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STATISTICAL EVALUATION OF THE EU COUNTRIES USING ECONOMIC INDICATORS

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Abstract: *The purpose of this paper is to evaluate the EU development area for the year 2012, using main statistical indicators. The cluster analysis and the Principal Component Analysis are the methods used to compare the 28 EU countries, the EU members, with each other and to determine the resemblances and the differences between them. The results show that the optimal solution is to create three clusters, allowing a suitable differentiation between the countries, while keeping the homogeneity among the countries it comprises.*

Key words: *EU countries, Principal Component Analysis, Cluster analyses.*

1. Introduction

European economies have faced a number of challenges in the past few years. After a hard recovery from the significant difficulties brought by the global economic crisis, concerns about the sustainability of debts in Greece and a number of other European countries continue to raise questions about the viability of the euro itself, and some about the sustainability of the European Union. Some countries are now facing another deep recession in the region, with the inflation rising, and concerns arise about the effects of these difficulties on other parts of the world.

Despite these challenges, several European countries continue to feature among the most competitive economies in the world prominently.

The present paper highlights the importance of the economic indicators of the EU countries members, using the latest theories in the field, an original model for determining the connection between economic factors. The paper aims to answer the problem of evaluating the EU development area for the year 2012, presenting the results of a comparative analysis conducted from the economic point of view, using the most recent statistical data.

The paper covers an empty space in the field of regional development evaluation, especially the EU economic development, using official statistics of Eurostat collected from a recent period, the year 2012. The work attempts at presenting the latest data, analysed with state of the art methods.

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The present paper contains a presentation of the economic variables used in this analysis, followed by a cluster analysis and then by a Principal Component Analysis.

The cluster analysis has the purpose to identify the groups (the EU Countries in this case) that are similar to each other, but different from other individual countries from the groups.

2. Methodology

The paper aims to scientifically discover an indicator by means of an analysis instrument of statistic data, SPSS, used for making a cluster analysis and a principal components analysis.

Cluster analysis represents a statistical and modern method for classification, through which relatively homogeneous complex groups of variables result, based on the values of the considered characteristics. After that, for a profound analysis and for retaining the significant variables for analysis, a principal components analysis was performed.

The principal components analysis method is a factorial method through which a number of new variables are constructed, as combinations of the initial variables, named primary indicators, having no correlation between them and a maximum variance. Within the principal components analysis the entire variance of the variables is explained.

The proximity indices express the similarities or the lack of them, which can be found between two subjects, considering all the active variables that describe the subject.

In this analysis, the SPSS program calculates the Euclidian distance for the quantitative data.

For the cluster analysis, the Ward's Method was used, because the goal of this cluster analysis is to form similar groups, on the criterion used for measuring similarity or distance. Distance is a measure of how far apart two objects are, while similarity measures shows how similar two objects are. For cases that are alike, distance measures are small and similarity measures are large.

The current analysis is made regarding the data found on eurostat.com, for 2012.
For the economic analysis of the cluster, we have chosen to study the 28 countries now part of the European Union by looking at major economic indices like:

- Population -in this section we can find the number of persons, counted on the 1st of January 2013.
- GDP - represents the gross domestic product, which is an indicator for a nation's economic situation, in this case at market prices.
- Employment rate by age group 20-64
- Inflation
- Comparative Price Levels of final consumption by private households including indirect taxes (EU28 = 100).
- General Government - General Deficit/Surplus % of GDP
- Imports of goods and services at current prices**.**
- Exports goods and services exports at current prices.

3. Results

Having all the criteria analysed simultaneously offers the big picture for the economic development of the 28 EU member countries and it allows the comparison of these countries. The data are collected from previous research made by Eurostat, so we can say that they are all valid and no missing value can be found.

The Agglomeration Schedule shows how each case was grouped during the grouping phases. The second column, Cluster Combined, contains the grouped cases; the stage cluster shows the stages in which the elements appeared previously, while the

next stage column shows the case in which it will later appear again.

We can find the lowest value for the coefficient (22.013) for the pair of countries Cyprus and Slovenia, which means that the two countries formed a group in the very first step, showing a lot of similarities, having the smallest distance between groups. The whole clustering process contains a total of 27 stages.

