

## **A Cluster Analysis of Industrial Production Indices in Some European Countries and Turkey**

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### **Abstract**

*The economic crisis had consequences on both the internal structural changes at mezzo economic level and the reorganisation of policies on industrial production of key categories of goods. To identify the changes in relations to industrial productions of some EU countries and also Norway and Turkey, the paper examines the characteristics of the main clusters formed from eight product categories according to the Statistical Classification of Products by Activity in the European Economic Community. In terms of the index of industrial production registered in 2014 compared to 2010, compared with analysed countries. Romania is both in the first value cluster, in Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel, and also in less performant clusters, in Manufacture of basic metals, Manufacture of computer, electronic and optical products or Manufacture of electrical equipment*

**Keywords:** *volume index of production; cluster analysis; confidence level; statistical hypothesis*

**JEL Classification:** *C19; L60; O50*

### **Introduction**

In the period 2010-2014, the efforts to overcome the economic crisis led to restructuring of economic agents. These efforts were characterized by redefining and resizing subsystems and relationships in their internal environment, and also by redefining the objectives, relations and positions of the economic agents in the markets in which they act. After having overcome the shock caused by the onset of economic crisis, economies of European countries had different trends in terms of industrial production indices, which were materialized by reducing activities in some areas and by increased production in others, each of them, seeking to adapt better to new conditions

Starting from these considerations, the primary objective of the study was to identify and analyse the characteristics of the main clusters formed from a set of indicators that define trends in industrial production in EU countries and also Norway and Turkey, in the year 2014 compared to 2010.

To this end, the main instrument used was cluster analysis. This is one of the most applied instruments with an extraordinary opportunity to study very large categories of economic and social aspects like economic behaviour (Gelder, 2014), public choice paradigm (McClure, 1995), psychology (Popa, 2010), etc. In economics, this analysis is present in a variety of subfields and directions, including the consolidation of economic development strategies (Ketels and Memedovic, 2008), the study of emerging economies (Pencea, 2010), entrepreneurship (Glaeser, Kerr and Ponzetto, 2010), finance Pierpaolo, et al., 2013), tourism industry (Jugănaru and Jugănaru, 2011), competitiveness (Vlasceanu, 2014) and last but not least, the IT (Boja, 2011) industry.

Based on these considerations, the paper looks at developments in industrial production indices, by product category, focusing on relations between their volumes in 2014 compared to 2010. The analysis is based on the Statistical Classification of Economic Activities in the European Community (NACE) and the Statistical Classification of Products by Activity in the European Economic Community (CPA). Starting from the series of available data and consistent with the analysis objectives, eight indicators were chosen: Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel, Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations, Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment.

## Research Methodology

Depending on the series of data, the paper analyses the structure of 21 EU countries and also Norway and Turkey, in terms of Volume index of production in industry - annual data (2010 = 100) available on Eurostat database, taking into account all eight indicators, as well as the analysis on specific categories. In this respect, three groups were formed.

In the first group, the following indicators were included: Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel. Given the data confidentiality of Manufacture of beverages (UK) and Manufacture of wearing apparel (Sweden), these were included in the analysis of production indices, corresponding to these indicators. The number of countries included was 21.

The second group includes two indicators: Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations. Data corresponding to values for these indicators have not been identified in Finland (confidentiality) and Sweden, 21 countries being included in the analysis.

The third group includes the following indicators: Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment. Excepting Finland because of data confidentiality, the analysis included 22 states.

To group the states based on the values of the considered indicators, cluster analysis (Rotaru, ed., 2006) was used, hierarchical cluster respectively.

The following matrix is given  $X = (x_{ij})_{i=1, \dots, n; j=1, \dots, m}$  where  $n$  is the number of countries and  $m$  is the number of indicators (variables) used to form the clusters. On each element of matrix  $X$ , the Z-score transformation was applied, having the form

$$y_{ij} = \frac{x_{ij} - \bar{x}_j}{\sigma_j} \quad (1)$$

Where  $x_{ij}$  represents the indices of industrial production in country  $i$ , for product  $j$ ,  $\bar{x}_j = \frac{\sum_{i=1}^n x_{ij}}{n}$   
 and  $\sigma_j = \sqrt{\frac{\sum_{i=1}^n (x_{ij} - \bar{x}_j)^2}{n-1}}$ .

