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Clustering of Developing Countries in Terms of Logistics Market Development with Fuzzy Clustering and Discriminant Analysis

Gelişmekte Olan Ülkelerin Lojistik Pazar Gelişimi Bakımından Bulanık Kümeleme ve Diskriminant Analizleriyle Kümelenmesi

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Abstract: Logistics performance indicators are important in determining the market development levels of countries. Especially the logistics markets of developing countries play an active role in increasing the country's economy and trade volumes. In this research, it is aimed to cluster the developing countries according to their level of logistics market development in 2022. For this reason, fuzzy clustering and discriminant analyzes have been applied in the research. The sample area of the study consists of 50 developing countries. The data of the research have been taken from "The Agility Emerging Markets Logistics Index" reports. The research has been carried out in two phases. In the first phase, developing countries are classified by fuzzy cluster analysis. According to the analysis findings, 2 clusters have been obtained as high and low logistics market development cluster. In the second phase, discriminant analysis has been conducted to test the cluster membership of clustered countries. According to the discriminant analysis findings, all cluster memberships have been confirmed. As a result of the research, the cluster membership status of the developing countries and cluster centers according to the variables have been determined and the obtained implications have been presented.

Keywords: Logistics Market Performance, Fuzzy Cluster Analysis, Discriminant Analysis, Developing Countries

JEL Classification: C38, O11, M00

Öz: Ülkelerin pazar gelişmişlik düzeylerinin belirlenmesinde lojistik performans göstergeleri önem arz etmektedir. Özellikle gelişmekte olan ülkelerin lojistik pazarları ülke ekonomi ve ticari faaliyet hacimlerinin artmasında etkin rol oynamaktadır. Bu araştırmada gelişmekte olan ülkelerin 2022 yılı lojistik pazar gelişmişlik düzeylerine göre kümelenmesi amaçlanmıştır. Bu nedenle araştırmada bulanık kümeleme ve diskriminant analizleri uygulanmıştır. Araştırmanın örneklem alanını 50 gelişmekte olan ülke oluşturmaktadır. Araştırmaya ait veriler "The Agility Emerging Markets Logistics Index" raporlarından alınmıştır. Araştırma iki safhada gerçekleştirilmiştir. Birinci safhada gelişmekte olan ülkeler bulanık kümeleme analiziyle sınıflandırılmıştır. Analiz bulgularına göre yüksek ve düşük lojistik pazar gelişmişlik kümesi olmak üzere 2 küme elde edilmiştir. Araştırmanın ikinci safhasında kümelenmiş ülkelerin küme üyeliklerinin test edilmesi amacıyla diskriminant analizi yapılmıştır. Diskriminant analizi bulgularına göre küme üyeliklerinin tamamı doğrulanmıştır. Araştırma sonucunda ülkelerin küme üyelik durumları, değişkenlere göre küme merkezleri tespit edilmiş ve elde edilen çıkarımlar paylaşılmıştır.

Anahtar Sözcükler: Lojistik Pazar Performansı, Bulanık Kümeleme Analizi, Diskriminant Analizi, Gelişmekte Olan Ülkeler

JEL Sınıflandırması: C38, O11, M00

1. Introduction

Logistics activities play a decisive role in international market competition conditions (Ekici et al., 2019). Countries are making efforts to improve their logistics performance by improving their logistics capabilities and digital capacities (Moldabekova et al., 2021).

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Especially, developing countries should focus on improving their logistics infrastructures to make their national markets attractive and provide economic development (Li et al., 2018). Developing countries need to know their current logistics performance to identify obstacles to the development of their logistics infrastructure and performance. There are studies in the literature to determine the logistics performance of countries. The logistics performance index (LPI) was developed by the World Bank to determine the logistics performance of countries. The logistics market performance of developing countries is published by The Agility Emerging Markets Logistics Index (AEMLI).

AEMLI bases the logistics market development of developing countries on four key factors. These factors are domestic logistics opportunities, international logistics opportunities, business fundamentals and digital readiness (AEMLI, 2022). While determining Domestic logistics opportunities, the urbanization, economy, population, business clustering, logistics market size and development of the country are taken into consideration. The country's customs procedures, connection infrastructures, logistics-intensive trade and market sizes are used in the determination of international logistics opportunities. In determining business fundamentals, economic indicators such as inflation, credibility, business environment and market accessibility are used. Digital capabilities, digital business models and indicators that affect digitalization are used to determine Digital Readiness.

According to AEMLI reports, differences in the logistics performance of developing countries can be observed. However, grouping of developing countries based on logistics performance sub-factors is not done. Knowing which group the countries are in from the developing countries in terms of logistics can provide benefits for countries in creating comparison and logistics development models. In addition, this information will be able to create awareness in terms of logistics of multinational enterprises operating in the market of developing countries. The aim of this research is to cluster the developing countries in terms of logistics market development. For this purpose, two research questions have been developed.

Research Question 1: Is it possible to cluster the logistics market performances of developing countries with the fuzzy clustering method?

Research Question 2: Can fuzzy cluster analysis findings be confirmed by discriminant analysis?

To find answers to the research questions identified above, in the second part of the research, a literature review of cluster analysis based on the logistics performance of the

countries has been made. In the third part, the variables used in the research, the sample area and the methodology are presented. In the fourth part, fuzzy clustering and discriminant analysis findings are given. In the fifth part, conclusions and implications based on the findings are given.

2. Literature Review

The indexes have been developed to determine the national logistics success, considering the logistics capabilities and logistics performances of the countries. LPI comes first among these indexes. LPI determines the logistics performance of countries and reveals the opportunities and obstacles that countries have in terms of logistics. It also helps to compare the logistics performance of countries. AEMLI deals with the markets of developing countries from a logistics perspective. AEMLI considers the logistics performance of countries depending on domestic and international opportunities, the level of openness of the market to foreign markets and the level of digitalization of trade. In addition, there are efforts to develop logistics performance indexes in the literature (Beysenbaev and Dus, 2020).

In the literature, there are studies dealing with the relationship between the logistics performance and trade (Martí et al., 2014a; Martí et al., 2014b; Puertas et al., 2014; Wang and Choi, 2018). These studies clearly show that logistics performance plays an important role in trade activities. Martí et al. (2014a) examined the relationship between LPI sub-factors and trade with the gravity model approach and concluded that the logistics performances of countries affected trade significantly. Puertas et al. (2014) explained the relationship between the logistics performances of countries and exports with the gravity model approach and argued that the logistics performance of exporting countries should be high. Martí et al (2014b) demonstrated the importance of logistics performance in facilitating trade. Wang and Choi (2018) determined that logistics performance is effective in increasing the volume of exports and imports with the panel data analysis method. Beysenbaev (2018) showed the logistics performances among the key factors that cause fluctuations in the trade volumes of the countries.