Agglomeration Schedule Table 1

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	13	24	22.013	0	0	4
2	6	14	48.701	0	0	6
3	17	23	84.517	0	0	9
4	13	22	127.040	1	0	15
5	15	25	171.115	0	0	8
6	6	18	235.086	2	0	11
7	10	28	308.983	0	0	19
8	3	15	404.648	0	5	14
9	2	17	501.802	0	3	18
10	4	27	623.329	0	0	20
11	6	11	777.402	6	0	14
12	7	20	934.960	0	0	17
13	1	9	1100.946	0	0	23
14	3	6	1285.046	8	11	21
15	8	13	1470.127	0	4	21
16	12	19	1660.897	0	0	19
17	7	26	1865.055	12	0	20
18	2	21	2096.926	9	0	24
19	10	12	2487.660	7	16	23
20	4	7	3024.006	10	17	22
21	3	8	3663.398	14	15	24
22	4	16	4788.602	20	0	25
23	1	10	6194.896	13	19	25
24	2	3	7874.151	18	21	27
25	1	4	15997.744	23	22	26
26	1	5	34791.602	25	0	27
27	1	2	63812.057	26	24	0

The table above shows how clusters can be formed. We took into consideration three hypotheses; in the first one, we have grouped the countries into three clusters, having the following structures:

The first cluster is formed by: Belgium, Denmark, Ireland, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Finland, Sweden, and the United Kingdom.

The second cluster is formed by: Bulgaria, the Czech Republic, Estonia, Greece, Croatia, Cyprus, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovenia, and Slovakia.

The third cluster is formed by: Germany.

For a more accurate classification we tried to divide the countries into four groups and we had the result illustrated below:

The first cluster is formed by: Belgium, Spain, France, Italy, the Netherlands, and the United Kingdom.

The second cluster is formed by: Bulgaria, the Czech Republic, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovenia, and Slovakia.

The third cluster is formed by: Denmark, Ireland, Luxembourg, Austria, Finland, and Sweden.

The fourth cluster is formed by: Germany.

When we grouped the countries into five clusters, we have obtained this result:

The first cluster is formed by: Belgium, Spain, France, Italy, the Netherlands, and the United Kingdom.

The second cluster is formed by: Bulgaria, Hungary, Poland, Romania.

The third cluster is formed by: the Czech Republic, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Malta, Portugal, Slovenia, and Slovakia.

The fourth cluster is formed by: Denmark, Ireland, Luxembourg, Austria, Finland, and Sweden.

The fifth cluster is formed by: Germany.

As it can be seen, Germany is an outliner, it is a country that is different from all the other 27 countries, and it seems that it cannot be grouped together with other counties in any of the 3 hypotheses.

If a visual representation of the distance at which clusters are grouped is wanted, one can look at the display called the dendrogram. The dendrogram is always read from left to right. Vertical lines show joined clusters. The scale indicates the distance at which clusters are joined. The observed distances are rescaled so they can fall into the range from 1 to 25, so that the actual distances are not seen; however, the ratio of the rescaled distances within the dendrogram is the same as the ratio of the original distances.

When one reads a dendrogram, one wants to determine at what stage the distances between clusters that are combined is larger. One must look for large distances between sequential vertical lines.

The dendrogam allows the graphic representation of the cohesion of the clusters formed. It represents a tree-shaped graph that shows the level at which two clusters are joined by marking a vertical line that connects the horizontal lines, the so called branches, which correspond to the united groups. The cluster is obtained by cutting the dendrogram at a certain level.

From the dendrogram bellow it can be noticed that Germany stays apart from the other 27 counties, having a different economic situation. Besides that, we have two other clusters formed, as already mentioned. The *first cluster* is formed by: Belgium, Denmark, Ireland, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Finland, Sweden, the United Kingdom.

The second cluster is formed by: Bulgaria, the Czech Republic, Estonia,

Greece, Croatia, Cyprus, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovenia, Slovakia.