Starting from matrix X, after applying the transformations (1) we obtain the matrix

$$Y = (y_{ij})_{i=1, \dots, n; j=1, \dots, m} \tag{2}$$

Matrix Y contains the standardized values (with 0 mean and 1 variance) of the initial values of the m variables. Starting from matrix Y we obtain the proximity matrix:

$$W = (w_{ij})_{i=1, \dots, n; j=1, \dots, n} \tag{3}$$

Matrix W contains the distances between the n elements (the countries being the subject of cluster grouping) of the set X. To determine the values of the elements of matrix W, various methods can be used (Euclidean distance, Euclidean squared distance, Manhattan, Chebychev, Minkowski etc.).

Using the Euclidean squared distance, the elements of matrix W are determined as follows:

$$w_{ik} = \sum_{j=1}^m (y_{ij} - y_{kj})^2, i, j = \overline{1, n}, k = \overline{1, n}, j \neq i, k \neq i$$

$$w_{ii} = 0$$

To determine the distance between clusters, the Average linkage between groups method was used.  $(R = \{r_i\})_{i \in (1, N \cap C^*)}$  and  $(P = \{p_j\})_{j \in (1, N \cap C^*)}$  being two clusters, then the distance between them is:

$$N \cdot \sum_{R \in C} \sum_{P \in C} d(R, P) \tag{4}$$

To process and analyse data, the SPSS (we mention in this regard the works of Howitt and Cramer (2008), and Popa (2008)) and Excel, Data Analysis module, Oprea and Zaharia (2011) were used.

### A Cluster Analysis with Eight Indicators

A first analysis focused on cluster structuring of 18 EU states, as well as Norway and Turkey, in terms of the industrial production index realized in 2014 compared to 2010, of all eight indicators taken into account: Manufacture of food products (FP), Manufacture of beverages (BV), Manufacture of wearing apparel (WA), Manufacture of chemicals and chemical products (CHP), Manufacture of basic pharmaceutical products and pharmaceutical preparations (PHP), Manufacture of basic metals (BM), Manufacture of computer, electronic and optical products (COP), Manufacture of electrical equipment (EE).

After standardizing the values of the variables using the Z-score method (relation 1) and the Average linkage method for classification, the obtained dendrogram is shown in Figure 1. Considering the Rescaled Distance Cluster Combine, a first significant cluster consists of six states: Spain, Italy, Germany, Netherlands, Czech Republic and France. The values of analysed indicators for the states in this cluster are shown in Table 1.

**Table 1.** The values of average, standard deviation (Std.dev.) and variation coefficient (V), corresponding to the cluster formed by: Spain, Italy, Germany, Netherlands, Czech Republic and France

	FP	BV	WA	CHP	PHP	BM	COP	EE
<b>Average</b>	100.59	100.42	85.85	99.91	106.06	98.68	100.61	96.70
<b>Std.dev.</b>	3.05	3.52	7.11	7.13	8.83	5.23	15.11	19.39
<b>V (%)</b>	3.03	3.51	8.28	7.14	8.33	5.30	15.02	20.05

