Bulletin of the *Transilvania* University of Braşov • Vol. 3 (52) - 2010
Series V: Economic Sciences

EDUCATION IN EUROPEAN COUNTRIES

Nicoleta PETCU[1]

Abstract: *Education, vocational training and lifelong learning play a vital role in both an economic and social context. The paper herein aims to identify Romania's place within the UE-countries, considering a series of general indices: total public expenditure on education as a percentage of GDP, private expenditure on education as % of GDP, annual expenditure on public and private educational institutions per pupil/student - by level of education, school expectancy, pupils and students, students - tertiary education, mobility of students in Europe, science and technology graduates, doctorate students in science and technology fields. Analysis methods: main components analysis, cluster analysis.*

Key words: *education indicators – non-finance, indicators on education finance, cluster analysis.*

1. Introduction

The European Council adopted in 2001 a set of goals and objectives for education and training systems that are to be attained by 2010, with education ministers agreeing on three goals:

- to improve the quality and effectiveness of education and training systems;
- to ensure that they are accessible to all;
- to open up education and training to the wider world.

These ambitious goals were subsequently subdivided into specific objectives covering the various types and levels of education and training, including areas such as: teacher training; basic skills; the integration of information and communication technologies (ICTs); efficiency of investments; language learning; lifelong guidance; flexibility to make learning accessible to all; mobility; and citizenship education.

2. Indicators

2.1 Indicators on Education Finance

Total public expenditure on education - (EUR PPS million). Generally, the public sector funds education either by bearing directly the current and capital expenses of educational institutions (direct expenditure for educational institutions) or by supporting students and their families with scholarships and public loans as well as by transferring public subsidies for educational activities to private firms or non-profit organisations (transfers to private households and firms); both types of transactions together are reported as total public expenditure on education.

Private expenditure on education as % of GDP - Expenditure on educational institutions from private sources as % of GDP, for all levels of education combined (%). Expenditure on educational institutions from private sources comprises

[1] Department of Management and Economic Informatics, *Transilvania* University of Braşov

school fees; materials such as textbooks and teaching equipment; transport to school (if organised by the school); meals (if provided by the school); boarding fees; and expenditure by employers on initial vocational training.

Public expenditure on education - Percent of GDP. This indicator is defined as total public expenditure on education, expressed as a percentage of GDP. Generally, the public sector funds education either by bearing directly the current and capital expenses of educational institutions or by supporting students and their families with scholarships and public loans as well as by transferring public subsidies for educational activities to private firms or non-profit organisations. Both types of transactions together are reported as total public expenditure on education.

2.2 Education indicators – non-finance

Pupils and students - Excluding pre-primary education (1 000). Total number of persons who are enrolled in the regular education system in each country. It covers all levels of education from primary education to postgraduate studies. It corresponds to the target population for education policy.

Students - Tertiary education (1 000). Total number of persons who are enrolled in tertiary education (including university and non-university studies) in the regular education system in each country. It corresponds to the target population for policy in higher education. It provides an indication of the number of persons who had access to tertiary education and are expected to complete their studies, contributing to an increase in the educational attainment level of the population in the country in case they continue to live and work in the country at the end of their studies.

Mobility of students in Europe - Tertiary education. This indicator presents the incoming and outgoing students for each country, using the figures provided by the host country on foreign students enrolled in tertiary education by nationality. It includes only the EU/EEA/Candidate countries and the nationalities corresponding to these countries. Countries do not have details of the numbers of their home students studying abroad. For a given nationality, the number of students studying abroad is calculated by summing the numbers provided for this nationality by the receiving countries. The lack of data on the distribution of students by nationality in certain countries leads to the underestimation of the values.

Science and technology graduates by gender - Tertiary graduates in science and technology per 1 000 of population aged 20-29 years. The indicator "Tertiary graduates in science and technology" includes new tertiary graduates in a calendar year from both public and private institutions completing graduate and post graduate studies compared to an age group that corresponds to the typical graduation age in most countries. It does not correspond to the number of graduates in these fields who are available in the labour market in this specific year. The levels and fields of education and training used follow the 1997 version of the International Standard Classification of Education (ISCED97) and the Eurostat Manual of fields of education and training (1999).

Doctorate students in science and technology fields - Total - (% of the population aged 20-29). Students participating in the second stage of tertiary education in the science and technology fields of study, as a percentage of the population 20-29 years old. This table includes the total number of students in

tertiary programs which leads to an advanced research qualification (ISCED level 6), in the educational fields Science, Mathematics and Computing and Engineering, Manufacturing and Construction. The levels and fields of education and training used follow the 1997 version of the International Standard Classification of Education (ISCED97) and the Eurostat Manual of fields of education and training (1999).