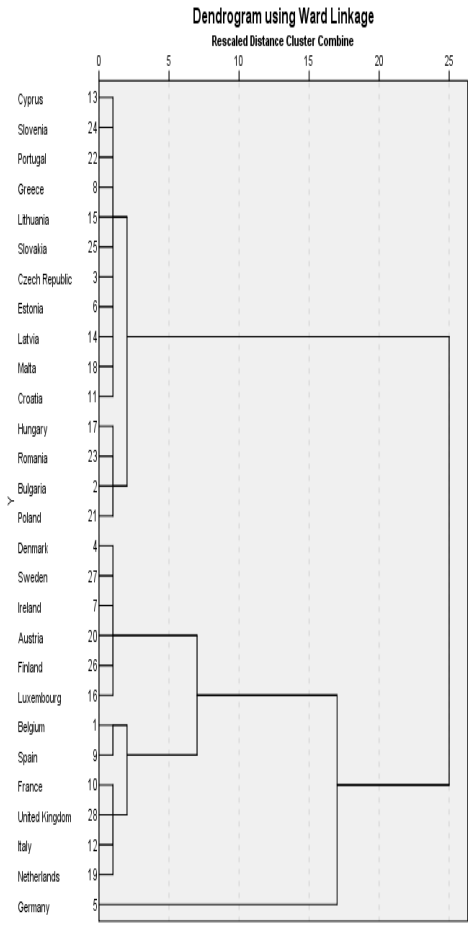

Fig. 1. *Dendogram*

It is clear that the countries are grouped by the economic status that they had in 2012.

Principal Component Analysis

The principal component analysis is part of the descriptive methods, which analyse the interdependencies between variables. It has the role to identify the main components by explaining certain components or attitudes of individuals.

In the principal component analysis, it can be noticed the interdependencies between several variables, where we can identify two main components that gather the main information detained by the variables and are able to explain and simplify the process of reading the final result. A factorial analysis is accomplished, precisely a principal components analysis, in order to retain only the indicators that are essential for the study of the economic development of the EU countries.

This analysis was performed in SPSS, considering all the variables used in the cluster method.

The table below shows the mean for each variable included in the model. It can be seen that the mean is quite different for each variable, except for the imports and exports variables.

Descriptive Statistics Table 2

	Mean	Std. Deviation	Analysis N
GDP	24.9036	10.64677	28
Employment Rate	67.9321	6.41613	28
Inflation	2.8750	.92681	28
Comparative Price Levels	90.9429	24.69036	28
General Government General Deficit/Surplus	-3.8250	2.66939	28
Imports	19.8855	27.16741	28
Exports	20.7810	29.20998	28

Then the SPSS System calculates the correlation coefficients between the variables taken into consideration, two by two.

There are some strong correlations between GDP and the Comparative Price Levels, the Employment Rate and Comparative Price Levels, but the strongest correlation is between Imports and Exports.

The lowest correlation is between Imports and Government General Deficit/Surplus followed by the correlation Price Levels and Government General Deficit/Surplus.

Establishing the main 2 components, the program calculates the correlation coefficients between all the variables and the main components.

Communalities Table 3

	Initial	Extraction
GDP	1.000	.502
Employment Rate	1.000	.712
Inflation	1.000	.584
Comparative Price Levels	1.000	.717
General Government General Deficit Surplus	1.000	.829
Imports	1.000	.580
Exports	1.000	.589

Extraction Method: Principal Component Analysis.

Table 4 shows the total value explained by each component. It can be observed that 64.4% of the total variance is explained by the two components, the last components explaining fewer and fewer.

The third one can explain a plus 19.2%, but we will take into consideration only two main components.

Total Variance Explained Table 4

Com-ponent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumu-la-tive %	Total	% of Variance	Cumu-lative %	Total	% of Variance	Cumulative %
1	3.090	44.136	44.136	3.090	44.136	44.136	3.068	43.827	43.827
2	1.423	20.331	64.468	1.423	20.331	64.468	1.445	20.641	64.468
3	1.350	19.282	83.750						
4	.613	8.761	92.510						
5	.375	5.353	97.864						
6	.145	2.076	99.940						
7	.004	.060	100.000						

Extraction Method: Principal Component Analysis.