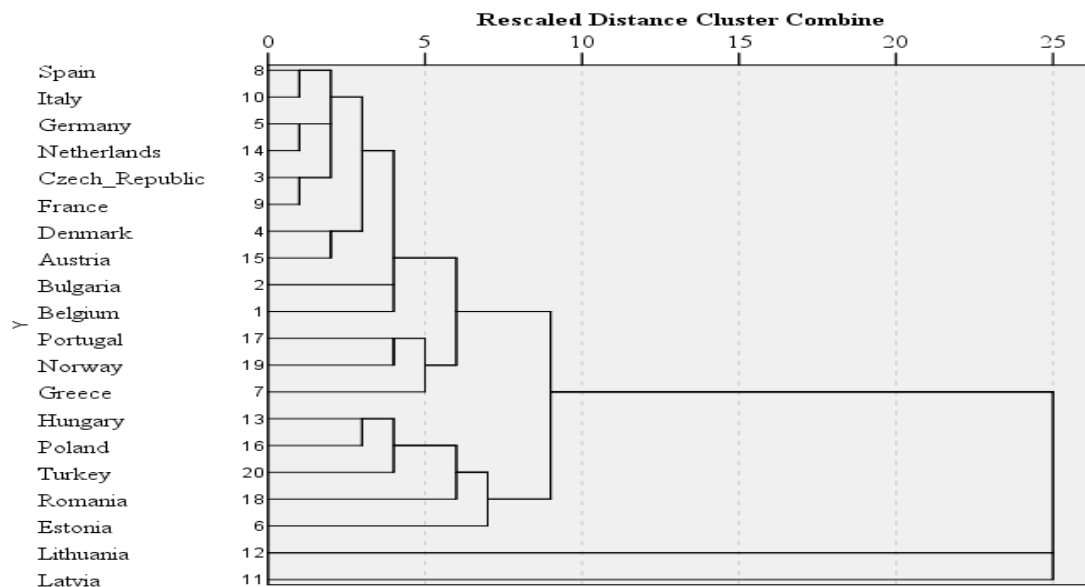
Source: own calculus

For this first cluster, for a significance threshold of  $\alpha=0.15$  (Confidence Level 85%), we reject the null hypothesis ( $H_0$ ) and accept the  $H_1$  hypothesis: all the averages are statistically significant.

In these conditions, the values of standard deviation highlight the fact that, for the states in this cluster, there is a very good similarity (Confidence Level 95%, significance threshold  $\alpha=0.05$ ) between the evolution of industrial production indices of Manufacture of food products and Manufacture of beverages which increased on average by 0.59% and 0.42% respectively, as well as in the case of Manufacture of basic metals, where it has been recorded a mean reduction of production by 1.32%.

For a Confidence Level of 90% (significance threshold  $\alpha=0.1$ ), a similar evolution is recorded in the case of Manufacture of wearing apparel and Manufacture of chemicals and chemical products, where production decreases have been recorded, on average, by 14.15% and 0.09% respectively, as well as in the case of Manufacture of basic pharmaceutical products and pharmaceutical preparations, where increases by 6.06% have been recorded.

However, in the case of Manufacture of computer, electronic and optical products and Manufacture of electrical equipment, they are statistically significant only for a significance threshold of  $\alpha=0.15$  (Confidence Level 85%). It should be outlined that, in the case of these product categories, there are great differences between industrial production indices, which for Manufacture of computer, electronic and optical products fall between 77.29% in Spain and 115.64% in Germany, and for Manufacture of electrical equipment, between 74.53% in Italy and 131.05% in Czech Republic.



**Fig. 1.** The dendrogram using Average Linkage (Between Groups), in the case of eight variable analysis

Source: own construction using SPSS

Extending this cluster with four more states, Denmark, Austria, Bulgaria and Belgium, leads to modifications of the values shown in Table 1. Except Manufacture of electrical equipment (Table 2), where the standard deviation recorded a slight decrease, given that it continues to have very high values, the standard deviation values for the other seven variables have increased.

**Table 2.** The average, standard deviation (Std.dev.) and variation coefficient (V) values corresponding to the cluster formed by: Spain, Italy, Germany, Netherlands, Czech Republic, France, Denmark, Austria, Bulgaria and Belgium

	<b>FP</b>	<b>BV</b>	<b>WA</b>	<b>CHP</b>	<b>PHP</b>	<b>BM</b>	<b>COP</b>	<b>EE</b>
<b>Average</b>	100.12	102.32	84.68	102.99	118.76	101.07	103.65	97.82
<b>Std.dev.</b>	4.68	5.24	8.88	9.13	19.08	6.29	16.42	18.73
<b>V (%)</b>	4.68	5.12	10.48	8.86	16.06	6.23	15.84	19.15

Source: own calculus

Extending the initial cluster with four more states produced modifications regarding the significance threshold corresponding to the values of the eight variables. Therefore, the significance threshold corresponding to the value of indices of the Manufacture of basic pharmaceutical products and pharmaceutical preparations increases from  $\alpha=0.1$  to  $\alpha=0.15$  (Confidence Level decreases from 90% to 85%), and the significance threshold corresponding to the value of indices of the Manufacture of computer, electronic and optical products decreases from  $\alpha=0.15$  to  $\alpha=0.1$  (Confidence Level increases from 85% to 90%).

The data in Table 2 show that the industrial production in the 10 states forming the cluster is relatively constant for Manufacture of food products (an increase of only 0.12%) and it showed slight increases for Manufacture of beverages (2.32%) and Manufacture of basic metals (1.07%).

