

# Multivariate Analysis of Structural Economic Indicators for Croatia and EU 27

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*Abstract:* - The last (5<sup>th</sup>) wave of EU enlargement ended on 1<sup>st</sup> January 2007 with the accession of Romania and Bulgaria. Many countries of the South-Eastern Europe aspire to join the EU. Croatia appears to be the next prospective member, so the aim of this paper was to classify Croatia and EU 27 Member States according to the structural economic indicators. In that sense, the cluster analysis was applied. The mentioned countries were gathered into homogenous groups in terms of the following structural economic indicators: GDP per capita, total employment rate and comparative price levels. The hierarchical cluster analysis and non-hierarchical cluster analysis were applied and gave similar results.

*Key-Words:* - Classification, Structural economic indicators, Multivariate method, Cluster analysis, Ward's method, K-means method.

## 1 Introduction

At the end of the 1980s and the beginning of 1990s, after the Cold war, and after the collapse of communism there was an opportunity for the European integration process to focus on countries of former Eastern Bloc. After the unification of Germany, or to be more precise, ten years later, 5<sup>th</sup> expansion wave of European Union took place and it symbolised the biggest swing in the integration of European continent by the number of new members as well as by abolition of segmentation on European East and West. On 1<sup>st</sup> May 2004, EU expanded on 10 new countries: Estonia, Lithuania, Latvia, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Malta and Cyprus. The last (5<sup>th</sup>) wave of enlargement ended on 1<sup>st</sup> January 2007 with the accession of Romania and Bulgaria. Many countries of South-Eastern Europe aspire to join the EU [9]

Croatia appears to be the next prospective member. Apart from Croatia, Macedonia and Turkey already have the candidate status, while Albania, Bosnia and Herzegovina, Serbia and Montenegro participate to a different extent in the Stabilisation and Association process (which provides a legal framework for the relations between the EU and potential members in the

period prior to possible accession). In many cases, these partnerships are seen as a first step towards closer integration, but they are not a guarantee for full membership [4]. It is a common view that enlargement poses a severe challenge for EU structural and cohesion policies. Far less clear and uncontroversial is the empirical and analytical basis for that statement.

This paper focuses on chosen structural economic indicators of Croatia in comparison to the ones of EU 27. The main purpose is to investigate to what extent Croatian economy resembles economies of EU 27 Member States in terms of structural economic indicators. In other words: in what group of countries does Croatia come under, since it's natural to suppose that it should group with the countries with a similar historical and economic background (Central and Eastern European countries).

According to the research of Christian Weise (German Institute for Economic Research), despite recent growth rates above EU 15 average, economic convergence remains limited. Poland, Slovenia, Hungary, Slovakia and Czech Republic display the most positive macroeconomic indicators. Considerable labour market changes have occurred associated with the process of

economics restructuring, privatisation and liberalization. These include a sharp fall in industrial employment and a substantial rise in service sector employment, but noticeable differences with the employment structure of the EU Member States remain. Unemployment has risen in all CEE countries to varying extents. Income levels and standard of living have declined and poverty has spread considerably with a variation between countries and a disproportional effect on certain social groups. The spread of sub-national disparities in GDP and unemployment in the CEECs is smaller than in other EU Member States.

According to the previously mentioned research, disparity patterns (at NUTS II level) include the following: GDP per capita in CEE regions is considerably less than EU average (only Prague and Bratislava lie above this level), regional unemployment is relatively low in CEE in comparison to the EU 15 (with noticeable sub-national variation), CEE regions are in general more sparsely populated than the EU 15 and agriculture dominates regional employment structures in, for example, Romania and Poland to much greater extent than in the EU 15. However, the increasing uncertainties regarding the EU absorption capacity and its future enlargements, as well as unsorted institutional issues seem not to be affecting Croatia's current path towards the accession [7].

Croatia's small size causes little concern about the impact it would have on EU institutions, policies and its budget. Therefore it has been repeatedly confirmed by EU officials that Croatia would join the EU as quickly as possible, provided that it fulfils all the required accession criteria which primarily relate to the progress with adopting and implementing the EU law. In some areas, however, they also include broader political and economic reforms [4].

## 2 Problem Formulation

In this paper the structural indicators of Croatian economy (CR) were analysed: GDP per capita (GDPpc), total employment rate (EMPL) and comparative price levels (PRICE) in comparison with those of: Belgium (BE), France (FR), Italy (IT), Greece (GR), Spain (SP), Czech Republic (CZ), Lithuania (LI), Estonia (ES), Latvia (LA), Cyprus (CY), Portugal (PT), Slovenia (SN), Bulgaria (BU), Hungary (HU), Poland (PL), Romania (RO), Slovakia (SK), Malta (MA), Denmark (DE), Germany (GE), Austria (AU),

United Kingdom (UK), Netherlands (NE), Sweden (SW), Ireland (IR), Finland (FI) and Luxembourg (LU). Using cluster analysis, the main purpose of the paper was to explore in which group of countries Croatia fits in based on enumerated structural economic indicators [1, 2, 3, 5, 6]. The data for the analysis were taken from Eurostat web site for the year 2007.

