

PROPOSED INDEX CALCULATION FOR ECONOMICS RANKING

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Received: February 21, 2018 / Revised: May 12, 2018 / Accepted: June 20, 2018
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Abstract: *Index; is a display in which more than one variable is included and is used to measure the proportional variation of the movements of these variables. Indices are useful because they allow summarization and comparison by making the data simple. In this study; a new index calculation has been proposed with the help Fuzzy Clustering method. Calculation of Index prepared with 10 index values used in the literature. The indices are; Open Market, Budget Transparency, European 2020-Competitiveness, Economic Freedom (by Heritage Foundation), Economic Freedom (by Fraser Institute), Depth of credit information, Financial Stability, Trade Facilitation, Financial Innovation and Global competition. FCM Calculations are made with Matlab.2016 and other calculations are made with Microsoft Excel.2017 programmes.*

There are variables which have different numbers and structures used in each index calculation. These variables have different weights within themselves. In this study, weights were calculated for the new index value which will be created by using the sequences created because of these indices. The weights of each index value obtained by the Fuzzy Clustering Analysis are multiplied by the index values to create a new index order.

European countries were re-ordered under the title “Economy”. It can interpret this new index order as a general summation of all other orders. Thus, the order of the countries under different subject headings will be calculated together with the orders in a specific area (economy, law etc.).

Keywords: *Index Calculation, FCM, Economics*

JEL Classifications C38 · C43 · C82

This paper was presented at the Second International Scientific Conference on Economics and Management – EMAN 2018, March 22 2018, Ljubljana, Slovenia, www.eman-conference.org

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1. INTRODUCTION

Index; is a display in which more than one variable is included and is used to measure the proportional variation of the movements of these variables. This proportional change can vary according to time or place. Therefore, indices are useful because they allow summarization and comparison by making the data simple. The indices can be used for comparisons, current situation analyzes or future estimates that are calculated for different years, settlement areas or items.

In recent years, many organizations have calculated their own index values. These indices, which do not have legal and economic sanctions, are perhaps the most important indicators in terms of showing the current situation of countries, cities or societies. It is also possible to analyze the future with different calculations of indexes made with different variables. With these indices we can see the closest position to the truth about the point and the future of mankind.

Many countries or organizations calculate their own index values in relevant areas. Indices as “Index of Mother” prepared by Save the Children Organization and “Index of Better Life” prepared by the OECD can be given as examples. These indices can be presented by sorting, by grouping or mapping observations. So that the results are both presented and visually summarized by the interested persons or institutions.

In literature, there can be seen relevant papers about indices. Carlsson and Lundström (2002) investigate what specific types of economic freedom measures are important for growth. Gwartney, Lawson and Holcombe (1999) examine 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. Lerman and Yitzhaki (1984) derive a convenient way to calculate the Gini coefficient, using the covariance. Harzing and Van der Wal (2009) proposed a new data source (Google Scholar) and metric (Hirsch's h index) to assess journal impact in the field of economics and business.

2. INDEX OF ECONOMICS

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, Kim, 2015). Economic freedom and democracy affects economic performance by identifying organizational structure. One of the important part of this performance is the index of economics. The Index of Economic Freedom is a helpful tool for a variety of audiences, including academics, policymakers, journalists, students, teachers, and those in business and finance.

Few foundations calculate his own indices with different methods. To give an example to this indices; Index of Economic Freedom (prepared by Heritage Foundation and Wall Street Journal), Economic Freedom of the World (prepared by Fraser Institute) and World Survey of Economic Freedom (prepared by Freedom House).

In an economically free society, individuals are free to work, produce, consume and invest in any way they please. With the help economic freedom index, we simply analyses the country's economic freedom levels or classify them in to similar groups.

3. CLUSTERING ANALYSIS

Clustering is the assignment of a set of observations into subsets (called *clusters*) so that observations in the same cluster are similar in some sense. Clustering is a method of unsupervised learning, and a common technique for statistical data analysis used in many fields, including machine learning, data mining, pattern recognition, image analysis, bioinformatics and marketing.

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 classify the data into groups (Balasko, Abonyi and Feil, 2005).

In fuzzy clustering, fuzzy techniques are used to cluster the data and with these techniques an object can be classified in more than one cluster. This approach comes into the picture as an suitable method when the clusters cannot be separated from each other distinctly or when some units are uncertain about membership.

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. Fuzzy clustering is based on distance measurements as well like crisp clustering algorithms. 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, 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 crisp clustering methods is that it provides more detailed information on the data. But there will be too much output when there are too many individuals and clusters so it will difficult to summarize and classify the data. Moreover, fuzzy clustering algorithms, which are used when there is uncertainty, are generally complicated (Oliveira, Pedrycz, 2007).

4. FUZZY C-MEANS

Fuzzy C-Means algorithm forms the basis of all clustering techniques that depend on objective function. It was developed by Bezdek (1974a, 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.