The reduction, on average, by 15.32% of the Manufacture of wearing apparel is also significant. Including the four states in this cluster led to a significant modification of average and standard deviations of Manufacture of basic pharmaceutical products and pharmaceutical preparations, from 99.91% to 118.76% for the average deviation and from 8.84% to 19.08% for the standard deviation. These modifications occur because the index of Manufacture of basic pharmaceutical products and pharmaceutical preparations, the case of the newly added countries, has values between 121.97% in Austria and 152.19% in Belgium. Adding new states would lead to more inconclusive results.

A second cluster is formed by Portugal, Norway and Greece. Its main characteristics are shown in Table 3.

**Table 3.** The average, standard deviation (Std.dev.) and variation coefficient (V) values, corresponding to the cluster formed by: Portugal, Norway and Greece

	<b>FP</b>	<b>BV</b>	<b>WA</b>	<b>CHP</b>	<b>PHP</b>	<b>BM</b>	<b>COP</b>	<b>EE</b>
<b>Average</b>	100.24	87.01	86.56	89.37	101.27	97.49	96.93	92.10
<b>Std.dev.</b>	5.46	5.01	23.84	6.70	6.39	8.97	21.12	33.97
<b>V (%)</b>	5.44	5.76	27.54	7.50	6.31	9.20	21.79	36.89

Source: own calculus

The cluster formed by Portugal, Norway and Greece is much more homogeneous. This characteristic is also due to the fact that it consists of only three states as opposed to six, respectively ten states included in the clusters analysed above.

For a Confidence Level of 90% ( $\alpha=0.1$ ), the average values for Manufacture of food products, Manufacture of basic pharmaceutical products and pharmaceutical preparations, and Manufacture of beverages are statistically significant. Therefore we can conclude that in those

three countries, the volume of Manufacture of food products was relatively constant (with an increase of only 0.24%), the volume of Manufacture of basic pharmaceutical products and pharmaceutical preparations recorded an increase of 1.27%, and the volume of Manufacture of beverages decreased, on average, by 12.99%.

Also, for a Confidence Level of 85% ( $\alpha=0.15$ ), the average values for Manufacture of chemicals and chemical products, and Manufacture of basic metals are statistically significant. Consequently, another characteristic of this cluster is the volume decrease for Manufacture of basic metals, by 2.51%, and also for Manufacture of chemicals and chemical products, by 10.63%.

For the cluster formed by Portugal, Norway and Greece, for the value of variance for Manufacture of wearing apparel, Manufacture of computer, electronic and optical products, and Manufacture of electrical equipment, we accept the null hypothesis: the averages are not statistically significant.

A third cluster is formed by Hungary, Poland, Romania, Estonia and Turkey. Its main characteristics are shown in Table 4.

**Table 4.** The average, standard deviation (Std.dev.) and variation coefficient (V) values corresponding to the cluster formed by: Hungary, Poland, Romania, Estonia and Turkey

	FP	BV	WA	CHP	PHP	BM	COP	EE
<b>Average</b>	115.89	106.35	108.69	116.44	113.72	110.52	136.68	129.50
<b>Std.dev.</b>	3.92	10.11	6.43	7.24	19.73	10.38	60.25	21.49
<b>V (%)</b>	3.38	9.51	5.91	6.22	17.35	9.39	44.08	16.59

Source: own calculus

Regarding this cluster, for five out of all eight indicators, the values of variance are statistically significant. For Manufacture of basic pharmaceutical products and pharmaceutical preparations, Manufacture of computer, electronic and optical products, and Manufacture of electrical equipment, for a significance threshold of  $\alpha=0.15$ , we accept the null hypothesis: the averages are not statistically significant.

Also, for a Confidence Level of 90% ( $\alpha=0.1$ ), the average values for Manufacture of beverages, Manufacture of wearing apparel, Manufacture of chemicals and chemical products, and Manufacture of basic metals are statistically significant. Therefore we can conclude that the five countries forming this cluster are characterized by significant increases of production volume for these four product categories, with values between 6.35% for Manufacture of beverages, and 16.44% for Manufacture of chemicals and chemical products.

## Manufacture of Food, Beverages and Wearing Apparel

A first refining of the analysis regarding the structure of the analysed states, related to industrial production indices on product categories, covered Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel.

To identify the clusters, the Single linkage method was also used, resulting in the dendrogram shown in Figure 2. To analyse the characteristics of the obtained clusters, the average and standard deviation have been determined for each of the three indicators, and to evaluate the representativeness of average values, the values of variation coefficients have been calculated.

