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CLASSIFICATION OF EUROPEAN UNION MEMBER AND CANDIDATE COUNTRIES ACCORDING TO EASE OF DOING BUSINESS INDEX USING FUZZY CLUSTERING

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ABSTRACT
Countries encourage both their own citizens and foreign investors to do business in order to keep the economy going. However, problems that may arise while doing business or long periods of waiting for certain procedures might push away investors to other countries. The World Bank and the International Finance Corporation prepare Doing Business Reports to showcase the environment of business in countries. These reports compose an index for ease of doing business for each country, helping these countries to know their strength and weakness in terms of doing business. The reports also help investors to compare the state of each country and make a decision. This study aims to classify the countries that are member or candidate to the European Union according to Doing Business Index through fuzzy clustering analysis. Two clusters are formed at the end of the study and the results are interpreted.

Keywords: Doing Business Report, Ease of Doing Business Index, Fuzzy Clustering

AVRUPA BİRLİĞİ'NE ÜYE VE ADAY ÜLKELERİN İŞ YAPMA KOLAYLIĞI ENDEKSİNE GÖRE BULANIK KÜMELEME ANALİZİ İLE SINIFLANDIRILMASI

ÖZET
Ülkeler, ekonomilerini canlı tutmak adına hem kendi vatandaşlarını hem de yabancı yatırımcıları iş yapmaya yönlendirmek istemektedirler. Ancak, iş yaparken karşılaşılan problemler veya belirli işlemler için bekleme sürelerinin çok uzun olması yatırımcıların başka ülkelere gitmesine neden olabilmektedir. Ülkelerin iş yapma ortamlarının ortaya koyulması adına Dünya Bankası ve Uluslararası Finans Kuruluşu tarafından İş Yapma Raporları oluşturulmaktadır. Bu raporlarda, ülkelerin iş yapma kolaylığı endeksi oluşturulmaktadır. Bu endeks ile ülkeler iş yapmadaki güçlü ve zayıf yönlerini belirleyebilmektedirler. Yatırımcılar ise ülkelerin karşılaştırmalı olarak durumlarını görüp karar verme imkanı bulmaktadırlar. Bu çalışmada, Avrupa Birliği'ne üye ve aday ülkelerin İş Yapma Kolaylığı Endeksi'ne göre bulanık kümeleme analizi ile sınıflandırılması amaçlanmıştır. Çalışmanın sonucunda 2 küme oluşturulmuş ve sonuçlar yorumlanmıştır.

Anahtar Kelimeler: İş Yapma Raporu, İş Yapma Kolaylığı Endeksi, Fuzzy Kümeleme

1. INTRODUCTION

Today, all countries in the world have economic problems. The most fundamental way to deal with these problems is to attract foreign investors into the country or to provide ease of doing business for citizens. To this end, countries adopt the approach that keeping the economy going and developing policies that provide opportunities for citizens are one of the most important objectives for a country. In parallel with this, international institutions and countries draw more attention to the quality of law, agreements that shape daily economic activities, and bureaucratic processes that keep up with what economic units expect. Through these kinds of endeavors, countries aim to enhance their competitive power, and fasten economic growth and development (Yardımcıoğlu, İzgi Şahbaz, & Savaşan, 2013).
The World Bank and the International Finance Corporation publishes Ease of Doing Business Index since 2003 for countries to be able to see their environment for business and to compare themselves with other countries. The World Bank defines this index as "to encourage economies to compete with each other using regulatory best practices and present measurable criteria for reforms through collecting and analyzing extensive quantitative data in order to make a basis for comparison of business regulatory environments among economies and within different periods of time". The Doing Business Report is first of its kind regarding that it uses a ranking method rather than an approach based on perception in measuring the regulations the business environments have on a micro level and hence helps the decision-maker who is to make an investment make healthier choices (Kangal, Eroğlu, & Çoban, 2018).
There are many researches in literature about the Ease of Doing Business Index. In their study, Morris and Aziz (2011) aimed to figure out the factors that affect the inflow of foreign direct investment in Sub-Saharan African and Asian countries. For this aim, they applied the correlation analysis with inflow of foreign direct investment, Ease of Doing Business Index and other indices that make up this index. The study concluded that registering property and trading across borders indices affect the inflow of foreign direct investment. In their study, Yardımcıoğlu, İzgi Şahbaz and Savaşan (2013) examined the relationship of Ease of Doing Business Index and Good Governance Index with income. As a result of the study, it was concluded that as good governance weakens, business environment deteriorates and the income might decrease not only due to good governance problems but also due to weak business environments. In their study, Yardımcıoğlu, İlhan and Gerekli (2014) compare the countries Mexico and Turkey based on 2010-2013 Ease of Doing Business Index reports. In conclusion, they found out that Mexico displayed the lowest performance on indices related to enforcing contracts, registering property, getting electricity and paying taxes. On the other hand, Turkey displayed the lowest performance on resolving insolvency and dealing with construction permits. Taş, Uçacak and Çiçek (2017) investigated if there is a statistical relationship between Information and Communication Technologies Development Index and Ease of Doing Business Index. The study showed that there is positive strong relationship between the two indices. Consequently, it was concluded that when a country develops in terms of information technologies, it is also expected that doing business gets easier in that country. In their study, Kangal, Eroğlu and Çoban (2018) comparatively examined MINT member countries based on Ease of Doing Business Index. They showed that Mexico and Turkey are