Clustering analyzes based on the logistics performance of the countries are useful in determining the countries that are close to each other. Thus, by identifying the differences between country groups, it creates awareness both in the execution of commercial activities and in determining the deficiencies of the logistics performances of the countries. Roy et al. (2018) clustered 129 countries according to LPI data. According to the K-means cluster analysis, a total of 5 clusters were obtained in the study. Polat et al. (2022) classified 150 countries according to their carbon dioxide emissions and the efficiency levels of their

logistics performances. In the research, countries are divided into 3 clusters. Using LPI data, Alyoubi (2021) divided the countries into 3 classes with K-means cluster analysis. In addition, the logistics performances of the Kingdom of Saudi Arabia and neighboring countries were compared. Burmaoğlu and Sesen (2011) grouped 133 countries with global competitiveness index data by clustering and discriminant analysis. They also clustered 121 countries using LPI. As a result of both clustering analyzes, 2 clusters were obtained. Kálmán and Tóth (2021) conducted a cluster analysis of 160 countries, considering logistics and competitiveness levels. As a result of the research, they obtained a total of 3 clusters as low, medium, and high logistics and competitiveness. Aboul-Dahab and Ibrahim (2020), who made cluster analysis with 19 Arab countries, used logistics performance and GDP variables. In the research, it has been determined that Arab countries are divided into 3 clusters. Anuşlu and Fırat (2019) used LPI as well as the Enviromental performance index, Sustainable development goals index and Global innovation index data to cluster 116 countries according to Industry 4.0. They determined that the countries were divided into 3 clusters. In the sample area of Brazil's 39 possible competitor countries, Faria et al. (2015) performed clustering analysis with the LPI variable. It was determined that the countries were divided into 3 clusters as high logistics performance group, medium logistics performance group and low logistics performance group. Eren and Ömürbek (2021) subjected OECD countries to cluster analysis according to LPI. OECD countries are divided into 4 clusters. Danacı and Nacar (2017) performed a clustering analysis with import, export and LPI scores of 28 European Union countries and Turkey. A total of 5 clusters were obtained. In the literature, the studies in which clustering analysis was applied by considering the logistics performances of the countries are shown in the Table 1.

Table 1. Logistics Performance and Cluster Analysis Literature Review

Authors	*Variables*	*Sampling*	*Number of Cluster*
Burmaoglu and Sesen (2011)	GCI	133 Countries	2 Cluster
	LPI	121 Countries	2 Cluster
Faria et al. (2015)	LPI	39 Countries	3 Cluster
Danacı and Nacar (2017)	Import, Export and LPI	28 Countries	5 Cluster
Roy et al. (2018)	LPI	129 Countries	5 Cluster
Anuşlu and Fırat (2019)	LPI, EPI, SDGI and GII	116 Countries	3 Cluster
Aboul-Dahab ve Ibrahim (2020)	GDP and LPI	19 Countries	3 Cluster
Kálmán and Tóth (2021)	GCI and LPI	160 Countries	3 Cluster
Eren and Ömurbek (2021)	LPI	37 Countries	4 Cluster
Alyoubi (2021)	LPI	160 Countries	3 Cluster
Polat et al. (2022)	LPI and CO_2 Emission	150 Countries	3 Cluster

Notes: LPI: Logistics Performance Index, GCI: Global Competitiveness Index, EPI: Environmental Performance Index, SDGI: Sustainable Development Goal Index, GII: Global Innovation Index, GDP: Gross domestic product, CO_2 Emission: Carbon Dioxide Emissions

3. Methodology

3.1. Variables and Sampling

In this research, it is aimed to cluster the developing countries according to the logistics market development of 2022. In this context, it is aimed to apply fuzzy clustering and discriminant analysis. There are 4 basic variables in the evaluation of the logistics market development level of developing countries. These variables are domestic logistics opportunities (DLO), international logistics opportunities (ILO), business fundamentals (BF), and digital readiness (DR) (AEMLI, 2022). The DLO reflects the development level of the developing countries' internal logistics market. The ILO reflects the level of international logistics market development of developing countries. BF refers to the business environment, market independence and rule of law levels of developing country markets. DR, on the other hand, explains the digitally led, innovation-oriented and skills rich levels of developing countries (Kara, 2022).

The sample area of this empirical research consists of 50 developing countries. Data for developing countries were obtained from the AEMLI 2022 report. AEMLI 2022 data is presented in Appendix 1. The variables used in fuzzy clustering analysis and discriminant analysis and the information about the sample area are shown in the Table 2.

Table 2. Variables and Sampling

Analysis	*Independent Variables*	*Sampling*	*Period*
Fuzzy Cluster Analysis	Domestic Logistics Opportunities, International Logistics Opportunities, Business Fundamentals, Digital Readiness	50 Countries	2022
Discriminant Analysis	Domestic Logistics Opportunities, International Logistics Opportunities, Business Fundamentals, Digital Readiness	50 Countries	2022

3.2. Fuzzy Cluster Analysis

Clustering analyzes are based on grouping similar data in the data set (Hartigan, 1975). The main purpose of cluster analysis is to ensure that the distance between the data in the cluster is at the minimum distance and the distance between the clusters is at the maximum distance (Liao, 2005). In the literature, clustering analyzes are divided into hierarchical and partitioning techniques (Saxena et al., 2017). Single-linkage clustering, Complete-linkage clustering, Average-linkage clustering, and enhanced hierarchical clustering (BIRCH, CURE,

ROCK, CHAMELEON) techniques are included in hierarchical clustering. Fuzzy c-means clustering, and k-means clustering are among Partition clustering methods.

Euclidean distance or Manhattan distance calculations are used to determine the distances between objects in cluster analysis. Euclidean distance was used in this study. Eq. (3.1) is used to calculate the Euclidean distance. Eq. (3.2) is used in the calculation of δ_{ijk}, since the objects are interval variable.

$$d_{jk} = \sqrt{\frac{\sum_{i=1}^{p} \delta_{ijk}^2}{P}} \tag{3.1}$$

$$\delta_{ijk} = z_{ij} - z_{ik} \tag{3.2}$$

Unlike other cluster analyses, fuzzy set analysis does not directly accept objects as a set element. Instead, it calculates the probability of each object being found in all determined clusters (Arı and Yıldız, 2018). The basic condition is that the sum of the probabilities equal "1" (Şahin and Hamarat, 2002). Trauwaert et al., (1991) expressed the fuzzy clustering algorithm as Eq. (3.3).

$$Min\ C = \sum_{k=1}^{K} \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} m_{ik}^2 m_{jk}^2 d_{ij}}{2 \sum_{j=1}^{N} m_{jk}^2} \tag{3.3}$$

K = total number of clusters;

d_{ij} = the distance between i and j units.

m_{ik} = unknown membership of unit i to set k.

m_{jk} = unknown membership of unit j to set k.