**Table 5.** The cluster component for Manufacture of food, beverages and wearing apparel

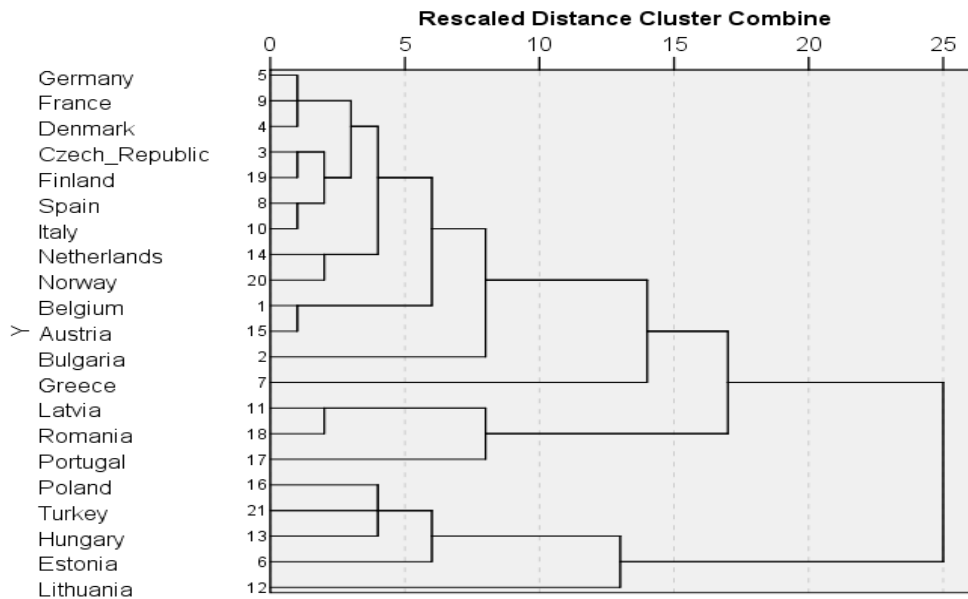
Cluster	Country
1	Belgium, Czech Republic, Denmark, Germany, Spain, France, Italy, Netherlands, Austria, Finland, Norway
2	Estonia, Hungary, Poland, Turkey
3	Latvia, Portugal, Romania
4	Bulgaria
5	Greece
6	Lithuania

Source: Own construction

To analyse the structuring of the 21 states (Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Greece, Spain, France, Italy, Latvia, Lithuania, Hungary, Netherlands, Austria, Poland, Portugal, Romania, Finland, Norway and Turkey) taken into account depending on the index values of the industrial production recorded in 2014 compared to 2010 related to the three product categories, there have been considered three out of the six resulted clusters (Table 5).

For cluster 1, for a significance threshold of  $\alpha=0.05$  (Confidence Level 95%), we reject the null hypothesis ( $H_0$ ) and accept the  $H_1$  hypothesis: the averages are statistically significant for Manufacture of food products and Manufacture of beverages. In these circumstances there is a great similarity in the way the industrial production volumes evolved in these two product categories. For Manufacture of food products, the states in this cluster recorded in 2014 production values around the 101.01% average, respectively 103.10% for Manufacture of beverages.

For Manufacture of wearing apparel we accept the  $H_1$  hypothesis (the averages are statistically significant) for a significance threshold of  $\alpha=0.1$  (Confidence Level 90%). Except Finland, the volume of Manufacture of wearing apparel decreases in all the other countries. At the cluster level, there was a decrease of 12.83%.



**Fig. 2.** The dendrogram, using Average Linkage (Between Groups), in the case of Manufacture of food, beverages and wearing apparel

Source: own construction using SPSS

The second cluster contains 4 states (Table 5). For this cluster, we rejected the null hypothesis ( $H_0$ ) and accepted the  $H_1$  hypothesis (the averages are statistically significant) for a significance threshold of  $\alpha=0.1$  (Confidence Level 90%), for the values of all indicators.

The countries in this cluster are characterized by significant increases of the industrial production volume for all three product categories included in the average, with 8.95% for Manufacture of wearing apparel and 115.64% for Manufacture of food products.