the most advantageous countries, and excluding credit obtainment and bankruptcy remedies, the most disadvantageous countries are Indonesia and Nigeria.

This study aims to classify European Union member and candidate countries according to their Ease of Doing Business Index through fuzzy clustering analysis. The reason that European Union member and candidates are preferred is that the European Union has regulations regarding doing business and Turkey is a candidate country. The reason fuzzy clustering analysis is preferred is that it yields the most realistic results among other clustering analyses. Since the degree of membership to a cluster of units, or in other words the probability of units to be part of a cluster, is calculated, more information can be obtained about the real position of units. Fuzzy clustering analysis is especially preferred in classifying similar units, as in this study.

2. MATERIALS AND METHODS

2.1. Data Source

This study is based on data by the "Doing Business 2019" report published by the World Bank and International Finance Corporation (The World Bank, 2019). This report is shared with the public in a regular fashion since 2003. While the report evaluates 133 countries in 2003, it evaluates 190 countries in 2019. The overall objective of the report is to present the duration and cost of meeting governmental requirements related to establishing and maintaining a business, transnational trade, taxpaying and business shutdown. The report constitutes a general index under the name of Ease of Doing Business Index. This index is composed of 10 topics and 41 indicators under these 10 topics. These topics and indicators are shown in Table 1.

Table 1: Topics and Indicators

Topic	Indicator
Starting a Business	Procedures (number)
	Time (days)
	Cost (% of income per capita)
	Minimum Capital (% of income per capita)
Dealing with Construction Permits	Procedures (number)
	Time (days)
	Cost (% of warehouse value)
	Building quality control index (0–15)
Getting Electricity	Procedures (number)
	Time (days)
	Cost (% of income per capita)
	Reliability of supply and transparency of tariffs index (0–8)
Registering Property	Procedures (number)
	Time (days)
	Cost (% of property value)
	Quality of land administration index (0–30)

Getting Credit	Strength of legal rights index (0–12)
	Depth of credit information index (0–8)
Protecting Minority Investors	Extent of disclosure index (0–10)
	Extent of director liability index (0–10)
	Ease of shareholder suits index (0–10)
	Extent of shareholder rights index (0–10)
	Extent of ownership and control index (0–10)
	Extent of corporate transparency index (0–10)
Paying Taxes	Payments (number per year)
	Time (hours per year)
	Total tax and contribution rate (% of profit)
	Post-filing index (0–100)
	Time to comply with VAT refund (hours) Time to obtain VAT refund (weeks) Time to comply with corporate income tax correction (hours) Time to complete a corporate income tax correction (weeks)
Trading Across Borders	Documentary compliance (hours) (Time to export)
	Documentary compliance (hours) (Time to export)
	Documentary compliance (US$) (Cost to export)
	Border compliance (US$) (Cost to export)
	Documentary compliance (hours) (Time to import)
	Documentary compliance (hours) (Time to import)
	Documentary compliance (US$) (Cost to import)
	Border compliance (US$) (Cost to import)
Enforcing Contracts	Time (days)
	Cost (% of claim)
	Quality of judicial processes index (0–18)
Resolving Insolvency	Recovery rate (cents on the dollar)
	Strength of insolvency framework index (0–16)

Each topic in Table 1 is calculated as an index with certain formulations. Consequently, each country can view their score and ranking and compare themselves with other countries with respect to each topic. Ease of Doing Business Index is determined with survey studies, arranged to cover small and medium-sized businesses which constitute a large part of the private sector, and focused on various criteria and measures applied to businesses (Koç , Kaya, & Şenel, 2017).