$m_{jk} \geq 0\ and\ \sum_{k=1}^{K} m_{ik} = 1; i: 1, \dots, n\ and\ k: 1, \dots, K$

where m_{ik} represents the unknown membership of the object *i* in cluster *k* and d_{ij} is the dissimilarity between objects *i* and *j*.

Dunn's partition coefficient F(U)", "Normalized Dunn's partition coefficient Fc(U)", "Kaufman partition coefficient D(U)" and "Normalized fman partition coefficient Dc(U)" calculations are considered in determining the number of clusters in fuzzy clustering analysis. The calculation of F(U) is shown in Eq. (3.4). The calculation of Fc(U) is shown in Eq. (3.5). D(U) is shown Eq. (3.6). The calculation of Dc(U) is shown in Eq. (3.7). The highest Fc(U) and lowest Dc(U) should be considered in determining the most accurate number of clusters.

$$F(U) = \frac{1}{N} \sum_{k=1}^{K} \sum_{i=1}^{N} m_{ik}^2 \tag{3.4}$$

$$Fc(U) = \frac{F(U) - (1/K)}{1 - (1/K)} \tag{3.5}$$

$$D(U) = \frac{1}{N} \sum_{k=1}^{K} \sum_{i=1}^{N} (m_{ik} - s_{ik})^2 \tag{3.6}$$

$$Dc(U) = \frac{D(U)}{1 - (1/K)} \tag{3.7}$$

In the calculation of D(U), calculations called "silhouettes" are used (Kaufman and Rousseeuw, 1990). Eq (3.8) is used in the calculation of Silhouettes (s_i). Eq. (3.9) is used in a_i and b_i calculations.

$$s_i = \frac{b_i - a_i}{\max(a_i, b_i)} \tag{3.8}$$

$$a_i = \frac{1}{n}\sum_{j=1}^{n} d_{ij} \; ; n \in A \text{ and } b_i = \frac{1}{n}\sum_{j=1}^{n} d_{ij} \; ; n \in B \tag{3.9}$$

Compute the silhouette s_i as follows:

If the number of elements of the set A is n=1 then s=0;

If $a_i < b_i$ then $s_i = 1 - a_i/b_i$

If $a_i > b_i$ then $s_i = b_i/a_i - 1$

If $a_i = b_i$ then $s_i = 0$

The shadow statistic s_i takes values between +1 and -1. If this value approaches +1, the units are clustered correctly, and if it approaches 0, it represents the unstable structure that emerges in the clustering. While this value is expected to be greater than 0.50 in determining the appropriate cluster structure; A silhouette value close to -1 indicates incorrect clustering (Yılancı, 2010; Arı and Yıldız, 2018).

3.3. Discriminant Analysis

Discriminant analysis is used to estimate group membership of objects. If the total number of N objects, K clusters and the total number of objects belonging to each cluster ((N_k) is known.

The i^{th} observation is represented by X_{ki},

M represent the vector of means of these variables across all groups,

M_k The vector of means of observations in the k^{th} group.

Calculations of S_T in Eq. (3.10), S_W in Eq. (3.11), and S_A in Eq. (3.12) are presented:

$$S_T = \sum_{k=1}^{K}\sum_{i=1}^{N_k}(X_{ki} - M)\,(X_{ki} - M)' \tag{3.10}$$

$$S_W = \sum_{k=1}^{K}\sum_{i=1}^{N_k}(X_{ki} - M_k)\,(X_{ki} - M_k)' \tag{3.11}$$

$$S_A = S_T - S_W \tag{3.12}$$

Wilks' lambda (A goodness-of-fit parameter) is defined as Eq. (3.13).

$$\Lambda = \frac{|S_W|}{|S_T|} = \prod_{j=1}^{m}\frac{1}{1+\lambda_j} \tag{3.13}$$

The canonical correlation (r_{cj}) is defined as Eq. (3.14).

$$r_{cj} = \sqrt{\frac{\lambda_j}{1+\lambda_j}} \tag{3.14}$$

The overall covariance matrix (T) is defined as Eq. (3.15).

$$T = \left(\frac{1}{N-1}\right) S_T \quad (3.15)$$

The within-group covariance matrix (W) is defined as Eq. (3.16).

$$W = \left(\frac{1}{N-K}\right) S_W \quad (3.16)$$

The among-group (or between-group) covariance matrix (A) is defined as Eq. (3.17).

$$A = \left(\frac{1}{K-1}\right) S_A \quad (3.17)$$

The linear discriminant functions are defined as Eq. (3.18).

$$LDF_k = W^{-1} M_k \quad (3.18)$$

The standardized canonical coefficients are defined as Eq. (3.19).

$$V_{ij}\sqrt{w_{ij}}\ ,\ v_{ij} \epsilon\ V, w_{ij} \epsilon\ W, \quad (3.19)$$

The correlations between the independent variables and the canonical variates are defined as Eq. (3.20).

$$Corr_{jk} = \frac{1}{\sqrt{w_{ij}}} \sum_{i=1}^{p} v_{ik}\ w_{ij} \quad (3.20)$$

Tabachnick et al. (2007) explained that unequal group size and missing data, multivariate normality and outliers, homogeneity of covariance matrices, linearity, multicollinearity, and singularity should be checked in discriminant analysis.

4. Empirical Findings

4.1. Fuzzy Cluster Analysis Findings

Fuzzy cluster analysis was performed with the NCSS 2022 package program. Variables of fuzzy cluster analysis are Domestic Logistics Opportunities, International Logistics Opportunities, Business Fundamentals and Digital Readiness. Distance type is Euclidean. The fuzzy clustering analysis findings in terms of market development of developing countries are shown in Table 3. When Table 3 is examined, the number of clusters with the highest Fc(U) value and the lowest Dc(U) value is 2. For this reason, it has been accepted that developing countries are divided into two clusters in terms of logistics market development. Membership summary for clusters and probabilities of countries for clusters are in Appendix 2.