As an indicator of economic activity, Gross domestic product (GDP) was chosen. It is defined as the value of all goods and services produced less the value of any goods or services used in their creation. The volume index of GDP per capita in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU-27) average set to equal 100. Basic figures are expressed in PPS, i.e. a common currency that eliminates the differences in price levels between countries allowing meaningful volume comparisons of GDP between countries.

Another structural indicator of interest is total employment rate. The employment rate is calculated by dividing the number of persons aged 15 to 64 in employment by the total population of the same age group. The indicator is based on the EU Labour Force Survey. The survey covers the entire population living in private households and excludes those in collective households such as boarding houses, halls of residence and hospitals. Employed population consists of those persons who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent.

Comparative price level is the last indicator chosen for this analysis. Comparative price level is the ratio between Purchasing power parities (PPPs) and market exchange rate for each country. The ratio is shown in relation to the EU average (EU27 = 100).

Although this analysis is accompanied by a number of constraints that have to be taken into account when interpreting the results, it is quite interesting to know in which groups of EU 27 countries was Croatia classified.

## 3 Problem Solution

The cluster analysis was applied to classify EU 27 countries and Croatia according to the three structural economic indicators: GDP per capita, total employment rate and comparative price levels.

At first, three previously mentioned variables were standardized to avoid measurement differences.

The multicollinearity for the three selected variables was examined. All VIF values were smaller than 5 which denote that there is no high multicollinearity.

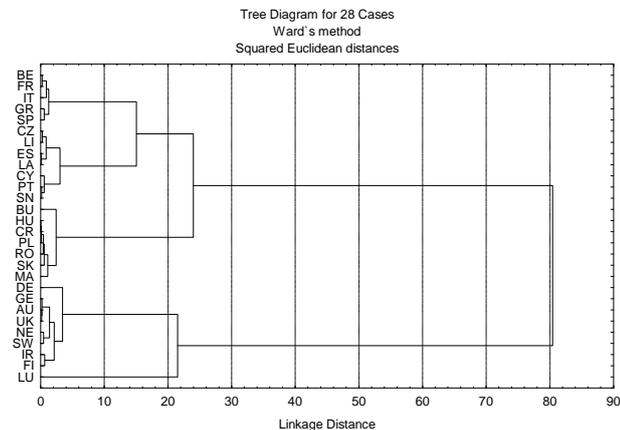
At first the hierarchical cluster analysis was run. The non-hierarchical cluster analysis was then used to improve the results of the cluster solution given by the hierarchical cluster analysis.

The cluster analysis was also run to classify Croatia and 12 European countries which joined during the last two waves of enlargement. The hierarchical and non-hierarchical cluster analyses were also applied.

### 3.1 Hierarchical cluster analysis

The hierarchical cluster analysis was run using the standardized variables (SGDPpc, SEMPL and SPRICE). Various methods of hierarchical cluster analysis were first provided to find out the number of clusters. The four-cluster solution given by the Ward's method with squared Euclidean distances was chosen as the best solution. Figure 2 shows the dendrogram obtained by Ward's method with Squared Euclidean distances. The analysed countries are listed along the left vertical axis of the dendrogram.

Fig.1 Dendrogram (Ward's method, Squared Euclidean distances)



On the basis of the dendrogram in Figure 1 and by examining the linkage distances we may choose the solution with two or four clusters.

In the two-cluster solution the first cluster comprises nineteen countries and the second nine countries. The first cluster consist of the following countries: Belgium, France, Italy, Greece, Spain, Czech Republic, Lithuania, Estonia, Latvia, Cyprus, Portugal, Slovenia, Bulgaria, Hungary, Croatia, Poland, Romania, Slovakia and Malta. The

second cluster consists of: Denmark, Germany, Austria, United Kingdom, Netherlands, Sweden, Ireland, Finland and Luxembourg. Table 1 shows the classification of countries in the four clusters obtained by the Ward's method with the Squared Euclidean distances.

In the four-cluster solution the first cluster comprises twelve countries (Belgium, France, Italy, Greece, Spain, Czech Republic, Lithuania, Estonia, Latvia, Cyprus, Portugal, Slovenia), the second cluster seven (Bulgaria, Hungary, Croatia, Poland, Romania, Slovakia, Malta), the third cluster eight (Denmark, Germany, Austria, United Kingdom, Netherlands, Sweden, Ireland, Finland) and the fourth cluster only one country, Luxembourg.