3. *k*-Means Method

Model parameters

The primary calculation in *k*-means is an iterative process of calculating cluster centres and assigning records to clusters [3]. The primary steps in the procedure are:

1. Select initial cluster centres
2. Assign each record to the nearest cluster
3. Update the cluster centres based on the records assigned to each cluster
4. Repeat steps 2 and 3 until either:

- In step 3, there is no change in the cluster centres from the previous iteration, or
- The number of iterations exceeds the maximum iterations parameter.

Clusters are defined by their centres. A **cluster centre** is a vector of values for the (encoded) input fields. The vector values are based on the mean values for records assigned to the cluster.

Selecting initial cluster centres

The user specifies *k*, the number of clusters in the model. Initial cluster centres are chosen using a maximin algorithm:

1. Initialize the first cluster centre as the values of the input fields for the first data record.
2. For each data record, compute the minimum (Euclidean) distance between the record and each defined cluster centre.
3. Select the record with the largest minimum distance from the defined cluster centres. Add a new cluster centre with values of the input fields for the selected record.
4. Repeat steps 2 and 3 until *k* cluster centres have been added to the model.

Once initial cluster centres have been chosen, the algorithm begins the iterative assign/update process.

Assigning records to clusters

In each iteration of the algorithm, each record is assigned to the cluster whose centre is closest.

Closeness is measured by the usual squared Euclidean distance

$$d_{ij} = \left\| X_i - C_j \right\|^2 = \sum_{q=1}^{Q} (x_{qi} - c_{qj})^2 \quad (1)$$

where *X*i is the vector of encoded input fields for record *i*, *C*j is the cluster centre vector for cluster *j*, *Q* is the number of encoded input fields, *x*qi is the value of the *q*th encoded input field for the *i*th record, and *c*qj is the value of the *q*th encoded input field for the *j*th record.

For each record, the distance between the record and each cluster centre is calculated, and the cluster centre whose distance from the record is smallest is assigned as the record's new cluster.

When all records have been assigned, the cluster centres are updated.

Updating cluster centres

After records have been (re)assigned to their closest clusters, the cluster centres are updated. The cluster centre is calculated as the mean vector of the records assigned to the cluster:

$$C_j = \overline{X}_j \quad (2)$$

where the components of the mean vector $\overline{X}_j$ are calculated in the usual manner,

$$\overline{x}_{qj} = \frac{\sum_{i=1}^{nj} x_{qi}(j)}{n_j} \quad (3)$$

where *n*j is the number of records in cluster *j*, $x_{qi}(j)$ is the *q*th encoded field value for record *i*which is assigned to cluster *j*.

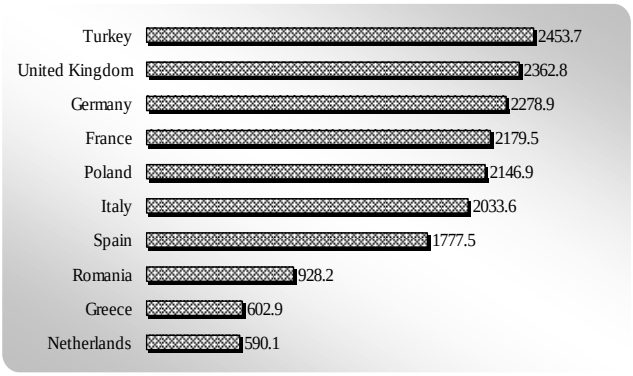


Fig. 1. *Total number of persons who are enrolled in tertiary education (The first 10 countries)*

This figure includes the total number of persons who are enrolled in tertiary education (including university and non-university studies) in the regular education system in each country. It corresponds to the target population for policy in higher education. It provides an indication of the number of persons who had access to tertiary education and are expected to complete their studies, contributing to an increase in the educational attainment level of the population in the country in case they continue to live and work in the country at the end of their studies.

