clustering analysis has been shown to give effective results when we have difficulty in deciding individuals. While classifying, it can produce more clear results with complicated data structures when compared with other clustering or classifying methods. With this study, it has been presented that fuzzy clustering analysis can be successfully used for index calculation or ranking measures.

We can simply notice that, results of Fuzzy Clustering Analysis is clearly satisfactory for ranking the countries via economic freedom index calculation. With different analysis methods, organizations can better analyze their current situation. With the help of this study, it has been presented that fuzzy clustering analysis (classification methods) can be successfully used for index calculation or ranking measures

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Appendix.1. Classification Results of 2013

Afghanistan	Iraq	Algeria	Australia	Libya	Albania
Sudan	Korea, North	Angola	Austria	Liechtenstein	Armenia
	Somalia	Argentina	Bahrain		Azerbaijan
		Belarus	Barbados		Bahamas, The
		Bhutan	Belgium		Bangladesh
		Bolivia	Botswana		Belize
		Burma	Canada		Benin
		Burundi	Chile		Bosnia and Herzegovina
		Chad	Cyprus		Brazil
		China	Czech Republic		Bulgaria
		Comoros	Denmark		Burkina Faso
		Congo, Dem. Rep.	Estonia		Cambodia
		Congo, Rep.	Finland		Cameroon
		Cuba	France		Cape Verde
		Ecuador	Germany		Central African Republic
		Equatorial Guinea	Hong Kong		Colombia
		Eritrea	Hungary		Costa Rica
		Ethiopia	Iceland		Cote d'Ivoire
		Guinea	Ireland		Croatia
		Guinea-Bissau	Israel		Djibouti
		Guyana	Italy		Dominica
		Haiti	Japan		Dominican Republic
		Iran	Korea, South		Egypt
		Kiribati	Lithuania		El Salvador
		Laos	Luxembourg		Fiji
		Lesotho	Malta		Gabon
		Liberia	Mauritius		Gambia, The
		Maldives	Netherlands		Georgia
		Micronesia	New Zealand		Ghana
		Nepal	Norway		Greece
		Papua New Guinea	Poland		Guatemala
		Russia	Portugal		Honduras
		Sao Tome and Principe	Saint Lucia		India
		Sierra Leone	Singapore		Indonesia
		Solomon Islands	Slovenia		Jamaica
		Suriname	Spain		Jordan
		Syria	Sweden		Kazakhstan
		Tajikistan	Switzerland		Kenya
		Timor-Leste	Taiwan		Kuwait
		Togo	United Kingdom		Kyrgyz Republic
		Tonga	United States		Latvia
		Turkmenistan	Uruguay		Lebanon
		Ukraine			Macau
		Uzbekistan			Macedonia
		Venezuela			Madagascar
		Vietnam			Malawi
		Zimbabwe			Malaysia
		Kosovo			Mali
					Mauritania
					Mexico

					Moldova
					Mongolia
					Montenegro
					Morocco
					Mozambique
					Namibia
					Nicaragua
					Niger
					Nigeria
					Oman
					Pakistan
					Panama
					Paraguay
					Peru
					Philippines
					Qatar
					Romania
					Rwanda
					Saint Vincent
					Samoa
					Saudi Arabia
					Senegal
					Serbia
					Seychelles
					Slovakia
					South Africa
					Sri Lanka
					Swaziland
					Tanzania
					Thailand
					Trinidad and Tobago
					Tunisia
					Turkey
					Uganda
					United Arab Emirates
					Vanuatu
					Yemen
					Zambia

Appendix.2. Classification Results of 2014

NorthKorea	Afghanistan	Albania	TimorLeste	Australia
Liechtenstein	Algeria	Armenia		Austria
Syria	Angola	Azerbaijan		Barbados
Somalia	Argentina	Bahamas		Belgium
	Bangladesh	Bahrain		Botswana
	Belarus	Belize		Canada
	Bhutan	Benin		Chile
	Bolivia	BosniaHerzegovina		Cyprus
	Burma	Brazil		CzechRepublic
	Burundi	Bulgaria		Denmark
	Cameroon	BurkinaFaso		Estonia
	CentralAfricanRepublic	Cambodia		Finland