It can be seen that on the basis of the three chosen structural economic indicators and Ward's method with Squared Euclidean distances Croatia was classified in the group of countries that have similar historical and political background: Bulgaria, Hungary, Poland, Romania, Slovakia and Malta.

Croatia's GDP pc is 61,9 PPS or 38,1% below EU 27 average, which is similar to the level of the same indicator in Hungary, Malta, Poland and Slovakia. However, Bulgaria and Rumania that gathered into the same group have much lover GDP pc reaching approximately 40% of the average value of that indicator in EU 27.

When comparing total employment rate in the second cluster, the situation is quite different. Bulgaria and Slovakia have the highest employment rates (around 60% or 5.4% below EU 27 average), while other countries of the same cluster have lower employment rates being approximately around 57%.

Malta and Croatia have the highest comparative price levels in the second cluster (around 70 PPS or 30% below EU 27 average), while other countries in the same cluster reach around 60 PPS or 40% below EU 27 average. The lowest Comparative price levels are in Bulgaria, reaching 46.5 PPS.

### 3.2 Non-hierarchical cluster analysis

The non-hierarchical cluster analysis was used to improve the previously mentioned four-cluster solution given by the hierarchical cluster analysis, Ward's method with squared Euclidean distances. The K-means method of non-hierarchical cluster analysis with the Euclidean distances was provided. The standardized variables were also used (SGDPpc, SEMPL and SPRICE).

The K-means method was resulted in the similar structure of the clusters as the clusters given

by the Ward's method with the squared Euclidean distances. Table 1 shows the classification of countries in four clusters given by the Ward's method and the K-means method. It can be seen that only Lithuania was classified differently by the K-means method. Lithuania was classified by the Ward's method with Belgium, France, Italy, Greece, Spain, Czech Republic, Estonia, Latvia, Cyprus, Portugal, and Slovenia and by the K-means method with Bulgaria, Hungary, Croatia, Poland, Romania, Slovakia and Malta.

On the basis of the three chosen structural economic indicators and K-means method Croatia was grouped along with Bulgaria, Hungary, Poland, Romania, Slovakia, Malta and Lithuania.

Table 1 Classification of countries in four clusters (Ward's method and K-means method)

Country	Ward's method	K-means method
Belgium	1	3
France	1	3
Italy	1	3
Greece	1	3
Spain	1	3
Czech Republic	1	3
<i>Lithuania</i>	<i>1</i>	<i>4</i>
Estonia	1	3
Latvia	1	3
Cyprus	1	3
Portugal	1	3
Slovenia	1	3
Bulgaria	2	4
Hungary	2	4
Croatia	2	4
Poland	2	4
Romania	2	4
Slovakia	2	4
Malta	2	4
Denmark	3	1
Germany	3	1
Austria	3	1
United Kingdom	3	1
Netherlands	3	1
Sweden	3	1
Ireland	3	1
Finland	3	1
Luxembourg	4	2

The way to identify the nature of each cluster is to examine their means on each dimension. For this purpose the plot of means for each cluster was constructed. Figure 2 shows the plot of means for the four clusters obtained by the K-means method.

Fig.2 Plot of means for four clusters

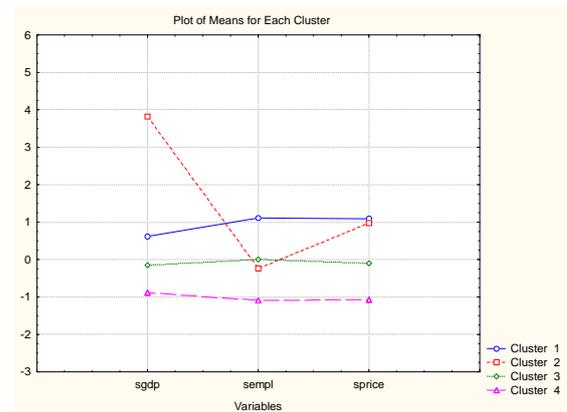
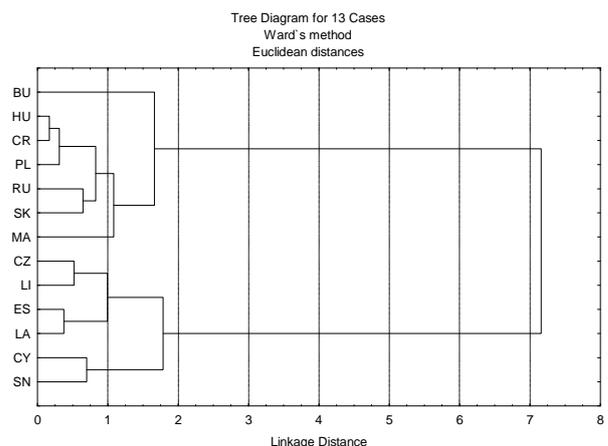


Figure 2 shows that in the fourth cluster, all of the three examined structural economic indicators are below average. On the other hand, in second cluster, where Luxembourg was grouped, GDP pc is well above the EU 27 average.