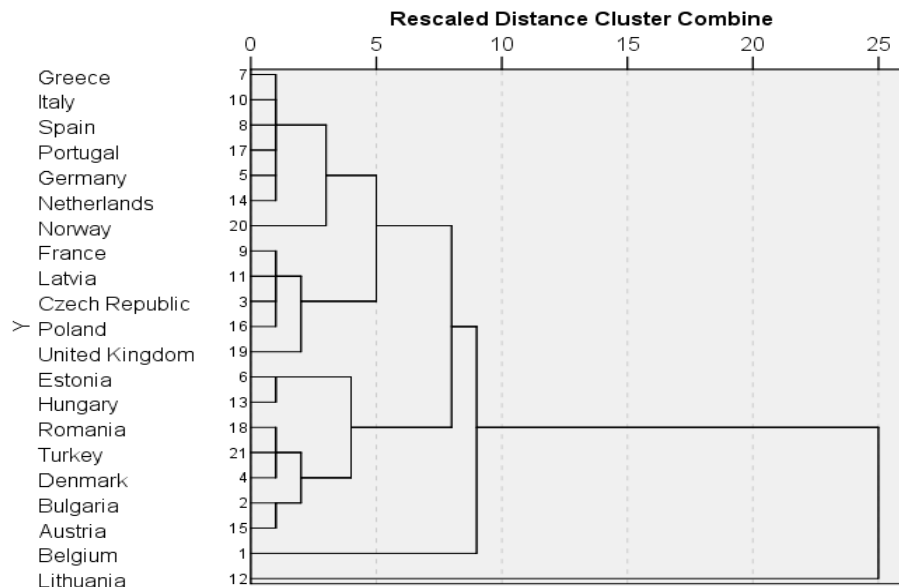
The third cluster considered in this category of products consists of Latvia, Portugal and Romania. An important characteristic of this cluster is the very high similarity between the volumes of Manufacture of wearing apparel, which increased with values around an average of 8.92%. For the average value recorded in this product category, Confidence Level is 95%.

The average values of the indices of industrial production at the other two indicators are statistically significant for a Confidence Level of 88% (significance threshold  $\alpha=0.12$ ) and outline an increase in production in 2014 compared to 2010, with an average of 10.13% for Manufacture of food products, as well as a decrease of Manufacture of beverages compared to 2010, in average, with 10.31%.

According to the dendrogram shown in Figure 2, at the continuation of including new members in the already analysed clusters, Bulgaria followed by Greece would enter cluster 1, and Lithuania in cluster 2. But these extensions would affect the values of Confidence Level of variable averages, lowering them, which would lead to lower result accuracy and altered conclusions.

## Manufacture of Chemical and Pharmaceutical Products

A second direction of refining the analysis was based on the indices Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations. The dendrogram obtained for these indicators is shown in Figure 3.



**Fig. 3.** The dendrogram, using Average Linkage (Between Groups), in the case of Manufacture of chemical and pharmaceutical products

Source: own construction using SPSS



To analyse the structuring of the considered states (Table 6) depending on the index values of the industrial production recorded in 2014 compared to 2010, related to Manufacture of chemicals and chemical products and Manufacture of basic pharmaceutical products and pharmaceutical preparations, two out of the four resulted clusters have been taken into account.

**Table 6.** The cluster component for Manufacture of chemicals and chemical products and Manufacture of basic pharmaceutical products and pharmaceutical preparations

Cluster	Country
1	Czech Republic, Germany, Greece, Spain, France, Italy, Latvia, Netherlands, Poland, Portugal, United Kingdom, Norway
2	Bulgaria, Denmark, Estonia, Hungary, Austria, Romania, Turkey
3	Belgium
4	Lithuania

Source: Own construction

The first cluster is formed by 12 states (Table 6). For this cluster, the average values of production indices in 2014 compared to 2010, for Manufacture of chemicals and chemical products and Manufacture of basic pharmaceutical products and pharmaceutical preparations, are statistically significant for a significance threshold of  $\alpha=0.10$  (Confidence Level 90%). For the two product categories, the value of production volume in 2010 differs insignificantly compared to 2010. At cluster level, a decrease of 0.61% is recorded for Manufacture of chemicals and chemical products, and an increase of 0.21% for Manufacture of basic pharmaceutical products and pharmaceutical preparations.

The second cluster is formed by 7 states (Table 6). This cluster is characterized by significant increases of the industrial production volume for the two product categories. At cluster level, the volume of Manufacture of chemicals and chemical products increased in 2014 with 14.44% compared to 2010, and the volume of Manufacture of basic pharmaceutical products and pharmaceutical preparations increased in the same period with 27.65%.