Table 3. Fuzzy Clustering Analysis Findings of Developing Countries

Number Clusters	*Average Distance*	*Average Silhouette*	$F(U)$	$Fc(U)$	$D(U)$	$Dc(U)$
2	19.412884	0.408846	0.5701	**0.1403**	0.2209	**0.4418**
3	12.927109	0.136847	0.3770	0.0655	0.4731	0.7096
4	9.637860	0.247422	0.3534	0.1379	0.4094	0.5459
5	7.555266	0.213134	0.2864	0.1080	0.5486	0.6857

As a finding of the fuzzy cluster analysis, the clusters and the countries included in the clusters are shown in Table 4. There are 21 countries in Cluster 1 and 29 countries in Cluster 2. Among the countries included in Cluster 1, the 3 countries with the highest probability of being in the cluster are Chile, Oman, and Turkey. Among the countries included in Cluster 2, the 3 countries with the highest probability of being in the cluster are Lebanon, Cambodia, and Paraguay.

The cluster centers of the variables used in the formation of Cluster 1 and Cluster 2 are given in the Table 5. The country at the cluster center of Cluster 1 is Chile. The country at the cluster center of Cluster 2 is Lebanon. When the cluster centers of the variables are compared, It was concluded that Cluster 1 was more successful than Cluster 2 in all variables. It has been understood that the developing countries in Cluster 1 have higher development than Cluster 2 in terms of domestic logistics opportunities, international logistics opportunities, business fundamentals and digital readiness variables, which are the sub-factors of logistics market development. The greatest distance between the clusters is in the digital readiness variable. At this point, the biggest difference between the two clusters in terms of logistics market development is the digital readiness levels of the countries. In addition, the smallest distance between clusters is in the domestic logistics opportunities variable. At this point, the smallest difference between the two clusters in terms of logistics market development is the domestic logistics opportunities levels of the countries.

Table 4. Clustering of Developing Countries in Terms of Logistics Market Development

Cluster 1	*Cluster 2*
Chile (%73,88), Oman (%72,85), Turkey (%72,73), Thailand (%70,57), Kuwait (%70,52), Qatar (%69,66), Bahrain (%69,62), Russia (%69,34), Saudi Arabia (%69,11), Indonesia (%68,54), Jordan (%68,47), Malaysia (%68,05), Vietnam (%67,18), Kazakhstan (%63,88), Uruguay (%63,66), UAE (%62,91), Morocco (%62,25), Mexico (%60,55), India (%60,51), China (%57,69), Egypt (%54,81),	Lebanon (%79,78), Cambodia (%79,17), c (%79,04), Uganda (%77,42), Sri Lanka (%75,54), Bangladesh (%75,07), Argentina (%74,11), Ukraine (%73,95), Nigeria (%72,41), Tanzania (%71,73), Ecuador (%71,33), Peru (%71,28), Ethiopia (%70,95), Pakistan (%70,38), Bolivia (%70,03), Colombia (%69,77), Iran (%67,68), Ghana (%67.51), Tunisia (%67,41), Algeria (%67,06), Mozambique (%63,54), Angola (%62,48), Venezuela (%61,25), Myanmar (%60,47), Libya (%58,91), Brazil (%56,12), Kenya (%55,88), South Africa (%55,43), Philippines (%50,67),

Note: The probability percentages of countries belonging to the cluster are shown in parentheses.

Table 5. Cluster Centers of Variables

Variables	*Cluster 1*	*Cluster 2*
Domestic Logistics Opportunities	4.87	4.76
International Logistics Opportunities	5.17	4.6
Business Fundamentals	7.17	4.13
Digital Readiness	6.14	4.33
Country	Chile	Lebanon

4.2. Fuzzy Cluster Analysis Findings

Discriminant analysis was carried out due to the validation of the number of clusters obtained by fuzzy clustering analysis and the status of belonging to the clusters of objects. Discriminant analysis was performed with the NCSS 2022 package program according to the steps suggested by Tabachnick et al. (2007). Group means and standard deviations of the variables are shown in the Table 6.

Between-Group Correlation\Covariance, Within-Group Correlation\Covariance and Total Correlation\Covariance values of the variables are shown in the Table 7.

The effect of independent variables on discriminant analysis is shown in the Table 8. All variables are significant at the 0.05 level. Since R-Squared Other X's values are below 0.99, there are no multicollinearity problems.

Linear discriminant function coefficients and the regression coefficients are shown in Table 9. In addition, the clustering estimation percentages of each country are shown in Appendix 3.

The canonical correlation analysis results of the discriminant analysis are shown in Table 10. Canonical correlation analysis level is significant at the 0.05 level. Countries are shown in Linear Discriminant Scores, Regression Scores, and Canonical Scores Appendix 4. It is also shown in the Linear Discriminant Scores Plots, Regression Scores Plots and Canonical Scores Plots Appendix 5 of the countries.

The results determined by fuzzy cluster analysis were tested with discriminant analysis. According to the discriminant analysis findings, the fuzzy clustering analysis findings were 100% confirmed. Fuzzy clustering and discriminant results are compared in the Table 11.

Table 6. Cluster Centers of Variables

Variables	*Group Means*			*Group Standard Deviations*		
	Cluster 1	*Cluster 2*	*Overall*	*Cluster 1*	*Cluster 2*	*Overall*
DLO	5.472857	4.657931	5.0002	1.017109	0.3080628	0.8009726
ILO	5.606667	4.471724	4.9484	1.194325	0.5611981	1.040366
BF	6.641905	3.691724	4.9308	1.082791	1.414613	1.945638
DR	6.044286	4.243104	4.9996	1.014532	1.048203	1.361759

Notes: DLO=Domestic Logistics Opportunities, ILO= International Logistics Opportunities, BF= Business Fundamentals, DR= Digital Readiness

Table 7. Correlation\Covariance Scores of Variables

Variables	*Between-Group Correlation\Covariance*				*Within-Group Correlation\Covariance*				*Total Correlation\Covariance*			
	DLO	*ILO*	*BF*	*DR*	*DLO*	*ILO*	*BF*	*DR*	*DLO*	*ILO*	*BF*	*DR*
DLO	8.08	11.26	29.28	17.87	0.48	0.47	0.11	0.34	0.64	0.69	0.70	0.70
ILO	1.00	15.68	40.78	25.89	0.77	0.77	0.25	0.49	0.83	1.08	1.07	0.98
BF	1.00	1.00	106.01	64.72	0.12	0.22	1.65	0.92	0.45	0.53	3.78	2.22
DR	1.00	1.00	1.00	39.51	0.47	0.53	0.69	1.06	0.64	0.69	0.83	1.85