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

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 actual number of clusters and the membership degrees of the individuals beforehand to be able to put this technique into practice. However, in practice, it

is difficult to know these parameters before the application. For these, it is possible to find these values through the method of trial and error or through some techniques developed [11]. The objective function used for this clustering method is as follows:

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

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:

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

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, Cadenas and Martin, 1999).

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

U cluster prototypes are updated in all iteration and the processes are repeated until $\|U^{(t)} - U^{(t-1)}\|$ value reach to previously determined error term. After FCM algorithm 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 (Erilli, Yolcu, Eğrioglu, Aladağ and Öner, 2011).

5. PROPOSED INDEX CALCULATION

Indices are calculated with the help of several variables. The proposed index is calculating with fuzzy clustering analysis. The suggested steps are given as follows:

- i. The variables forming each index value (they must be in the same cluster) are clustered by the fuzzy clustering analysis. (Here, it will be easier to organize the data as 2 clusters. It is the easiest method to set up a very large number of observations in addition to the observations that make up the index value for this and set the result as 2 sets).
- ii. After applying the FCM method, cluster membership degrees of each observation are calculated. Cluster membership degrees take place between 0 and 1 for each observation.
- iii. The membership degrees are multiplied with scores and rankings used in related indices separately.
- iv. This is done for all index values which will be used in proposed index.

At the end, two different index sequences based on both rank order and scoring are calculated.

6. APPLICATION

In application, it is used 10 different indices for 42 European countries to calculate new proposal index. The indices are; Open Market, Budget Transparency, European 2020-Competitiveness, Economic Freedom (by Heritage Foundation), Economic Freedom (by Fraser Institute), Depth of credit information, Financial Stability, Trade Facilitation, Financial Innovation and Global competition. FCM Calculations are made with Matlab.2016 and other calculations are made with Microsoft Excel.2017 programmes.

Every index calculation prepared with different variables. The variables used in index calculations is given below:

Economic Freedom index - Heritage Foundation (Property Rights, Freedom from corruption, Fiscal Freedom, Government Spending, Business Freedom, Labor Freedom, Monetary Freedom, Trade Freedom, Investment Freedom, Financial Freedom), European 2020 Competitiveness Index (Enterprise environment, Digital agenda, Innovative Europe, Education and training, Labour market and employment, Social inclusion, Environmental sustainability), Open Market (Trade Openness, Trade Policy Regime, Foreign Direct Investment Openness, Trade Enabling Infrastructure), Budget Transparency Index (The open budget survey results), Economic Freedom - Fraser Institute (The breadth of the State's field of activity: expenditures, taxes and initiatives, Legal structure and property rights Powerful money access International trade liberty, Legislation on credit, labor and business), Financial Stability Index (Regulatory Capital / Risk Weighted Assets, Regulatory Stage 1 Capital / Risk Weighted Assets, Unpaid Debts (Decrease in Provisions) / Capital, Unpaid Debts / Total Gross Debts), Trade Facilitation Index (market access, customs management, infrastructure and working environment), Financial Innovation Index (public expenditure, venture capital), Global competition Index (Basic requirements, infrastructure, macroeconomic situation, health and primary education)

In analysis, the variables that located in each index are clustered by FCM separately and cluster membership degrees are calculated for each observation. In Table.1, results of FCM membership degrees are given for selected countries for Open Market and Competitiveness Indices.

Table 1: FCM Results for selected indices and countries

COUNTRIES	Open Market		FCM	Competitiveness		FCM
	Ranking	Score		Ranking	Score	
Germany	17	3,9	0,9966	7	5,28	0,9987886283
Albania	34	3,1	0,9178	35	3,4	0,9980829292
Austria	15	4,1	0,9997	8	5,16	0,9991957125
Belarus	34	3,1	0,9178	35	3,4	0,9982250786
Belgium	6	4,6	0,9631	12	4,93	0,9990932259
United Kingdom	20	3,9	0,9753	10	5,13	0,9982526951
Bosnia-H.	34	3,1	0,9178	35	3,4	0,9982250786
Bulgaria	25	3,7	0,9987	31	3,75	0,9993472675
Czech Rep.	11	4,1	0,992	21	4,33	0,9999967039
Denmark	16	4,0	0,9993	6	5,32	0,9979980533
Estonia	12	4,1	0,9967	15	4,74	0,9997489385
Finland	21	3,9	0,9864	1	5,70	0,9969806536

France	23	3,7	0,9684	13	4,81	0,9991981639
Croatia	34	3,1	0,9178	27	3,87	0,9991182493
Netherlands	2	4,8	0,958	5	5,41	0,9976840355
Ireland	3	4,8	0,9579	14	4,75	0,9998348288
Spain	26	3,6	0,952	16	4,47	0,9999818968

The new index calculation was made separately according to the 10 index scores and rankings of the countries. The total score is calculated by multiplying the scores and the total ranking is calculated by multiplying the rankings with FCM coefficients in Microsoft Excel.