Notice that ComparativePriceLevels, GDP, Employment Rate, Imports and Exports are strongly correlated with the first component, whereas the General Government General Deficit Surplus and Inflation are connected with the second component.

The process of the axes rotations does not change much of the whole picture. The process of rotation has the purpose of enlarging the correlation between the variables and the two main components. The results concerning the correlation coefficients are obtained by the axes rotation using the Varimax method (it has the effect of maximizing the highly correlated variables with the components).

Component Matrix Table 5

	Component	
	1	2
GDP	.709	.001
Employment Rate	.694	.479
Inflation	-.504	.575
Comparative Price Levels	.808	-.253
General Government General Deficit Surplus	.175	.893
Imports	.761	-.009
Exports	.767	.014

Extraction Method: PrincipaL Component Analysis.
a. 2 components extracted.

The graphic representation of the association between variables and the two main components shows that the first component is formed especially by social indicators and import and export values, and the second component is formed by governmental indicators such as inflation and Governmental General Deficit/Surplus, but they are represented in different quadrants, which means that those indicators are in strict opposition.

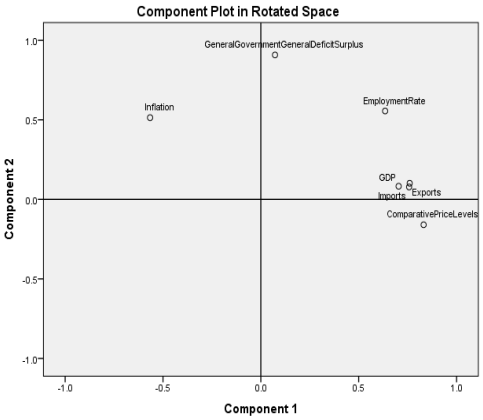

Fig. 2. *Component Plot in Rotated Space– The graphic representation of the association between components and variables*

There is a noticeable vicinity of attitudes of the countries with respect to the first factor, regarding the GDP, Employment Rate, Comparative Price Levels, Imports and Exports.

4. Conclusions

After a long period of economic uncertainty, the EU countries are trying to recover and gain ground, but unfortunately the world economy is facing new challenges. 2012 was a turning point for the economy of the European Union. 2013 is showing to be quite a good year, national economies are starting a slow growth, but the expectations for 2014 are big.

After six consecutive quarters of stagnation or contraction, the EU economy has posted positive growth in the second quarter of 2013. The recovery is expected to continue, and to gather some speed next year. However, it is too early to declare the crisis over and many challenges are here to come.

The goal of this cluster analysis is to form similar group. Distance is a measure of how far apart two objects are, while similarity measures how similar two objects are. For cases that are alike, distance measures are small and similarity measures are large.

The cluster analysis grouped the countries into three clusters, having the following structure:

The first cluster is formed by: Belgium, Denmark, Ireland, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Finland, Sweden, and the United Kingdom.

The second cluster is formed by: Bulgaria, the Czech Republic, Estonia, Greece, Croatia, Cyprus, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovenia, and Slovakia.

The third cluster is formed by: Germany.

It seems that Germany is the most different country, from an economic point of view; it stands out from the 28 EU countries.

There are some strong correlations between the GDP and the Comparative Price Levels, the Employment Rate and Comparative Price Levels, but the strongest correlation is between Imports and Exports.

For the principal component analysis we shall notice the interdependencies between several variables, on which we can identify two main components that gather the main information detained by the variables and are able to explain and simplify the process of reading the final result. A factorial analysis was accomplished, precisely a principal components analysis, in order to retain only the indicators essential for the study of the economic development of EU countries. The association between variables and the two main components shows that the first component is formed especially by social indicators and import and export values, and the second component is formed by governmental indicators such as inflation and Governmental General Deficit/Surplus, but they are represented in different quadrants, which means that those indicators are in strict opposition.

A moderate expansion of the economic activity is expected in the second half of 2013. It remains the hope that 2012 was the final year for the major economic crisis, and now things will go only better.

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