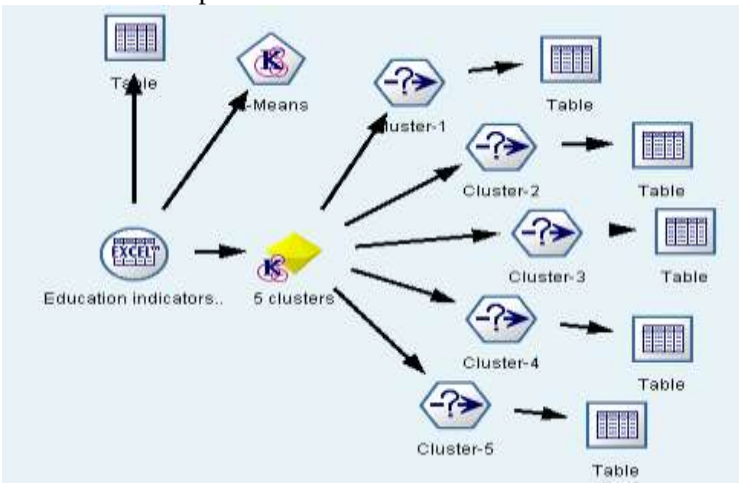
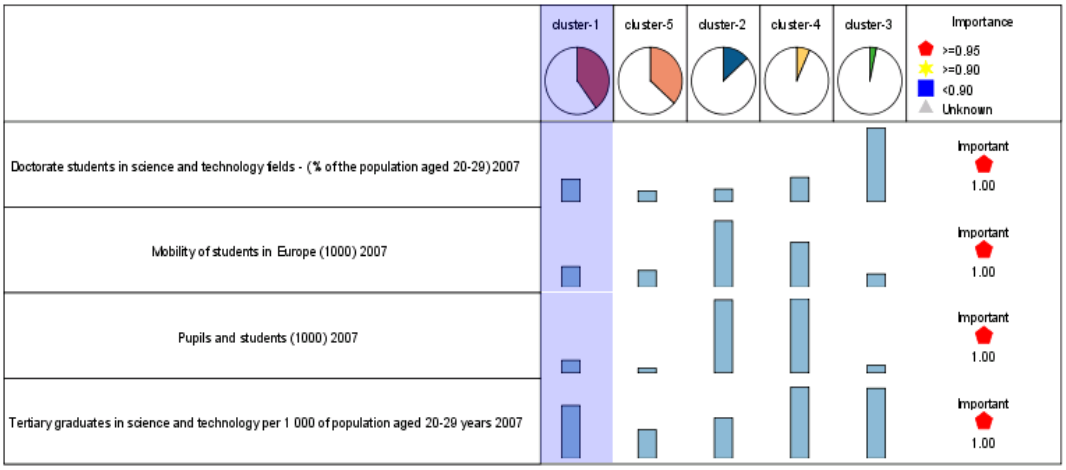


Fig. 2. *Education indicators – non-finance*



		Doctorate students ...	Pupils and students...	Tertiary graduates...	Mobility of student...	$KM-K-Means	$KMD-K-Means
1	Belgium	0.250	2417.700	14.000	9.100	cluster-1	0.147
2	Czech Republic	0.720	1855.600	12.000	7.100	cluster-1	0.275
3	Denmark	0.270	1154.500	16.400	5.500	cluster-1	0.224
4	Estonia	0.460	268.400	13.300	3.200	cluster-1	0.208
5	Ireland	0.350	1054.300	18.700	28.800	cluster-1	0.368
6	Spain	0.250	7555.700	11.200	23.500	cluster-1	0.423
7	Lithuania	0.240	759.700	18.100	6.800	cluster-1	0.304
8	Austria	0.540	1457.300	11.100	10.800	cluster-1	0.215
9	Portugal	0.400	1881.100	18.100	14.600	cluster-1	0.238
10	Romania	0.350	3839.400	11.900	20.300	cluster-1	0.207
11	Slovakia	0.450	1079.400	11.900	24.600	cluster-1	0.227
12	Sweden	0.790	2060.600	13.600	11.400	cluster-1	0.273

		Doctorate student...	Pupils and student...	Tertiary graduates...	Mobility of students in Europe ...	$KM-K-Means	$KMD-K-Means
1	Germany	0.420	14250.600	11.400	65.400	cluster-2	0.374
2	Italy	0.250	9500.200	12.100	36.500	cluster-2	0.217
3	Poland	0.180	8416.300	13.900	38.100	cluster-2	0.311
4	Turkey	0.100	16687.300	6.200	37.700	cluster-2	0.418

	Doctorate students i...	Pupils and students (1000) 2007	Tertiary graduate...	Mobility of students in Europ...	$KM-K-Means	$KMD-K-Means
Finland	1.380	1251.300	18.800	8.900	cluster-3	0.000

		Doctorate students...	Pupils and students ...	Tertiary graduate...	Mobility of students in Europe...	$KM-K-Means	$KMD-K-Means
1	France	0.400	12296.000	20.700	48.600	cluster-4	0.305
2	United Kingdom	0.510	12606.900	17.500	11.800	cluster-4	0.305

		Doctorate students...	Pupils and students...	Tertiary graduate...	Mobility of students in Europe...	$KM-K-Means	$KMD-K-Means
1	Bulgaria	0.220	1175.200	8.400	22.600	cluster-5	0.184
2	Greece	0.530	1964.400	8.500	35.800	cluster-5	0.458
3	Cyprus	0.160	145.800	4.200	21.400	cluster-5	0.268
4	Latvia	0.150	449.800	9.200	3.300	cluster-5	0.160
5	Hungary	0.160	1916.100	6.400	7.400	cluster-5	0.124
6	Malta	0.040	74.800	7.100	1.000	cluster-5	0.206
7	Slovenia	0.210	394.800	9.800	2.400	cluster-5	0.189
8	Croatia	0.200	728.100	6.800	9.200	cluster-5	0.062
9	Macedonia	0.010	368.500	4.600	6.700	cluster-5	0.246
10	Iceland	0.150	85.000	10.200	3.300	cluster-5	0.204
11	Norway	0.410	1078.900	9.300	10.600	cluster-5	0.181