Table 8. Correlation\Covariance Scores of Variables

Variable	*Lambda*	*F-Value*	*F-Prob*	*R-Squared Other X's*
DLO	0.742693	16.63	0.000170	0.716297
ILO	0.704180	20.16	0.000045	0.746056
BF	0.428489	64.02	0.000000	0.716805
DR	0.565123	36.94	0.000000	0.801624

Table 9. Linear Discriminant Function Coefficients and The Regression Coefficients

Variables	*Linear Discriminant Functions*		*Regression Coefficients*	
	Cluster 1	*Cluster 2*	*Cluster 1*	*Cluster 2*
Constant	-40.20555	-24.74749	-1.052125	2.052125
DLO	11.7731	10.58615	0.1167978	-0.1167978
ILO	-0.4395546	-0.9205015	0.04732605	-0.04732605
BF	4.096679	2.125039	0.194013	-0.194013
DR	-1.45041	-0.8350983	-0.06054785	0.06054785

Table 10. Canonical Correlation Analysis

Fn	*Inv(W)B Eigenvalue*	*Ind'l Pcnt*	*Total Pcnt*	*Canon Corr*	*Canon Corr 2*	*F-Value*	*Numer DF*	*Denom DF*	*Prob Level*	*Wilks' Lambda*
1	1.578712	100.0	100.0	0.7824	0.6122	17.8	4.0	45.0	0.0000	0.387790

Table 11. Comparison of Fuzzy Clustering and Discriminant Analysis Findings

Fuzzy Cluster Analysis			*Discriminant analysis*		
Cluster 1	*Cluster 2*	*Total*	*Cluster 1*	*Cluster 2*	*Total*
21	29	50	21	29	50

5. Results and Discussion

As a result of fuzzy clustering and discriminant analysis, developing countries are divided into 2 clusters according to their logistics market development levels. It has been determined that the first cluster countries are more successful in all sub-factors than the second cluster countries. For this reason, it can be mentioned that the first cluster countries have a high level of market development in terms of logistics. In the classifications made according to different sample groups in the literature, it has been determined that the countries are clustered according to their logistics performance.

In the literature, there are studies that divide countries into two clusters, three clusters, four clusters and five clusters. Burmaoglu and Sesen (2011) clustered 133 countries in two groups, considering logistics performance and competitiveness. Likewise, Kálmán and Tóth (2021), which deals with competitiveness and logistics performances, clustered 160 countries into three groups. Faria et al. (2015) gathered 121 countries in three clusters according to their country logistics performance. In the same way, Alyoubi (2021) clustered 160 countries into three groups. On the other hand, Roy et al. (2018) divided 129 countries into five clusters. Anuşlu and Fırat (2019) clustered countries into three groups according to different variables with logistics performance. Considering logistics performance and economic indicators, Aboul- Dahab and Ibrahim (2020) clustered 19 countries in three groups and Danacı and Nacar (2017) clustered 28 countries in five groups.

Faria (2015) associated cluster groups with logistics performance levels and expressed them as high, medium, and low logistics performance group clusters. In this study, evaluations were made according to the probability of countries belonging to clusters with fuzzy clustering analysis. So, the first cluster is called the high logistics market development cluster and the second cluster is called the low market development cluster. With this approach, it is seen that some countries have high probability of cluster membership and some low probability. The accuracy of cluster membership was tested by discriminant analysis. As a result of the test, 100% success was achieved. Thus, it supports that cluster distribution according to probabilities gives successful results. At this point, the results of the cluster memberships of the countries are as follows:

(i) Egypt, Morocco, and Jordan are in the high logistics market development cluster. But cluster membership probabilities are below 70%. Considering the AEMLI scores, it is lower than other cluster members. In this case, it can be said that these countries are very close to the low logistics market development cluster.

(ii) China, India, Brazil, Malaysia, Indonesia, Saudi Arabia, and Bahrain are in the high logistics market development cluster. But cluster membership probabilities are below 70%. Considering the AEMLI scores, it is higher than other cluster members. In this case, there is a possibility that these countries will leave the high logistics market development cluster and create a very high logistics market development cluster.

(iii) Philippines, South Africa, Kenya, Brazil, and Philippines are in the low logistics market development cluster. But cluster membership probabilities are below 60%. Considering the AEMLI scores, it is higher than other cluster members. In this case, it can be said that these countries are very close to the high logistics market development cluster.

(iv) Libya, Myanmar, Venezuela, Angola, and Mozambique are in the low logistics market development cluster. At the same time, the cluster member probabilities are below 70%. Considering the AEMLI scores, it is lower than other cluster members. At this point, there is a possibility that these countries will leave the low logistics market development cluster and create a very low logistics market development cluster.

Four variables from AEMLI reports were used in fuzzy cluster analysis and discriminant analysis. When the centers of the variables of the clusters are compared, the Cluster 1 center of the domestic logistics opportunities variable is 4.87 and the center of the Cluster 2 is 4.76. Cluster 1 center of international logistics opportunities variable is 5.17, Cluster 2 center is 4.6. Cluster 1 center of business fundamentals variable is 7.17, Cluster 2 center is 4.13. The center of Cluster 1 of the digital readiness variable is 6.14, the center of Cluster 2 is 4.33. The results obtained according to the cluster centers comparisons are as follows:

(i) The variable with the cluster centers furthest away is the business fundamentals variable. This indicates that there are great differences between clusters in regulatory environment, credit and debt dynamics, contract enforcement and anti-corruption frameworks, inflation and price stability, cost of crime and violence, market accessibility and domestic stability. This great distance is clearly observed in the AEMLI scores.

(ii) The variable with the closest cluster centers is the domestic logistics opportunities variable. domestic logistics markets describe slight differences in economy, population, income equality, urbanization, and development of business clusters. This low difference is clearly observed in AEMLI scores.

(iii) Cluster centers of digital readiness and international logistics opportunities variables are more stable than other variables. At this point, expected differences were observed between the clusters in international logistics markets, logistics intensive trade, infrastructure quality and connectedness, border procedures, digital business models and online commerce, digital skills, and human capital.

Finally, considering the 2022 logistics market development levels of developing countries, it is divided into two clusters. However, China, India, Brazil, Malaysia, Indonesia, Saudi Arabia and Bahrain consider that they can be separated from other developing countries with their logistical developments and create a higher successful cluster. In addition, Libya, Myanmar, Venezuela, Angola, and Mozambique consider that if they do not show the expected development in terms of logistics, they can leave other developing countries and form a less successful cluster.