The study involves 33 countries in total with 28 European Union member countries and 5 candidates. The study uses scores varying between 1 and 100 for the 10 indices that make up the Ease of Doing Business Index. A brief summary of these indices are as follows: Starting a Business index measures the days and cost spent for completing the procedures which an entrepreneur is required to accomplish to start a business. Dealing with Construction Permits Index shows the procedures required to build a simple merchandise warehouse in the largest trading city in the country and measures the days and cost spent to accomplish these procedures. Getting Electricity Index considers the procedures a local business need to go through to get electricity and the days spent and cost to accomplish these

procedures. Registering Property Index considers all the procedures that a company needs to accomplish to take ownership of another company. Getting Credit Index considers sharing of credit information of borrowers and lenders and their legal rights. Protecting Minority Investors Index considers the level of protection minority investors get against executives who attempt to use the company to their own interest. Paying Taxes Index shows the administrative burden on the company caused by taxes that medium-sized business are required to pay or by taxes that they pay. Trading Across Borders Index shows the documents required for exporting or importing goods through sea transportation and the duration and cost of all the transportation procedures. Enforcing Contracts Index evaluates how active judiciary in domestic courts are at resolving a trade case. Resolving Insolvency Index evaluates the duration, cost and result of liquidation of domestic assets (Akses, 2011).

2.2 Fuzzy Clustering

Fuzzy Clustering Method is described as the generalized form of k-means and medoids clustering methods which are both non-hierarchical clustering methods. Fuzzy Clustering Method is a method that is based on separating n units into k clustering without forcing those units to enter into a cluster and letting them be divergent units (Özdamar, 2004). In conventional clustering methods, units are certainly assigned to a cluster. However, in the fuzzy clustering method, it is required to calculate the membership coefficient and membership probability of units to different clusters. In clustering analysis, how the units belong to a cluster is considered in three different cases as absolute, fuzzy, and probabilistic. In absolute clustering, units either belong or do not belong to a cluster. In fuzzy clustering, units may belong to several clusters at the same time. In probabilistic clustering, a unit either belongs to a cluster or not, however the assignment of a unit to a cluster depends on the distribution of probability (Alptekin & Yeşilaydın, 2015). The certainty in conventional clustering approaches sometimes causes erroneous results. When there are units of observation equidistant to each homogeneous cluster, it is unclear which unit will be assigned to which cluster. This is the case where the concept of probability of membership to clusters becomes crucial (Bülbül & Camkıran, 2018). As fuzzy clustering method enables membership through degree of membership to clusters, it gives stronger and more natural results than conventional methods in many cases (Cebeci & Yıldız, 2015). Fuzzy clustering provides more detailed information about the data. It is however difficult to summarize and classify information when there are too many units and clusters, as there would be too many outputs (Zorlutuna & Erilli, 2018).

The most commonly used method in fuzzy clustering is fuzzy c-means clustering algorithm proposed by Bezdek and Hathaway (1987) and developed by Kaufman and Rousseeuw (1990). This algorithm aims to minimize the cost function calculated using distances and cluster memberships. The cost function is shown in Equation 1.

$$J = (U, c_1, \cdots, c_c) = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^{m} \, d_{ij}^{2} \qquad (1)$$

In Equation 1, U is the Membership Matrix composed of u_{ij}, membership probabilities. Membership probabilities take on values between 0 and 1, and the sum of membership probabilities of each unit is equal to 1. c_i is the cluster center of fuzzy group i; and d_{ij} is the Euclidean distance between the i^{th} cluster center and the j^{th} data point and m is a weighting exponent. The essential conditions for equation 1 to reach its minimum are;

$$c_i = \frac{\sum_{j=1}^{n} u_{ij}^{m} x_j}{\sum_{j=1}^{n} u_{ij}^{m}} \quad (2)$$

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{d_{ij}}{d_{kj}} \right)^{2/(n-1)}} \quad (3)$$

Fuzzy c-means algorithm involves 4 steps. The first step is initializing the membership matrix *U* with arbitrary values between 0 and 1. The second step is finding cluster centers using Equation 2. The third step is to calculate the cost function using Equation 1. Stop if either it is below a certain acceptance value or its improvement over previous iterations below a certain threshold. The last step is to form the *U* matrix using Equation 3 and returning to the second step (Saravananathan & Velmurugan, 2018). Since the result of this algorithm depends on the randomly generated values in the beginning, various algorithm have been and is currently being developed to eliminate problems that arise due to randomness (Zorlutuna & Erilli, 2018).

