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# Statistical insights from Romanian data on higher education

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## ABSTRACT

*This paper aims to use cluster analysis to make a comparative analysis at regional level concerning the Romanian higher education. The evolution of higher education in post-communist period will also be presented, using quantitative traits. Although the focus is on university education, this will also include references to the total education by comparison. Then, to highlight the importance of higher education, the chi-square test will be applied to check whether there is an association between statistical regions and education level of the unemployed.*

**Keywords:** *higher education, cluster analysis, chi-square test, R*

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## INTRODUCTION

The performance of the Romanian educational system has become an increasing concern, as a consequence of the results recorded at the Bacculaureate and tenure examinations. The transition from communism to capitalism has affected the entire Romanian educational system, including higher education. Not only the quality of the education has been discussed (Dragomirescu L., 2007 or Chiriac A. S., 2012), but also the need for its adjustments to the labor market has been acknowledged recently. Despite the large body of literature stressing the idea that something should be done, most of the contributions remained theoretical.

The paper provides a comparative quantitative analysis of the educational development in various Romanian regions, and discusses the evolution of post-communist education, with emphasis on the university education. The purpose of the regional analysis is to discover some typologies and identify disparities for balancing underdeveloped areas, in order to take measures to bring them at the same level.

## LITERATURE REVIEW

Unlike the past, when higher education was accessible only to a small number of people and taken as a privilege, a mass higher education addresses currently to an increasingly larger population, in an attempt to raise qualified human capital able to assist the economic growth and development: the Europe 2020 Strategy set the goal

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that 40% of young Europeans should have a higher education diploma by 2020. The increasing interest on the topic resulted, over the last 25 years, in a huge volume of research. Roman M. (2009) has discussed the current state of the Romanian higher education along with the progress in the implementation of Bologna process, stressing the importance of the demographic trend, which impacts both the evolution and the quality of the students' population as well as of the teachers'. Nicolescu L. (2003) provides insights from the business area, the main concern being the relationship between higher education and labor market / business environment. A SWOT analysis is done here showing strengths, weaknesses, opportunities and threats of public and private higher education institutions. 113 companies were involved in this study. Andrei T. et al (2010) conducted a comparative analysis involving three countries: Romania, Bulgaria and Hungary, using econometric techniques (Granger test, ADF unit root test) to identify the characteristics of the evolution of some time series based on important variables that characterize higher education.

Popovici A. (2012) discussed the challenges faced by the Romanian higher education in the European context, in the post-communist period. Very important, there have been references to the Europe 2020 strategy, about the incompatibility between the Romanian system of thinking and Bologna educational system and the internationalization of European and Romanian higher education. Pierson C. and Odsliu M. (2012) show Romania as a country facing profound transformation from a Soviet influence to one that can fit the EU standards, by applying successive reforms. Besides that, Dragoescu M. R. (2013) also shows changes in the Romanian higher education after 1990, by presenting the evolution of some relevant indicators and applying specific econometric methods: ADF test and the Engle Granger test for causality detection. Here too it is confirmed that extensive development cannot be sustained on a long term.

Mirica A. (2014) states that higher education is a solution to lower unemployment. To support this, the demand for higher education was quantified into the number of freshmen to the number of high school graduates, then the Engel-Granger methodology was used to examine long-term relationship, following a brief analysis of unemployment and higher education in the European context. Curaj A. et al (2015) presents the Romanian higher education reforms in the Bologna process, and also the national challenges. And one of the concerns here is the need for evaluation, to ensure quality and to compare institutions. The internal quality assurance in Romanian universities is suspected of remaining still at the status of formality.

This article aims for a different approach to expose the situation of higher education, reported at the same time to the European context. Besides updating the evolution of higher education, a regional comparison is conducted, by applying the cluster analysis to a number of characteristics that describe education quantitatively. According to Balu M. E. and Furtuna F. (2006), the territorial economics analysis can use cluster analysis for hierarchical classification, based on performance and strategy. The regional development program among European Union countries has determined the use of statistical analysis methods for a better coordination, but also for maintaining sustainability. A cluster algorithm for comparing the 8 Romanian regions was applied

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by Babucea A. G. (2007) using the average monthly nominal earnings of employed civilian population in the national economy areas (agriculture, forestry, industry, construction, trade, hotels and restaurants, transport, post and telecommunications, banking, financial and insurance, real estate, public administration, education, health and other next activities of the national economy).