### 3.3 Hierarchical cluster analysis for 13 countries

The cluster analysis was run using the standardized variables (SGDPpc, SEMPL and SPRICE). The two-cluster solution given by the Ward's method with squared Euclidean distances was chosen. Figure 3 shows the dendrogram obtained by Ward's method with Squared Euclidean distances.

Fig.3 Dendrogram for 13 countries (Ward's method, Squared Euclidean distances)



According to the dendrogram for 13 countries, the first cluster consists of seven countries: Bulgaria, Hungary, Croatia, Poland, Romania, Slovakia and Malta. The following countries were grouped in the second cluster: Czech Republic,

Lithuania, Estonia, Latvia, Cyprus and Slovenia. These results confirmed the results of cluster analysis on 28 countries.

### 3.4 Non-hierarchical cluster analysis for 13 countries

The K-means method of non-hierarchical cluster analysis with the Euclidean distances was provided on standardized variables (SGDPpc, SEMPL and SPRICE). Table 2 shows the classification of countries in two clusters given by the Ward's method and the K-means method.

Table 2 Classification of countries in two clusters (Ward's method and K-means method)

Country	Ward's method	K-means method
Bulgaria	1	1
Hungary	1	1
Croatia	1	1
Poland	1	1
Romania	1	1
Slovakia	1	1
Malta	1	1
Czech Republic	2	2
Lithuania	2	2
Estonia	2	2
Latvia	2	2
Cyprus	2	2
Slovenia	2	2

It can be seen that the K-means method was resulted in the same structure of the clusters as the clusters given by the Ward's method with the squared Euclidean distances.

Figure 4 shows the plot of means for the two clusters obtained by the K-means method.

Fig.4 Plot of means for two clusters

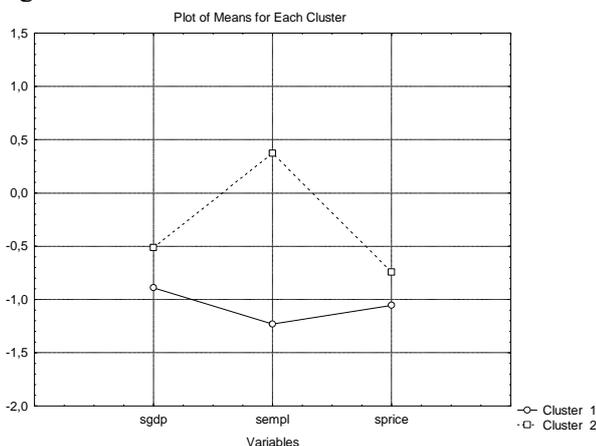


Figure 4 shows that in the first cluster, in which Croatia was grouped, all of the three examined structural economic indicators are below average.

## 4 Conclusion

The aim of this paper was to classify Croatia and EU 27 Member States according to structural economic indicators. The cluster analysis was used to classify those countries into groups which are homogenous in terms of the three structural economic indicators: GDP per capita, total employment rate and comparative price levels. Because of the measurement differences these three variables were firstly standardized. The hierarchical cluster analysis and non-hierarchical cluster analysis were used.

Various methods of hierarchical cluster analysis were first provided to find out the number of clusters. The best interpretative solution was provided by the Ward's method with the squared Euclidean distances. The four-cluster solution given by the Ward's method with squared Euclidean distances was chosen. According to the results of the Ward's method and the three chosen structural economic indicators Croatia was classified along with the following EU Member States: Bulgaria, Hungary, Poland, Romania, Slovakia and Malta

A non-hierarchical cluster analysis was then employed to improve the results of the four-cluster solution given by the hierarchical cluster analysis. The K-means method was resulted in the similar structure of the clusters as the clusters given by the hierarchical cluster analysis. On the basis of the three chosen structural economic indicators and K-means method Croatia was classified into the group of the following EU 27 Member States: Bulgaria, Hungary, Poland, Romania, Slovakia, Malta and Lithuania.

The hierarchical cluster analysis and non-hierarchical cluster analysis were run to classify Croatia and 12 European countries which joined during the last two waves of enlargement. Again the Croatia was grouped along with Bulgaria, Hungary, Poland, Romania, Slovakia and Malta.

The result of analysis is quite expected, since Croatia was grouped with the countries with similar economic and historical background. However it was interesting to test that fact methodologically. Further analysis on this particular area will include more economic structural indicators that might lead to conclusion in what way will Croatian economy be affected with the accession to European Union.

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