As the k-means method does, the Fuzzy clustering method requires the number of clusters to be determined. The researcher can decide on the number of clusters through his/her own experiences and through trial and error. However, since this may cause quite subjective results, there are some techniques developed. These techniques are named as Cluster Validity Indices. Cluster Validity Indices are generally grouped into two. The first group includes indices in which only membership values are used, and the second group includes indices in which membership values, cluster centers and data are used (Wang & Zhang, 2007). The most commonly used indices of the first group are Partition Coefficient and Partition Entropy indices developed by Bezdek (1974), and Modified Partition Coefficient Indices developed by Dave (1996). The most commonly used and modified indices in the second group are Kwon Index (1998) and Zhang Index (2007) (Joopudi, Rathi, Narasimhan, & Rengaswamy, 2013). There are many other indices. Cluster validity is an open-ended concept and can be formulized in different ways for special conditions in datasets. Hence, it is very difficult to decide on cluster validity (Cebeci & Yıldız, 2015). Consequently, no validity index yields absolute results and new indices are still being developed.

3. RESULTS

It is necessary to decide on the appropriate cluster number before implementation. There are many validity indices in literature to decide on the number of clusters. However, the concept of cluster validity is open-ended and it can be formulized in different ways for special conditions in the dataset. For this reason, it can be quite difficult to decide on cluster validity and hence the number of clusters (Cebeci & Yıldız, 2015). In this study, the cases in which there are 2 and 4 clusters are examined to decide on the number of clusters. The validity indices shown in Table 4 worsen with 3 clusters, and some indices are not calculated in case of 4 clusters. Consequently, the case of 2 clusters is found to be optimal and the results are examined. All analyses in the study are carried out using RStudio. The packages used in the study are "ppclust", "factoextra", "cluster" and "fclust".

Table 2 shows the clustering analysis results based on fuzzy c-means method in case of 2 clusters.

Table 2: Cluster Memberships

Country	Cluster 1 Membership Degree	Cluster 2 Membership Degree	Cluster Membership
Germany	0.6739576	0.3260424	1
Austria	0.7834724	0.2165276	1
Belgium	0.4735804	0.5264196	2
United Kingdom	0.6739508	0.3260492	1
Bulgaria	0.2608009	0.7391991	2
Czech Republic	0.6222572	0.3777428	1
Denmark	0.6781759	0.3218241	1
Estonia	0.517897	0.482103	1
Finland	0.7367072	0.2632928	1
France	0.6850069	0.3149931	1
Croatia	0.385173	0.614827	2
Netherlands	0.7150914	0.2849086	1
Ireland	0.6158471	0.3841529	1
Spain	0.805746	0.194254	1
Sweden	0.7567187	0.2432813	1
Italy	0.5968904	0.4031096	1
Cyprus	0.5141135	0.4858865	1
Latvia	0.4086321	0.5913679	2
Lithuania	0.4681258	0.5318742	2
Luxembourg	0.5073412	0.4926588	1
Hungary	0.2779769	0.7220231	2
Malta	0.4270792	0.5729208	2
Poland	0.5207725	0.4792275	1
Portugal	0.7749255	0.2250745	1
Romania	0.3026172	0.6973828	2
Slovak Republic	0.483343	0.516657	2
Slovenia	0.7037649	0.2962351	1
Greece	0.4160841	0.5839159	2
Albania	0.3480573	0.6519427	2
Montenegro	0.3026519	0.6973481	2
Macedonia	0.4929234	0.5070766	2
Serbia	0.2632617	0.7367383	2
Turkey	0.3253086	0.6746914	2

Examining Table 2, it is seen that 18 countries are in Cluster 1 and 15 countries are in Cluster 2. The countries are assigned to the cluster to which they have high membership degrees. Table 3 is created to better investigate the structure of the clusters.

Table 3: Final Cluster Prototype

	Starting a Business	Dealing With Construction Permits	Getting Electricity	Registring Property	Getting Credit	Protecting Minority Investors	Paying Taxes	Trading across Borders	Enforcing Contracts	Resolving İnsolvency
Cluster 1	90.13	73.88	85.55	75.50	59.91	64.18	83.27	97.25	66.35	75.32
Cluster 2	88.96	71.99	74.61	72.08	66.02	62.88	78.62	96.28	66.18	62.90

Investigating Table 3, it is observed that all variables except Getting Credit variable are highest in Cluster 1. Hence, it can be stated that the first cluster involves the countries which are best in terms of ease of doing business. Some cluster validity indices used to decide on the number of clusters in the beginning of the study are shown in Table 4. Since two clusters are preferred in the study, only results of those two clusters are shown.