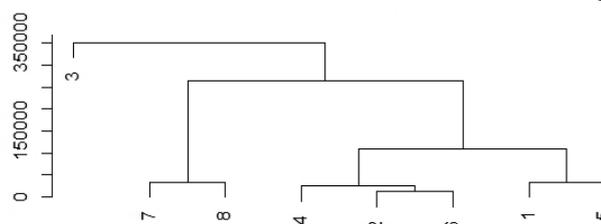
## CLASSIFICATION OF ROMANIAN REGIONS AFTER THE MAIN FEATURES OF EDUCATION

In the following, the cluster algorithm will be applied on the eight Romanian regions (West, Northwest, Northeast, Southeast, South-Muntenia, South-West Oltenia, Center, Bucharest-Ilfov). The characteristics chosen are: categories of school facilities, school population, number of teachers, number of PCs, number of classrooms and number of graduates. Data was collected from the website of the National Institute of Statistics, for 2013. As the number of graduates couldn't have been obtained until 2012, it was forecasted for 2013, using the polynomial model, the data being processed in Excel.

Cluster analysis was conducted in R using the k-means algorithm, first on the total education and then on the higher education, for subsequent comparison. For the graphic interpretation the regions were noted as follows: Northwest – 1, Center – 2, Northeast – 3, Southeast – 4, South-Muntenia - 5, Bucharest-Ilfov – 6, South-West Oltenia – 7, West - 8.

**Dendrogram resulted from the total education**

*Figure 1*



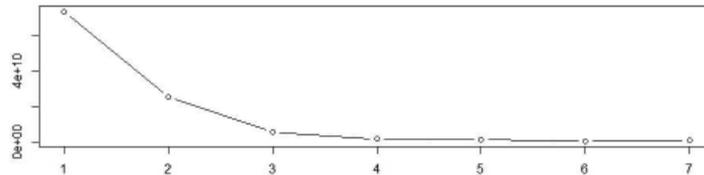
In creating the dendrogram the following commands were used:

```
> d <- dist(cluster_regions, method = "euclidean")  
> regions <- hclust(d, method="ward.D")  
> plot(regions)
```

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### Number of clusters on total education

Figure 2



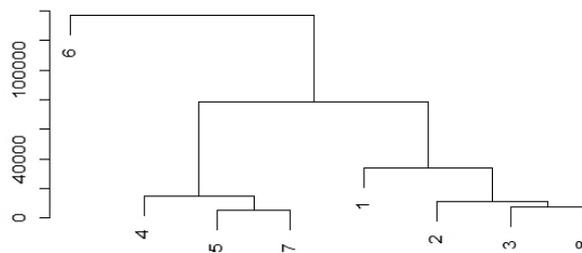
In determining the number of clusters the following commands were used:  
> wss <- (nrow(cluster\_regions)-1)\*sum(apply(cluster\_regions,2,var))  
> for (i in 1:7) wss[i] <- sum(kmeans(cluster\_regions, centers=i)\$withinss)  
> plot(1:7, wss, type="b", xlab="Number of Clusters",ylab="Within groups

sum of squares

As it can be seen from Figure 2, the ideal number of clusters would be 4. From Figure 1 we can determine the grouping possibilities for the 8 development regions. On the total education, the North East region is isolated. As for the rest, the North-West region is grouped with South Muntenia, Center with Southeast and Bucharest-Ilfov, while South-West Oltenia with the West. It may be noted that most regions were grouped with their neighbors. An interesting fact is that Bucharest-Ilfov was not isolated from the other regions.

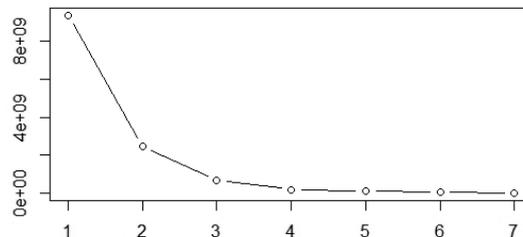
### Dendrogram resulted from the higher education