6. Suggestions and Limitations

With fuzzy clustering and discriminant analysis, countries were clustered according to their logistics market performances and suggestions were developed for the developing countries and researchers. Suggestions for countries are: (i) Although Egypt, Morocco, and Jordan are in the high logistics market performance group, membership status is weak. For this reason, these countries need to develop strategies for their logistics market performance levels and increase their cluster membership levels. In this context, macro-level policies should be developed and successfully implemented for the development of AEMLI scores and all sub-indicators. (ii) China, India, Brazil, Malaysia, Indonesia, Saudi Arabia, and Bahrain have high logistics market performance. It is recommended to continue with the current strategies and policies targeting logistics market development. At the same time, it is recommended that they exhibit innovative approaches to maximize their level of logistics market development. (iii) Philippines, South Africa, Kenya, Brazil, and Philippines have the lowest logistics market performance among developing countries. At this point, it is mentioned that the current logistics market strategies are insufficient. It is recommended that they take steps to increase their national and international logistics market opportunities with a change in strategy. (iv) Libya, Myanmar, Venezuela, Angola, and Mozambique are in the lower logistics market performance cluster. Therefore, they should develop strategies to improve their logistics market performance. Logistics opportunities should be created by identifying the strengths and weaknesses of the country, especially in terms of the logistics market.

Suggestions for researchers are: (i) Research can be conducted to identify cluster groups of logistics market performances of developed and underdeveloped countries. (ii) Fuzzy clustering analysis was applied in this study. Hierarchical clustering analyze can be applied with the same data set and the findings can be compared with these research findings. (iii) By considering the number of clusters obtained in this research, the logistics market performances of developing countries can be clustered with non-hierarchical clustering analysis. Cluster belonging statuses can be compared.

There are three limitations in this research. These are: (i) Only developing countries have been evaluated in terms of logistics market development levels. Developed and underdeveloped countries are not included in the research. (ii) Data for developing countries are obtained from the AEMLI 2022 report. Other logistics performance report data were not included in this study. (iii) Only 2022 performances of developing countries have been determined. Performances from previous years were excluded from the research. Finally, the

clustering of developing countries in terms of logistics market performances is brought to the literature.

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APPENDIX

Appendix 1. AEMLI 2022 Data (Raw Data)

Country	*Domestic Logistics Opportunities*	*International Logistics Opportunities*	*Business Fundamentals*	*Digital Readiness*	*Overall Index Score*
China	8.54	9.75	7.06	7.25	8.5
India	8.01	7.23	5.96	6.74	7.21
UAE	5.58	5.73	9.2	8.63	6.72
Malaysia	5.32	5.92	8.19	7.35	6.32
Indonesia	6.34	5.95	5.93	6.47	6.17
Saudi Arabia	5.35	5.51	8.16	7.07	6.14
Qatar	5.79	4.89	7.96	6.52	5.95
Thailand	5.13	6.01	5.82	6.54	5.78
Mexico	5.54	6.4	5.13	5.4	5.74
Turkey	5.28	5.87	5.87	5.96	5.69
Vietnam	5.02	6.01	5.48	5.75	5.55
Chile	4.87	5.17	7.17	6.14	5.55
Russia	5.2	5.67	5.51	5.89	5.53
Oman	4.92	4.89	7.26	5.69	5.41
Bahrain	4.99	4.68	7.3	5.16	5.28
Brazil	5.5	5.43	3.95	5.58	5.25
Kuwait	5.02	4.57	6.18	5.92	5.21
Philippines	5	5.25	4.38	5.99	5.16
Jordan	4.86	4.73	6.7	4.97	5.13
Morocco	4.59	5	6.81	4.34	5.04
Egypt	5.13	4.65	5.51	5	5.01
Kazakhstan	4.67	4.7	6.2	4.93	4.97
Uruguay	4.78	4.41	6.08	5.21	4.93
South Africa	4.69	4.95	5	5.17	4.91
Colombia	4.69	5.02	4.52	4.9	4.81
Peru	4.7	5.1	4.57	4.52	4.79
Pakistan	5.03	4.58	4.33	5.1	4.78
Kenya	4.55	4.61	4.92	5.43	4.78
Ukraine	4.79	4.97	4.46	4.64	4.77
Iran	5.13	4.23	4.3	5.19	4.71
Argentina	4.86	4.61	3.92	5.03	4.66
Ghana	4.57	4.42	4.62	5.14	4.63
Sri Lanka	4.49	4.72	4.36	4.82	4.6
Nigeria	5.18	4.28	3.53	4.81	4.55
Lebanon	4.76	4.6	4.13	4.33	4.53
Tunisia	4.58	4.48	5.03	4.06	4.53
Algeria	4.84	4.22	4.99	3.96	4.5
Ecuador	4.49	4.63	4.66	3.75	4.44
Bangladesh	4.99	4.38	3.44	4.38	4.44
Cambodia	4.4	4.47	4.22	4.34	4.39
Paraguay	4.39	4.46	4.23	4.38	4.38
Tanzania	4.56	4.09	4.72	4.14	4.35
Uganda	4.37	4.39	3.88	4.07	4.25
Bolivia	4.42	4.46	3.58	3.1	4.07
Ethiopia	4.36	4.36	3.15	3.42	4.01
Mozambique	4.19	4.4	1.41	2.91	3.6
Angola	4.3	4.26	1.02	2.8	3.52
Venezuela	4.45	3.86	0.45	3.62	3.48
Myanmar	4.4	4.25	0.69	1.83	3.32
Libya	4.4	2.2	0.6	1.64	2.59