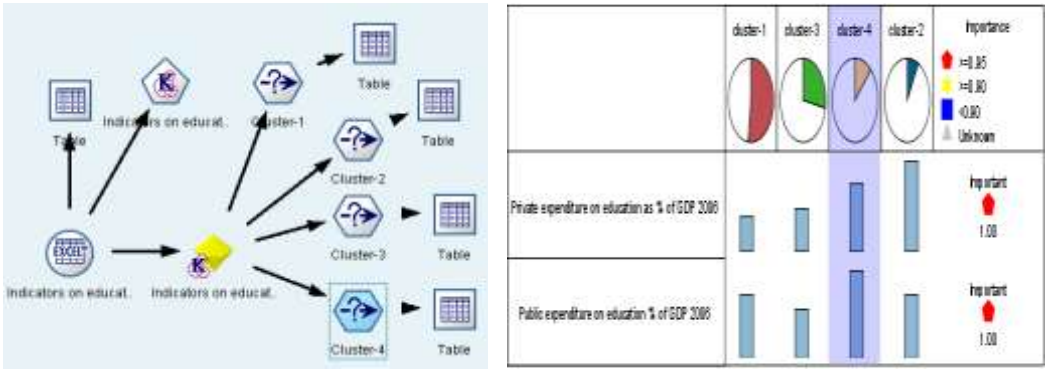


Fig. 3. *Indicators on education finance*

	Private expenditure on education as % of GDP 2006	Public expenditure on education % of GDP 2006	...	$KM-K-Mea...	$KMD-K-Means
Belgium	0.340	6.000	...	cluster-1	0.145
Estonia	0.340	4.800	...	cluster-1	0.171
Ireland	0.280	4.740	...	cluster-1	0.208
France	0.540	5.580	...	cluster-1	0.075
Latvia	0.660	5.070	...	cluster-1	0.186
Lithuania	0.460	4.840	...	cluster-1	0.140
Hungary	0.540	5.410	...	cluster-1	0.072
Austria	0.590	5.440	...	cluster-1	0.110
Poland	0.540	5.250	...	cluster-1	0.086
Portugal	0.440	5.250	...	cluster-1	0.049
Slovenia	0.780	5.720	...	cluster-1	0.263
Finland	0.150	6.140	...	cluster-1	0.275
Sweden	0.170	6.850	...	cluster-1	0.375

	Private expenditure on education as % of GDP 2006	Public expenditure on education % of GDP 2006	...	$KM-K-Means	$KMD-K-Means
Netherlands	0.880	5.460	...	cluster-2	0.217
United Kingdom	1.440	5.480	...	cluster-2	0.217

	Private expenditure on education as % of GDP 2006	Public expenditure on education % of GDP 2006	...	$KM-K-Means	$KMD-K-Means
Bulgaria	0.650	4.240	...	cluster-3	0.080
Czech Republic	0.560	4.610	...	cluster-3	0.088
Germany	0.700	4.400	...	cluster-3	0.125
Spain	0.520	4.280	...	cluster-3	0.025
Italy	0.380	4.730	...	cluster-3	0.172
Romania	0.400	3.480	...	cluster-3	0.200
Slovakia	0.620	3.790	...	cluster-3	0.111

	Private expenditure on education as % of GDP 2006	Public expenditure on education % of GDP 2006	...	$KM-K-Means	$KMD-K-Means
Denmark	0.590	7.980	...	cluster-4	0.240
Cyprus	1.210	7.020	...	cluster-4	0.286
Iceland	0.810	7.550	...	cluster-4	0.047

As a **conclusion**, using the cluster analysis, one can see that: from the education indicators – non-finance point of view, Romania is in cluster 1, from the indicators on education finance Romania is in cluster 3, low indicators.

References

1. Voineagu, V., Furtună, F., Voineagu, E., Ştefănescu, C.: *Analiza factorială a fenomenelor social-economice în profil teritorial / Factorial analysis of social-economic phenomena in territorial profile/*, Editura Aramis Print s.r.l., Bucureşti. 2002.
2. Petcu, N.: *Statistică – teorie şi aplicaţii în SPSS/Statistics – theory and applications in SPSS.* Editura Infomarket, Braşov. 2003.
3. Clementine 10.0 Node Reference.
4. Eurostat 2009*: Education in Europe – Key statistics 2007* – Issue number 37/2009.