Figure 3



### Number of clusters on higher education

Figure 4

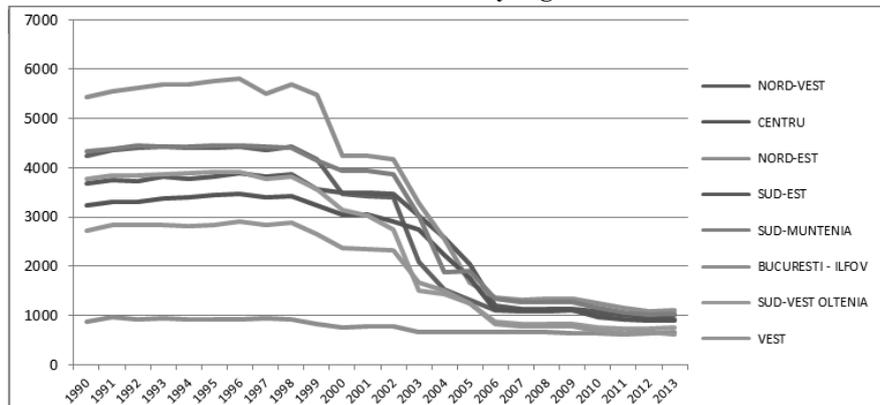


For higher education, as seen in Figure 4, the ideal number of clusters would also be 4 and from Figure 3 we can determine the possibilities for grouping the 8 development regions. Here, as expected, the Bucharest-Ilfov region is isolated. As for the rest, Southeast region is grouped with South Muntenia and West-Oltenia, Center with Northeast and West, and Northwest is slightly different than these.

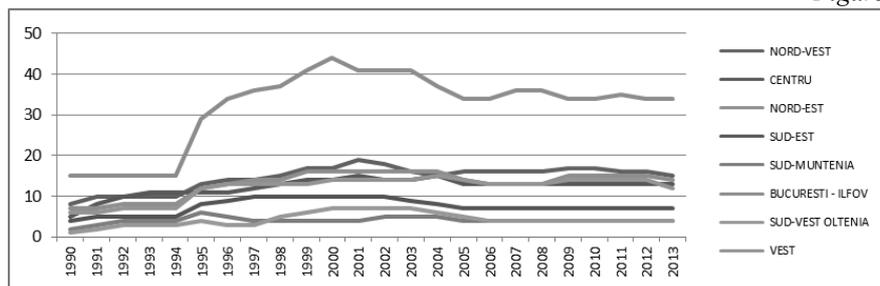
## REGIONAL HIGHER EDUCATION IN FIGURES

Further along, the development of characteristics used in the cluster analysis will be presented to better observe the differences or similarities between regions and whether these have been preserved over time. This data was also obtained from the website of the National Institute of Statistics.

**The evolution in number of schools by region between 1990 - 2013**



**The evolution in number of higher education institutions by regions between 1990 - 2013**



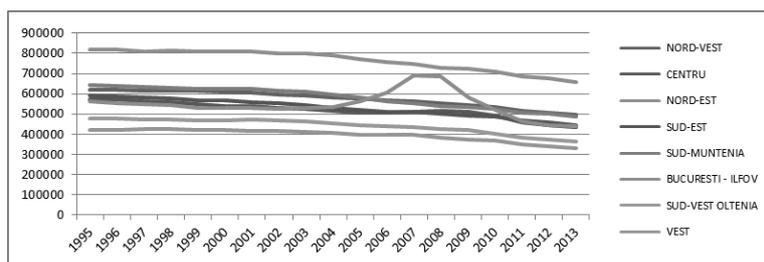
*Figure 6*

From the two graphs (Fig. 5 and Fig. 6) we can observe a very interesting phenomenon: although over the years there has been a decline in the total number of school units in most development regions, the number of higher education institutions

has recorder a slow but visible growth. The only exception is the Bucharest-Ilfov region, where we can see a stagnation of the number of schools and an explosive growth of the number of higher education institutions.

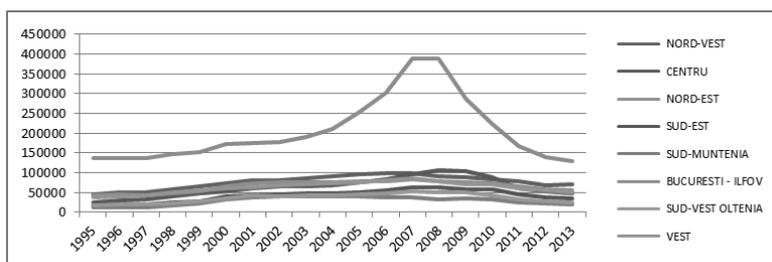
**Evolution of the school population by regions between 1995 - 2013**

Figure 7



**Evolution of the students' number by regions between 1995 - 2013**

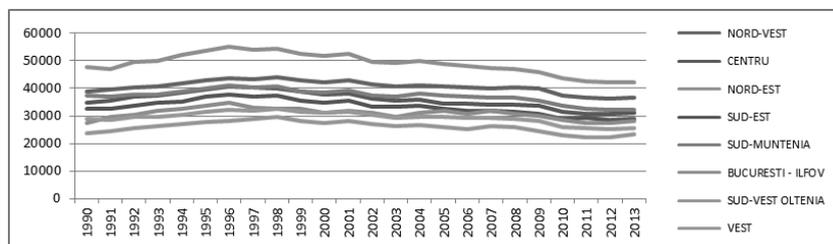
Figure 8



In these two graphs (Fig. 7 and Fig. 8), the Bucharest-Ilfov region spikes at some point in time, once again as an exception. In general, in most regions, although the total school population is decreasing, the total number of students is increasing in time.