Appendix 2. Membership Summary for Clusters

Country	*Cluster*	*Cluster Membership*	*Sum of Squared Memberships*	*Bar of Squared Memberships*	*Silhouette Amount*	*Silhouette Bar*	*Prob in 1*	*Prob in 2*
Chile	1	0.7388	0.6141	|IIIIIIIIIIIIIII	0.502	|IIIIIIIIIIIII	0.7388	0.2612
Oman	1	0.7285	0.6045	|IIIIIIIIIIIIIII	0.4748	|IIIIIIIIIII	0.7285	0.2715
Turkey	1	0.7273	0.6033	|IIIIIIIIIIIIIII	0.3898	|IIIIIIIIII	0.7273	0.2727
Thailand	1	0.7057	0.5847	|IIIIIIIIIIIIIII	0.3953	|IIIIIIIIII	0.7057	0.2943
Kuwait	1	0.7052	0.5842	|IIIIIIIIIIIIIII	0.3321	|IIIIIIIII	0.7052	0.2948
Qatar	1	0.6966	0.5773	|IIIIIIIIIIIIII	0.5014	|IIIIIIIIIIIII	0.6966	0.3034
Bahrain	1	0.6962	0.577	|IIIIIIIIIIIIII	0.4126	|IIIIIIIIII	0.6962	0.3038
Russia	1	0.6934	0.5748	|IIIIIIIIIIIIII	0.2772	|IIIIIII	0.6934	0.3066
Saudi Arabia	1	0.6911	0.5731	|IIIIIIIIIIIIII	0.5137	|IIIIIIIIIIIII	0.6911	0.3089
Indonesia	1	0.6854	0.5687	|IIIIIIIIIIIIII	0.4054	|IIIIIIIIII	0.6854	0.3146
Jordan	1	0.6847	0.5682	|IIIIIIIIIIIIII	0.3277	|IIIIIIIII	0.6847	0.3153
Malaysia	1	0.6805	0.5651	|IIIIIIIIIIIIII	0.504	|IIIIIIIIIIIII	0.6805	0.3195
Vietnam	1	0.6718	0.559	|IIIIIIIIIIIIII	0.254	|IIIIIII	0.6718	0.3282
Kazakhstan	1	0.6388	0.5386	|IIIIIIIIIIIII	0.1801	|IIIII	0.6388	0.3612
Uruguay	1	0.6366	0.5373	|IIIIIIIIIIIII	0.1654	|IIIII	0.6366	0.3634
UAE	1	0.6291	0.5333	|IIIIIIIIIIIII	0.4237	|IIIIIIIIIII	0.6291	0.3709
Morocco	1	0.6225	0.53	|IIIIIIIIIIIII	0.2228	|IIIIII	0.6225	0.3775
Mexico	1	0.6055	0.5223	|IIIIIIIIIIIII	0.1404	|IIII	0.6055	0.3945
India	1	0.6051	0.5221	|IIIIIIIIIIIII	0.3191	|IIIIIIIII	0.6051	0.3949
China	1	0.5769	0.5118	|IIIIIIIIIIII	0.2826	|IIIIIII	0.5769	0.4231
Egypt	1	0.5481	0.5046	|IIIIIIIIIIII	-0.0779	|	0.5481	0.4519
Lebanon	2	0.7978	0.6774	|IIIIIIIIIIIIIIII	0.5833	|IIIIIIIIIIIIII	0.2022	0.7978
Cambodia	2	0.7917	0.6701	|IIIIIIIIIIIIIIII	0.581	|IIIIIIIIIIIIII	0.2083	0.7917
Paraguay	2	0.7904	0.6687	|IIIIIIIIIIIIIIII	0.5783	|IIIIIIIIIIIIII	0.2096	0.7904
Uganda	2	0.7742	0.6503	|IIIIIIIIIIIIIIII	0.6005	|IIIIIIIIIIIIIII	0.2258	0.7742
Sri Lanka	2	0.7554	0.6305	|IIIIIIIIIIIIIII	0.5177	|IIIIIIIIIIIII	0.2446	0.7554
Bangladesh	2	0.7507	0.6257	|IIIIIIIIIIIIIII	0.5894	|IIIIIIIIIIIIIII	0.2493	0.7507
Argentina	2	0.7411	0.6162	|IIIIIIIIIIIIII	0.5323	|IIIIIIIIIIIII	0.2589	0.7411
Ukraine	2	0.7395	0.6148	|IIIIIIIIIIIIII	0.4882	|IIIIIIIIIIII	0.2605	0.7395
Nigeria	2	0.7241	0.6004	|IIIIIIIIIIIIII	0.5487	|IIIIIIIIIIIII	0.2759	0.7241
Tanzania	2	0.7173	0.5944	|IIIIIIIIIIIIII	0.4967	|IIIIIIIIIIII	0.2827	0.7173
Ecuador	2	0.7133	0.591	|IIIIIIIIIIIIII	0.499	|IIIIIIIIIIII	0.2867	0.7133
Peru	2	0.7128	0.5906	|IIIIIIIIIIIIII	0.4585	|IIIIIIIIIII	0.2872	0.7128
Ethiopia	2	0.7095	0.5878	|IIIIIIIIIIIIII	0.5826	|IIIIIIIIIIIIII	0.2905	0.7095
Pakistan	2	0.7038	0.5831	|IIIIIIIIIIIII	0.4623	|IIIIIIIIIII	0.2962	0.7038
Bolivia	2	0.7003	0.5802	|IIIIIIIIIIIII	0.5588	|IIIIIIIIIIIII	0.2997	0.7003
Colombia	2	0.6977	0.5782	|IIIIIIIIIIIII	0.4392	|IIIIIIIIII	0.3023	0.6977
Iran	2	0.6768	0.5625	|IIIIIIIIIIIII	0.4436	|IIIIIIIIII	0.3232	0.6768
Ghana	2	0.6751	0.5613	|IIIIIIIIIIIII	0.4228	|IIIIIIIIII	0.3249	0.6751
Tunisia	2	0.6741	0.5606	|IIIIIIIIIIIII	0.4213	|IIIIIIIIII	0.3259	0.6741
Algeria	2	0.6706	0.5582	|IIIIIIIIIIIII	0.4272	|IIIIIIIIII	0.3294	0.6706
Mozambique	2	0.6354	0.5367	|IIIIIIIIIIII	0.5142	|IIIIIIIIIIII	0.3646	0.6354
Angola	2	0.6248	0.5312	|IIIIIIIIIIII	0.498	|IIIIIIIIIIII	0.3752	0.6248
Venezuela	2	0.6125	0.5253	|IIIIIIIIIIII	0.4708	|IIIIIIIIIII	0.3875	0.6125
Myanmar	2	0.6047	0.5219	|IIIIIIIIIIII	0.4538	|IIIIIIIIIII	0.3953	0.6047
Libya	2	0.5891	0.5159	|IIIIIIIIIII	0.413	|IIIIIIIII	0.4109	0.5891
Brazil	2	0.5612	0.5075	|IIIIIIIIIII	0.2724	|IIIIIII	0.4388	0.5612
Kenya	2	0.5588	0.5069	|IIIIIIIIIII	0.25	|IIIIII	0.4412	0.5588
South Africa	2	0.5543	0.5059	|IIIIIIIIIII	0.2321	|IIIIII	0.4457	0.5543
Philippines	2	0.5067	0.5001	|IIIIIIIIIII	0.1604	|IIIII	0.4933	0.5067