	Chad	CapeVerde		France
	China	Colombia		Germany
	Comoros	CostaRica		HongKong
	Dem. Rep. Congo	CoeDivoire		Hungary
	RepublicCongo	Croatia		Iceland
	Cuba	Djibouti		Ireland
	Ecuador	Dominica		Israel
	Egypt	DominicanRepublic		Italy
	EquatorialGuinea	ElSalvador		Japan
	Eritrea	Fiji		SouthKorea
	Ethiopia	Gabon		Lithuania
	Guinea	Gambia		Luxembourg
	GuineaBissau	Georgia		Malta
	Guyana	Ghana		Netherlands
	Haiti	Greece		NewZealand
	India	Guatemala		Norway
	Iran	Honduras		Poland
	Iraq	Indonesia		Portugal
	Kiribati	Jamaica		SaintLucia
	Laos	Jordan		Singapore
	Lesotho	Kazakhstan		Slovenia
	Liberia	Kenya		Spain
	Libya	Kuwait		Sweden
	Maldives	KyrgyzRepublic		Switzerland
	Mauritania	Latvia		UnitedKingdom
	Micronesia	Lebanon		UnitedStates
	Nepal	Macau		Uruguay
	Nigeria	Macedonia		
	Pakistan	Madagascar		
	PapuaNewGuinea	Malawi		
	Russia	Malaysia		
	SaoTomePrincipe	Mali		
	SierraLeone	Mauritius		
	SolomonIslands	Mexico		
	Sudan	Moldova		
	Suriname	Mongolia		
	Tajikistan	Montenegro		
	Togo	Morocco		
	Tonga	Mozambique		
	Tunisia	Namibia		
	Turkmenistan	Nicaragua		
	Ukraine	Niger		
	Uzbekistan	Oman		
	Venezuela	Panama		
	Vietnam	Paraguay		
	Zimbabwe	Peru		
	Kosovo	Philippines		
		Qatar		
		Romania		
		Rwanda		
		Saint Vincent		

		Samoa		
		SaudiArabia		
		Senegal		
		Serbia		
		Seychelles		
		Slovakia		
		SouthAfrica		
		SriLanka		
		Swaziland		
		Taiwan		
		Tanzania		
		Thailand		
		TrinidadTobago		
		Turkey		
		Uganda		
		UnitedArabEmirates		
		Vanuatu		
		Yemen		
		Zambia		
		Brunei		

Appendix.3. Classification Results of 2015

Liechtenstein	Iraq	Albania	Timor-Leste	Afghanistan
	Korea, North	Armenia		Algeria
	Syria	Australia		Angola
	Somalia	Austria		Argentina
	Kosovo	Bahamas		Azerbaijan
		Bahrain		Bangladesh
		Barbados		Belarus
		Belgium		Belize
		Bosnia and Herzegovina		Benin
		Botswana		Bhutan
		Bulgaria		Bolivia
		Canada		Brazil
		Cabo Verde		Burkina Faso
		Chile		Burma
		Colombia		Burundi
		Costa Rica		Cambodia
		Croatia		Cameroon
		Cyprus		Central African Republic
		Czech Republic		Chad
		Denmark		China
		Dominica		Comoros
		Estonia		Congo
		Finland		Congo, Republic of
		France		Côte d'Ivoire
		Georgia		Cuba
		Germany		Djibouti
		Ghana		Dominican Republic
		Greece		Ecuador
		Hong Kong SAR		Egypt
		Hungary		El Salvador