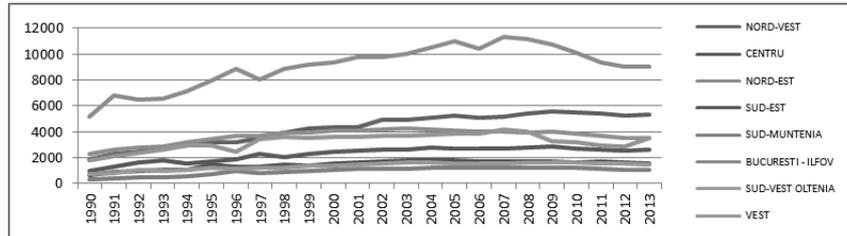
**Evolution of teachers (total) by region between 1990 - 2013**

Figure 9



**Evolution of teachers in higher education by region between 1990 - 2013**

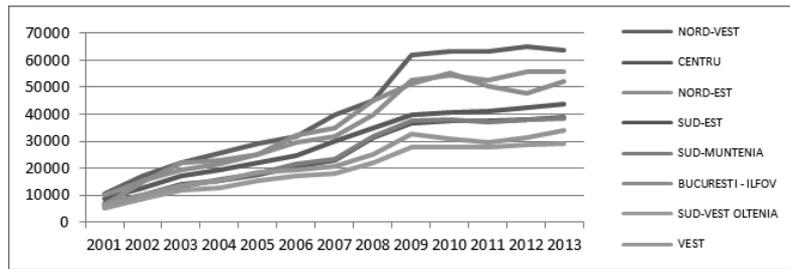
*Figure 10*



From these two graphs (Fig. 9 and Fig. 10) we can see that although the trend of total number of teachers is decreasing, for the higher education this number is slightly increasing. Analyzing the other graphics as well, this was an expected result.

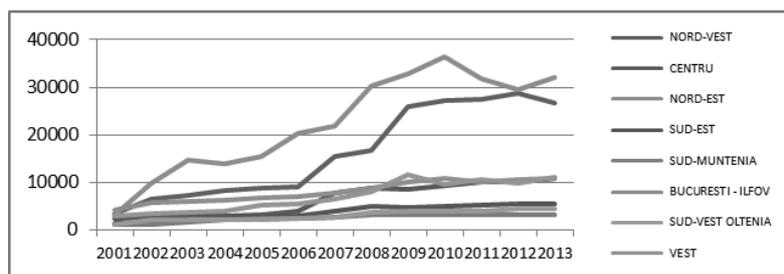
**Evolution of the number of PCs (total) by regions between 2001 - 2013**

*Figure 11*



**Evolution of the number of PCs in Higher Education by regions between 2001 - 2013**

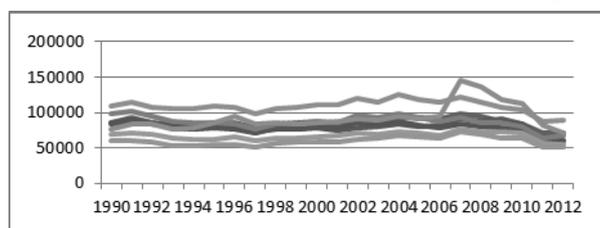
*Figure 12*



As for the number of PCs, a significant increase in both the total and higher education can be observed (fig. 12). What is noteworthy here is that per total, the North-West is best equipped in this regard, while in higher education is on the second place, very close to the Bucharest-Ilfov region (fig. 11).

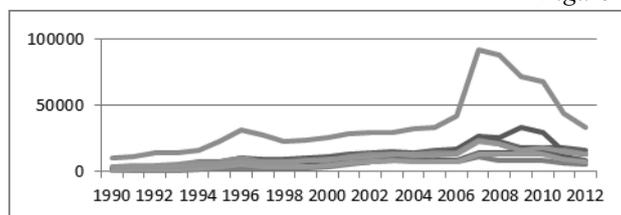
**Evolution of the number of graduates (total) by region between 1990 - 2012**

*Figure 13*



**Evolution of the number of graduates in higher education by region between 1990 -2012**

*Figure 14*



Regarding the total number of graduates by region (fig. 13 and fig. 14), a slight decrease can be observed on the total education, and a slight increase on higher education. Once again the Bucharest-Ilfov region is apart from the others.