As an example, for calculation, let's get the total score of Germany. The index scores of Germany's are given as follows: Open Market (3,9), Competitiveness (5,28), Economic Freedom-Heritage (74,2), Financial Stability (34,1), Global competition (5,65), Trade Facilitation (5,49), Depth of credit information (8), Budget Transparency (69), Financial Innovation (99) and Economic Freedom-Fraser (7,68). FCM Results for same indices are; 0,9966; 0,9987; 0,9779; 0,9999; 0,9977; 0,9998; 0,8219; 0,9565; 0,8587 and 0,7056. if we multiply the scores of each index with the results of the FCM, we get the following result: 255,9023.

The total scores and ranking scores for all countries are calculated similarly to this example. The total order is sorted from smallest to largest and the order of the proposed index is determined according to this order. Similarly, the total scores is sorted from largest to smallest and the index order according to the scores is determined.

The index ranking obtained according to the Rankings is given in the Table 2.

Table 2: Proposed Index Ranking According to Rankings Points

According to Rankings			
1	Switzerland	22	Latvia
2	Netherlands	23	Portugal
3	United Kingdom	24	Slovenia
4	Norway	25	Italy
5	Finland	26	Romania
6	Germany	27	Hungary
7	Denmark	28	Turkey
8	Sweden	29	Russia
9	Luxembourg	30	Bulgaria
10	Austria	31	Croatia
11	Iceland	32	Macedonia
12	Ireland	33	Albania
13	Estonia	34	Cyprus
14	Belgium	35	Ukraine
15	France	36	Greece
16	Lithuania	37	Serbia
17	Czech Republic	38	Bosnia and Herzegovina
18	Poland	39	Moldova
19	Spain	40	Montenegro
20	Slovakia	41	Kosovo under UNSCR 1244/99
21	Malta	42	Belarus

Similarly, the index ranking obtained according to the Scores is given in the Table 3.

Table 3: Proposed Index Ranking According to Score Points

According to Scores			
1	Finland	22	Italy
2	Sweden	23	Poland
3	Denmark	24	Spain
4	Switzerland	25	Slovenia
5	Netherlands	26	Croatia
6	Iceland	27	Romania
7	Estonia	28	Hungary
8	Norway	29	Bulgaria
9	Austria	30	Cyprus
10	Germany	31	Greece
11	France	32	Serbia
12	United Kingdom	33	Malta
13	Belgium	34	Russia
14	Lithuania	35	Macedonia
15	Czech Republic	36	Montenegro
16	Portugal	37	Kosovo under UNSCR 1244/99
17	Luxembourg	38	Moldova
18	Ireland	39	Albania
19	Latvia	40	Ukraine
20	Turkey	41	Belarus
21	Slovakia	42	Bosnia and Herzegovina

According to results given in Table 2 and 3, Nordic countries take place in top 10. Countries like Switzerland, United Kingdom and Netherlands are other countries at the top.

The question of which index order is more important here may come to mind. It may be thought that the sequential calculation is more realistic. Because there is a difference between the scorers, but the ranking is always between 1 and 42. Thus, the calculation shows that it performs with a certain range and minimum variance. The correlation coefficient between the two calculations is found as 0,922 and it is significant at level 0,01.

Finally, if we perform FCM to all countries with all scores we get 6 clusters according to economics variables. Classification results is given in Table 4:

Table 4: FCM Results for European Countries

Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI
Netherlands	Germany	Belgium	Czech Republic	Bulgaria	Albania
Switzerland	Austria	Ireland	Estonia	Italy	Belarus
Luxembourg	United Kingdom	Malta	France	Cyprus	Bosnia and Herzegovina
	Denmark		Spain	Hungary	Croatia
	Finland		Latvia	Poland	Montenegro

	Sweden		Lithuania	Romania	Kosovo under UNSCR 1244/99
	Iceland		Portugal	Turkey	Macedonia
	Norway		Slovakia		Moldova
			Slovenia		Russia
					Serbia
					Ukraine
					Greece

Looking to Table 4, we can say that first 2 cluster can be named as “Strong Economies”, cluster 3 and 4 can be named as “Medium-Level Economies”, cluster 5 and 6 can be named as “Weak Economies” for the European countries.

6. CONCLUSION

Today, many different indices are being calculated. The aim here is to see the current situation of the relevant countries, cities or companies and to compare them with the other competitors. All indices are using different types of variables and methods. So that different index results can be seen in the same area.

In this study, it is used Fuzzy Clustering Analysis to determine Index of Economics. A new index calculation has been proposed with the aid of 10 different index calculations previously calculated for the economics. The fuzzy clustering analysis was used in the proposed calculation. The proposed method is based on the scores and rankings aids used in previous index calculations.

According to the results of the analysis, the Nordic countries, Switzerland, Netherlands and the United Kingdom were in the top rankings in both index lists. It should not be surprising that these countries, which have strong economies, are also ranked high in their high prosperity rankings.

With different methods, organizations can better analyze their current situation. With the help of this study, it has been presented that fuzzy classification methods can be successfully used for index calculation or ranking measures.

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