		Iceland		Equatorial Guinea
		Ireland		Eritrea
		Israel		Ethiopia
		Italy		Fiji
		Jamaica		Gabon
		Japan		Gambia
		Jordan		Guatemala
		Korea, South		Guinea
		Latvia		Guinea-Bissau
		Lithuania		Guyana
		Luxembourg		Haiti
		Macau		Honduras
		Macedonia		India
		Malaysia		Indonesia
		Malta		Iran
		Mauritius		Kazakhstan
		Mexico		Kenya
		Montenegro		Kiribati
		Morocco		Kuwait
		Netherlands		Kyrgyz Republic
		New Zealand		Lao P.D.R.
		Norway		Lebanon
		Oman		Lesotho
		Peru		Liberia
		Poland		Libya
		Portugal		Madagascar
		Qatar		Malawi
		Romania		Maldives
		Saint. Lucia		Mali
		Saint. Vincent		Mauritania
		Samoa		Micronesia
		Serbia		Moldova
		Singapore		Mongolia
		Slovak Republic		Mozambique
		Slovenia		Namibia
		South Africa		Nepal
		Spain		Nicaragua
		Sweden		Niger
		Switzerland		Nigeria
		Taiwan		Pakistan
		Trinidad and Tobago		Panama
		Turkey		Papua New Guinea
		United Arab Emirates		Paraguay
		United Kingdom		Philippines
		United States		Russia
		Uruguay		Rwanda
		Brunei Darussalam		São Tomé and Príncipe
				Saudi Arabia
				Senegal
				Seychelles
				Sierra Leone

				Solomon Islands
				Sri Lanka
				Sudan
				Suriname
				Swaziland
				Tajikistan
				Tanzania
				Thailand
				Togo
				Tonga
				Tunisia
				Turkmenistan
				Uganda
				Ukraine
				Uzbekistan
				Vanuatu
				Venezuela
				Vietnam
				Yemen
				Zambia
				Zimbabwe

Appendix.4. Classification Results of 2016

Afghanistan	Iraq	Australia	Timor-Leste	Cuba
Albania	Libya	Austria	Kosovo	Korea, North
Algeria	Liechtenstein	Bahamas		
Angola	Syria	Bahrain		
Argentina	Yemen	Barbados		
Armenia	Somalia	Belgium		
Azerbaijan		Bosnia and H.		
Bangladesh		Botswana		
Belarus		Bulgaria		
Belize		Canada		
Benin		Cabo Verde		
Bhutan		Chile		
Bolivia		Colombia		
Brazil		Costa Rica		
Burkina Faso		Croatia		
Burma		Cyprus		
Burundi		Czech Republic		
Cambodia		Denmark		
Cameroon		Dominica		
Central African		Estonia		
Chad		Finland		
China		France		
Comoros		Georgia		
Congo		Germany		
Congo, Republic of		Greece		

Côte d'Ivoire		Hong Kong SAR		
Djibouti		Hungary		
Dominican Republic		Iceland		
Ecuador		Ireland		
Egypt		Israel		
El Salvador		Italy		
Equatorial Guinea		Jamaica		
Eritrea		Japan		
Ethiopia		Jordan		
Fiji		Korea, South		
Gabon		Latvia		
Gambia		Lesotho		
Ghana		Lithuania		
Guatemala		Luxembourg		
Guinea		Macau		
Guinea-Bissau		Macedonia		
Guyana		Malaysia		
Haiti		Malta		
Honduras		Mauritius		
India		Mexico		
Indonesia		Montenegro		
Iran		Netherlands		
Kazakhstan		New Zealand		
Kenya		Norway		
Kiribati		Oman		
Kuwait		Poland		
Kyrgyz Republic		Portugal		
Lao P.D.R.		Qatar		
Lebanon		Romania		
Liberia		Saint. Lucia		
Madagascar		Saint. Vincent		
Malawi		Samoa		
Maldives		Serbia		
Mali		Singapore		
Mauritania		Slovak Republic		
Micronesia		Slovenia		
Moldova		Spain		
Mongolia		Sweden		
Morocco		Switzerland		
Mozambique		Taiwan		
Namibia		Trinidad and Tobago		
Nepal		Turkey		
Nicaragua		United Arab Emirates		
Niger		United Kingdom		

Nigeria		United States		
Pakistan		Uruguay		
Panama		Brunei Darussalam		
Papua New Guinea				
Paraguay				
Peru				
Philippines				
Russia				
Rwanda				
São Tomé and Príncipe				
Saudi Arabia				
Senegal				
Seychelles				
Sierra Leone				
Solomon Islands				
South Africa				
Sri Lanka				
Sudan				
Suriname				
Swaziland				
Tajikistan				
Tanzania				
Thailand				
Togo				
Tonga				
Tunisia				
Turkmenistan				
Uganda				
Ukraine				
Uzbekistan				
Vanuatu				
Venezuela				
Vietnam				
Zambia				
Zimbabwe				