**THE ASSOCIATION BETWEEN DEVELOPMENT REGIONS AND LEVEL OF EDUCATION OF UNEMPLOYED**

To make an association between the development regions of Romania and education level of the unemployed, data from the website of the National Agency for Employment in February 2015, was collected and systematized.

**Level of education for unemployed on development regions in Romania**

*Table 1*

Development regions	Level of education for unemployed			Total individuals
	Primary	Secondary	Tertiary	
NORD-VEST	7213	4084	1707	13004
CENTRU	8099	4536	1854	14489
NORD-EST	11308	4496	1676	17480
SUD-EST	9978	4266	1513	15757
SUD-MUNTENIA	10765	5325	1712	17802
BUCURESTI - ILFOV	2244	2600	1537	6381
SUD-VEST OLTENIA	8146	5181	1867	15194
VEST	5267	3146	1529	9942
<b>Total individuals</b>	<b>63020</b>	<b>33634</b>	<b>13395</b>	<b>110049</b>

The data in Table 1 refers to the dependency of the two qualitative variables: X (development regions) and Y (level of education for unemployed) whose variants are more than two. Their distribution shows that the hypothesis of statistical dependency between the two variables can be accepted. Thus, in this case, the acceptance or rejection of the hypothesis of statistical dependence between two variables can be done by using the  $\chi^2$  test.

The test hypotheses are:

H0: Variable X is independent of Y;

H1: There is a relationship of association between the two variables.

So based on these data, the theoretical frequencies which are presented in Table 2, have been processed.

**The education for unemployed by region with expected frequencies calculated**

*Table 2*

Development regions	Level of education for unemployed			Total individuals
	Primary	Secondary	Tertiary	
NORD-VEST	7446.79	3974.38	1582.83	13004
CENTRU	8297.18	4428.24	1763.58	14489
NORD-EST	10009.99	5342.37	2127.64	17480
SUD-EST	9023.31	4815.77	1917.92	15757
SUD-MUNTENIA	10194.39	5440.78	2166.83	17802
BUCURESTI - ILFOV	3654.11	1950.21	776.69	6381
SUD-VEST OLTENIA	8700.90	4643.70	1849.39	15194
VEST	5693.33	3038.55	1210.13	9942
<b>Total individuals</b>	<b>63020</b>	<b>33634</b>	<b>13395</b>	<b>110049</b>

Then the empirical value of the random variable  $\chi^2_c$  can be calculated using the following relationship:

$$\chi^2_c = \sum \sum (n_{ij} - n_{ij}^*)^2 / n_{ij}^*, \text{ i.e. } \chi^2_c = 2531.92$$

Afterwards the empirical value can be compared with the theoretical one:

$$\chi^2_c = 2531.92 > \chi^2_{0.05;14} = 23.68$$

Hence the hypothesis of independence between variables is rejected, and therefore the distribution of the unemployed by level of education is influenced by the structure of the development regions. In other words, the shift of employees to unemployment was not made by chance. Most unemployed belong to the primary education level, then to secondary and finally to tertiary.

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## CONCLUSIONS

The importance of regional analysis should not be neglected, because, in order to refer to the Romanian higher education system in the European context, we should be able to compare regions for better administration, or more precisely, to bring them to a similar level of performance, depending on the particularities and the provided indicators. Romanian higher education system is moving with small steps towards its internationalization, but to fully accomplish this, some measures should be taken into consideration while determining the similarities or differences between regions. In Romania, with minor exceptions, the most developed region is Bucharest-Ilfov, the others being situated at a fairly large distance. Although, this can be explained by the fact that Bucharest is the capital of the country, nevertheless, the problem of a harmonious and balanced economic development and achieving a high quality of life should also be transferred to the other regions. Yet, an interesting fact, while taking into consideration quantitative traits that describe the Romanian total education, is that Bucharest-Ilfov was associated with other two regions (Center and Southeast) which denoted that Bucharest-Ilfov might be starting to blend in.

It can also be concluded that although overall Romanian education is experiencing a demographic decline, the university plan is registering a growth phenomenon, as shown in the illustrated graphics. This could mean that increasingly more Romanians are becoming aware that higher education is no longer inaccessible, but gradually became necessary to meet the labor market demands. Even the conducted analysis regarding the association between the development regions and the unemployed level of education, emphasizes that a more advanced training offers more stability and opportunities on the labor market.

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