Appendix 3. Linear Discriminant Estimation Percentages of Countries

Country	Actual	Predicted	Pcnt1	Pcnt2
China	1	1	100	0
India	1	1	99.4	0.6
UAE	1	1	99.9	0.1
Malaysia	1	1	99.5	0.5
Indonesia	1	1	93.3	6.7
Saudi Arabia	1	1	99.5	0.5
Qatar	1	1	99.6	0.4
Thailand	1	1	72.6	27.4
Mexico	1	1	72.9	27.1
Turkey	1	1	82.3	17.7
Vietnam	1	1	65.9	34.1
Chile	1	1	96	4
Russia	1	1	66.4	33.6
Oman	1	1	97.2	2.8
Bahrain	1	1	98.1	1.9
Brazil	2	2	12.3	87.7
Kuwait	1	1	77.6	22.4
Philippines	2	2	11.4	88.6
Jordan	1	1	93.9	6.1
Morocco	1	1	95.9	4.1
Egypt	1	1	65.8	34.2
Kazakhstan	1	1	82.3	17.7
Uruguay	1	1	75.4	24.6
South Africa	2	2	30.3	69.7
Colombia	2	2	17.1	82.9
Peru	2	2	23.2	76.8
Pakistan	2	2	13.2	86.8
Kenya	2	2	18.5	81.5
Ukraine	2	2	19.1	80.9
Iran	2	2	11.4	88.6
Argentina	2	2	5.5	94.5
Ghana	2	2	12.3	87.7
Sri Lanka	2	2	9.7	90.3
Nigeria	2	2	3.7	96.3
Lebanon	2	2	10.7	89.3
Tunisia	2	2	39	61
Algeria	2	2	43	57
Ecuador	2	2	26.5	73.5
Bangladesh	2	2	3.4	96.6
Cambodia	2	2	8	92
Paraguay	2	2	7.9	92.1
Tanzania	2	2	21.1	78.9
Uganda	2	2	4.7	95.3
Bolivia	2	2	5.1	94.9
Ethiopia	2	2	1.7	98.3
Mozambique	2	2	0.1	99.9
Angola	2	2	0	100
Venezuela	2	2	0	100
Myanmar	2	2	0	100
Libya	2	2	0	100

Appendix 4. Linear Discriminant Scores, Regression Scores and Canonical Scores

Country	*Cluster*	*Linear Discriminant Scores*		*Regression Scores*		*Canonical Scores*
		Score1	*Score2*	*Score1*	*Score2*	*Score1*
China	1	74.45812	65.63165	1.337517	-0.33752	3.7382
India	1	65.55942	60.42902	0.973818	0.026182	2.256396
UAE	1	48.14209	41.39222	1.133177	-0.13318	2.905665
Malaysia	1	42.71645	37.38756	0.993349	0.006651	2.335972
Indonesia	1	46.72969	44.09011	0.728716	0.271284	1.257787
Saudi Arabia	1	43.53307	38.25262	0.988583	0.011417	2.316551
Qatar	1	48.96415	43.51554	1.00513	-0.00513	2.383971
Thailand	1	31.9057	30.93343	0.56465	0.43535	0.589342
Mexico	1	35.38801	34.40049	0.56615	0.43385	0.595452
Turkey	1	34.77928	33.24083	0.620363	0.379637	0.816328
Vietnam	1	30.36362	29.70617	0.533671	0.466329	0.463124
Chile	1	35.3246	32.1571	0.780665	0.219335	1.469444
Russia	1	32.55207	31.87148	0.535947	0.464053	0.472399
Oman	1	37.05772	33.51119	0.817962	0.182038	1.621398
Bahrain	1	38.90673	34.97313	0.85605	0.14395	1.77658
Brazil	2	30.24829	32.21207	0.275738	0.724262	-0.58776
Kuwait	1	33.61768	32.37725	0.591037	0.408963	0.696849
Philippines	2	25.60777	27.65606	0.267421	0.732579	-0.62165
Jordan	1	35.17182	32.43455	0.738329	0.261671	1.296954
Morocco	1	33.2388	30.08762	0.779058	0.220942	1.462895
Egypt	1	33.46716	32.8126	0.533386	0.466614	0.461965
Kazakhstan	1	30.95779	29.42168	0.620133	0.379867	0.815393
Uruguay	1	31.48259	30.36427	0.579021	0.420979	0.647893
South Africa	2	25.81925	26.65281	0.386953	0.613047	-0.13464
Colombia	2	24.21369	25.79383	0.313488	0.686512	-0.43396
Peru	2	25.05225	26.24964	0.351151	0.648849	-0.28051
Pakistan	2	27.3415	29.22737	0.283404	0.716596	-0.55653
Kenya	2	23.61563	25.09659	0.323247	0.676753	-0.3942
Ukraine	2	25.54428	26.9881	0.326903	0.673097	-0.3793
Iran	2	28.41921	30.46925	0.26725	0.73275	-0.62234
Argentina	2	23.74877	26.5873	0.189661	0.810339	-0.93846
Ghana	2	23.12622	25.08788	0.275946	0.724054	-0.58691
Sri Lanka	2	21.4515	23.67955	0.249732	0.750268	-0.69371
Nigeria	2	26.3826	29.63359	0.149074	0.850926	-1.10382
Lebanon	2	24.45145	26.56871	0.260634	0.739366	-0.6493
Tunisia	2	26.46366	26.91168	0.424891	0.575109	0.019927
Algeria	2	29.62012	29.90192	0.441248	0.558752	0.086569
Ecuador	2	24.272	25.29347	0.368463	0.631537	-0.20998
Bangladesh	2	24.35674	27.69801	0.140189	0.859811	-1.14002
Cambodia	2	20.62447	23.06027	0.22929	0.77071	-0.777
Paraguay	2	20.49409	22.95146	0.227167	0.772833	-0.78565
Tanzania	2	25.01362	26.33338	0.33911	0.66089	-0.32957
Uganda	2	19.30519	22.31929	0.172384	0.827616	-1.00885
Bolivia	2	20.04096	22.95669	0.182064	0.817936	-0.96941
Ethiopia	2	17.15283	21.23258	0.067522	0.932478	-1.43608
Mozambique	2	8.745311	16.12444	-0.25714	1.257143	-2.75886
Angola	2	8.66373	16.68089	-0.31993	1.319926	-3.01465
Venezuela	2	7.081072	16.74096	-0.48157	1.481573	-3.67324
Myanmar	2	9.900429	17.85749	-0.31401	1.314012	-2.99056
Libya	2	10.70839	19.71193	-0.41699	1.416988	-3.410103

Appendix 5. Linear Discriminant Scores, Regression Scores and Canonical Scores