Table 4: Cluster Validity Indices

Dunn's Fuzziness Coefficient	0.5578421
Partition Entropy	0.6330237
Partition Coefficient	0.5578421
Modified Partition Coefficient	0.1156842
Fuzzy Silhouette Index	0.416637

The validity indices shown in Table 4 are the most common validity indices used in fuzzy c-means cluster algorithm. The validity indices are found using the "fclust" package. Validity indices are generally used to decide on the number of clusters. But, they cannot provide a solid information about whether there is a good clustering or not. Dunn's Fuzziness Coefficient is a coefficient that shows how

close the existing clustering is to a strong clustering with the cluster number determined. It is desired to have this coefficient close to 1 (Özdamar, 2004). Partition Coefficient Index is calculated using the matrix of clustering degrees (U) and it is desired to be maximum. Modified Partition Coefficient Index is a linear transformation of the Partition Coefficient and takes values between 0 and 1. Partition Entropy Index is again calculated using the matrix U and it is desired to be minimum. Fuzzy Silhouette Index is a more developed index compared to the other indices and uses more information. This value is desired to be maximum (Ferraro & Giordani, 2015). As a result, many of the indices in Table 4 cannot be an evidence for good clustering. However, the existing number is calculated to be the best among other cluster numbers. As explained in the theoretical section, no validity index yields absolute results and hence the developments on these indices are still ongoing.

4. CONCLUSIONS

In this globalized world, people prefer places where they can easily carry out their business rather than places where they live. The more problems people face when starting a business in a country, the less entrepreneurial attempts the citizens of that country undertake. This also causes less people to come to the country from other countries to start a business, resulting in economic problems for the country in question. The most significant remedy for the recent crisis that affected the whole world is the support for entrepreneurship and starting business. People make use of certain indicators to decide on the country that they are going to start a business. The Ease of Doing Business Index prepared by the World Bank and International Finance Corporation is the most commonly used indicator in this context. Countries can examine their situation based on this index and also view their position among other countries to make relevant policies. This study classifies the European Union member and candidate countries according to the Ease of Doing Business Index data using fuzzy clustering analysis. Two clusters were formed in the study. The first cluster included 18 countries, while the second included 15. Examining the profiles of the clusters, the first cluster is the one in which all variables except the variable for getting credit are the highest. In relation to income status, it is seen that the first cluster involves countries that have high income. On the other hand, the second cluster involves all the middle-income countries and also high-income countries. Moreover, the 5 candidate countries are also in the second cluster. According to the rankings based on Ease of Doing Business Index, many countries in the first cluster are among the highest ranked countries. As a country that is exception to this situation, Macedonia is ranked third in the Starting a Business Index although it is in the second cluster, and it is ranked 10^{th} among all countries in the world. As is known, fuzzy clustering analysis involves calculating cluster membership degrees. The units are assigned to the cluster to which they have the highest membership probability. Consequently, when probabilities are too close to each other, units are assigned as member to a cluster with a very little probability difference. The cluster membership degree of Macedonia is 0,4929 for the first cluster and 0,5070 for the second cluster. Macedonia is assigned to the second cluster due to a very small difference. Since fuzzy clustering analysis allows for overlapping clusters, this country may also be considered as a member of the first cluster. Similarly, Lithuania is ranked fifth in the Ease of Doing Business Index rankings and 14^{th} among all the countries in the world, although it is a member of the second cluster. Here, it is speculated that the reason that it is in the second cluster is that its Resolving Insolvency variable is at a low level. Finally, Latvia is ranked eighth in the Ease of Doing Business Index rankings and 19^{th} among all the countries in the world, although it is a member of the second cluster. And the reason for this is thought to be the low levels of Protecting Minority Investors and Resolving Insolvency variables. It is observed that the countries that are in lower places in the ranking by Ease of Doing Business Index are mostly in the

second cluster. Only Italy, Cyprus, and Luxembourg are in the first cluster even though they are ranked lower. Cyprus and Luxembourg are observed to have very similar cluster membership degrees. Here, the situation of Italy is striking. Italy is ranked 24th in the Ease of Doing Business Index rankings and 51st among all the countries in the world, although it is a member of the first cluster. Examining the variables, it is observed that Italy could be in the second cluster, but it also has very high levels in terms of the Trading Across Borders variables (Bezdek J. , 1974).

The European Union member and candidate countries are in the first 66 worldwide, however Greece is ranked 72nd and Malta is 84th. Consequently, these countries are considered to be at higher ranks in terms of Ease of Doing Business. It is believed that the policies and regulations the European Union follows during this process of doing business is effective on this high ranks. It is thought that the candidate countries endeavor to adapt to these policies and regulations in order to be a member. In this case, the candidate countries achieve better places at the Ease of Doing Business Index rankings.

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