The average values of the industrial production indices in 2014 compared to 2010 are statistically significant for a Confidence Level of 90% (significance threshold  $\alpha=0.10$ ) for Manufacture of chemicals and chemical products, and a Confidence Level of 85% (significance threshold  $\alpha=0.15$ ) for Manufacture of basic pharmaceutical products and pharmaceutical preparations.

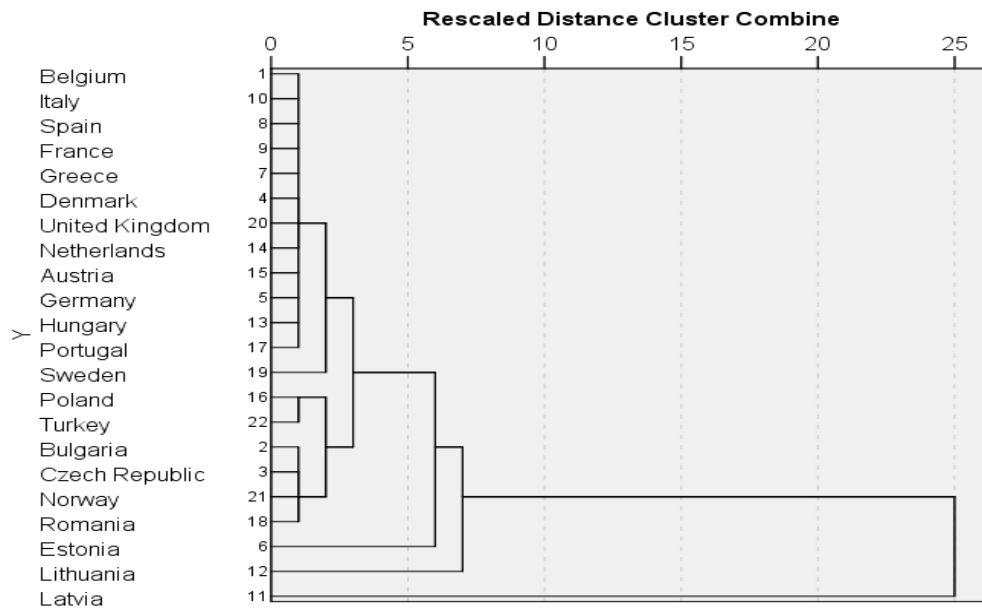
In the case of Belgium and Lithuania, due to large differences between the values of industrial production indices in these countries and the average values of the two clusters analysed above, they have been considered separately. Note that in 2014 in Belgium, the volume of Manufacture of basic pharmaceutical products and pharmaceutical preparations was 52.19% higher than in 2010, and in Lithuania the increase was double - 104.98%.

## **Manufacture of Basic Metals, Computer, Optical Products, and Electrical Equipment**

The third direction of refining the analysis focused on the last three indicators of the research: Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment. The Single linkage method was used to identify the clusters. The dendrogram obtained for these three indicators is shown in Figure 4.

To analyse the way in which the considered states can be grouped to identify some common characteristics about the Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment, considering the dendrogram shown in

Figure 3, the grouping of the states was conducted until two significant clusters were obtained (Table 6). Three clusters have also been obtained, each containing a single element.



**Fig. 4.** The dendrogram, using Average Linkage (Between Groups), in the case of Manufacture of basic metals, computer, optical products, and electrical equipment

Source: own construction using SPSS

The first cluster is formed by 13 states (Table 7). In this case, the average value of the industrial production index in 2014 compared to 2010 for Manufacture of basic metals is statistically significant for a Confidence Level of 95% (significance threshold  $\alpha=0.05$ ). This aspect outlines a good similarity in the evolution of this indicator, in the states forming the cluster. At cluster level, the volume of Manufacture of basic metals, in the analysed period, records an average increase of 1.84%.

For the other two product categories, for a significance threshold of  $\alpha=0.10$  (Confidence Level 90%), we reject the null hypothesis ( $H_0$ ) and accept the  $H_1$  hypothesis: the averages are statistically significant. In these conditions, the result is that both the volumes of Manufacture of computer, electronic and optical products, and Manufacture of electrical equipment, in the analysed period, have decreased with 8.92% and 10.51% respectively.

**Table 7.** The cluster component for Manufacture of basic metals, computer, optical products, and electrical equipment

Cluster	Country
1	Belgium, Denmark, Germany, Greece, Spain, France, Italy, Hungary, Netherlands, Austria, Portugal, Sweden, United Kingdom
2	Bulgaria, Czech Republic, Poland, Romania, Norway, Turkey
3	Estonia
4	Latvia
5	Lithuania

Source: Own construction

The second cluster includes Bulgaria, Czech Republic, Poland, Romania, Norway and Turkey. For this cluster, the average value of the Manufacture of electrical equipment index is statistically significant for a significance threshold of  $\alpha=0.10$  (Confidence Level 90%) and

outlines a significant increase, with an average value of 33.57% at cluster level, for the industrial production volume of this product category.

Also, for a significance threshold of  $\alpha=0.15$  (Confidence Level 85%), the average of the Manufacture of basic metals index is statistically significant. For this product category, the average at cluster level was in 2014 with 4.51% greater than in 2010.

Regarding the average value of the Manufacture of computer, electronic and optical products index, for a significance threshold of  $\alpha=0.15$  (Confidence Level 85%), we accept the null hypothesis: the averages are not statistically significant. This fact is due to low values of this indicator, recorded in Poland (92.41%). If Poland is excluded from this cluster, then the average value of this indicator (131.04%) would become statistically significant, but the statistical significations of the other two indicators would be negatively affected (the value corresponding to Manufacture of basic metals would become statistically insignificant, and the Confidence Level for Manufacture of electrical equipment would decrease from 95% to 90%).

The other three states not included in the two clusters analysed above, have recorded different evolutions in 2014 compared to 2010. As a result, if for Manufacture of electrical equipment there are significant increases (36.13% in Estonia, 108.55% in Latvia, 104.36% in Lithuania), for the other two indicators the values are extreme. While the Manufacture of basic metals in Estonia records an increase of 6.36%, in Latvia the production volume of these product categories is decreased to 30%. A similar situation is recorded for the Manufacture of computer, electronic and optical products. While in Latvia an increase by 75.47% is recorded, in Lithuania is recorded a decrease of 9.87%.

## **Conclusions**

The study – conducted on a set of 8 indicators of industrial production for 19 EU countries, to which another two have been added (Norway and Turkey) – was completed using the cluster analysis. This analysis assumed on one hand, developing the dendrogram, and on the other hand, the analysis of the following indicators: average, standard deviation, variation coefficient. At the same time, the study took into account the analysis of 8 indicators (Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel, Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations, Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment) resulting in three clusters, but also, for a more thorough analysis, it considered studying three distinct groups: group I (Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel) resulting in 6 clusters, group II (Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations) resulting in 4 clusters and group III (Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment) resulting in 5 clusters.

The period before the economic crisis is characterized by significant increases in imports and exports. Since the growth rate of imports was higher than the trade deficit increased continuously.

The obtained results refer to the following conclusions:

Regarding both the 8 indicators and the 3 groups, the main countries situated in the first cluster are: Germany, Spain, France, Italy, Netherlands; thus, it is outlined that these countries have the highest Volume index of industrial production in 2014 compared to 2010;

Other countries included in the first cluster established using the 8 indicators, countries having also a primordial position in other groups, are: Czech Republic (in groups I and II), Belgium, Denmark, Austria (in groups I and III) and Bulgaria, which does not appear in other groups;

Norway is the country which distances itself through a significant volume index of production in Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel, belonging to the first cluster of the group I of products (like Finland), and also in Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations (group II);

Portugal, United Kingdom and Greece represent the countries included in the first cluster, regarding the high level of volume index of production in Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations (group II) and Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment (group III);

In the first cluster of group II, Poland and Latvia are also included, and in the cluster of group III, Hungary and Sweden are included;

The other countries are distributed in clusters 2, 3, 4 and 5, corresponding to their performances and the category in which they were included for analysis;

Romania is included in the second cluster, in relation to the volume index of production in Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations (group II) and Manufacture of basic metals, Manufacture of computer, electronic and optical products, Manufacture of electrical equipment (group III); Romania also appears in the third cluster as a result of the analysis of the 8 indicators, but also for group I of Manufacture of food products, Manufacture of beverages, Manufacture of wearing apparel.

The cluster-based distribution of the results of industrial production indices in 2014 compared to 2010, on product categories and countries, targeted not only a comparative outlining of the development level, but also a constructive orientation of some global economic development policies, customized on already set levels. These development strategies might need future studies, with different visions on quantitative and qualitative analysis, which would include the presented indicators or other ones, considered more significant in the established context..

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