

## MEASUREMENT OF QUALITY OF HIGHER EDUCATION IN EUROPEAN UNION COUNTRIES

**Marta Targaszewska**

**Abstract.** The paper presents the results of a comparative analysis of the quality of higher education in seventeen member states of the European Union in 2007. The author applies two methods of multivariate analysis. The first one is called Principal Components Analysis and the second is linear ordering. These two methods help assess the similarities and differences between countries and also place countries in order from the best to the worst. The author examines such variables as the organization of higher education and curricula, the governance of higher education institutions and funding. All of these variables influence the quality of higher education.

**Keywords:** measurement quality of higher education, Principal Components Analysis, linear ordering.

**JEL Classification:** C38, I21, I23.

### 1. Introduction

Higher education plays an important role in the European Union's future. There are several initiatives concentrating on this problem. The first one is the Bologna Declaration (1999). The Declaration is the basis of a process whose main aim is the assurance of higher education quality (Pluta-Olearnik, 2006, p. 161). Another one is the Lisbon Strategy (2000), which concentrates on a competitive and most dynamic knowledge-based European economy (Jelonek, Skrzyńska, 2010, p. 15). Both initiatives had an influence on educational policy before 2010. After that year, the way of developing higher education was shown by the strategy "Europe 2020" and "The Higher Education Modernization Agenda" (WWW1). The goals of modernizing tertiary education are: governance, curricula and funding

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(WWW2). The above actions were taken to improve the quality and competitiveness of the European Union's higher education.

The first aim of the article is to identify the knowledge and factors affecting the competitiveness and the quality of higher education in European Union countries, an assessment of the similarities and differences between them. The second goal is to arrange these countries in order from the best to the worst, where the ordering criterion is the level of quality of higher education. Two methods of Multivariate Analysis – Principal Components Analysis and linear ordering – were used to achieve these purposes.

## **2. Measurement methods and data**

The literature review referring to the quality of higher education indicates the three most popular definitions. Firstly, quality of education can be understood as the degree of needs fulfillment of clients (students, their parents, employees, employers, society, labor market). This is a result of didactic and non-didactic work of an institution (Doroszewicz, 2011, p. 87). This view explains education as service, where quality is a function of the discrepancy between customer expectations and their perception of the service (Zeithaml, Parasuraman, Berry, 1990, p. 176). The most popular instruments for measuring service quality are SERVQUAL and IPA (Sztejnberg, 2008, pp. 78, 111). Secondly, quality of tertiary education can be also seen as the creation of common standards of quality assurance, where measurements rely on accreditation, auditing, monitoring and evaluation of realization of standards (Ciekot, 2007, p. 25). Thirdly, quality in higher education is defined as the degree of fulfillment of the aims established by the institutions (Jelonek, Skrzyńska, 2010, p. 22). From this point of view, the best method of measuring is self-assessment (Mazurek-Łopacińska, 2009, p. 65). Benchmarking in higher education (*A Practical Guide...*, 2008) and rankings of universities are also very important diagnostic instruments and self-improvement tools (Hazelkorn, 2011, p. 16). Both of these tools improve quality and universities' competitiveness (Nazarko et al., 2008, p. 27).

First of all, the quality of tertiary education is determined by such factors as (Doroszewicz (Ed.), 2011, p. 87): teaching and administrative staff, material resources of the university and the way of teaching. Secondly, bibliometric indicators, number of research programs, mobility of students, number of faculties and budget (Hazelkorn, 2011, pp. 50-60). Finally, it is worth noting the institutions which are encouraged to cooperate with uni-

versities (industries, firms, public bodies, future employers) (see Bellon, 2007, pp. 137, 138).

Because of the availability of all data, statistical analysis covered the year 2007. Variables were collected from the OECD reports “Education at a Glance” (WWW3). The first step of the analysis was to examine the differentiation of selected variables. The variables for which the level of differentiation was lower than 10% were not included in the research (Dziechciarz (Ed.), 2003, p. 30). After that, for the next step, the following data were taken:

- employment rates and educational attainment ( $X_1$ ),
- relative earnings of the population with income from employment ( $X_2$ ),
- annual expenditure by educational institutions per student ( $X_3$ ),
- relative proportions of private expenditure on educational institutions ( $X_4$ ),
- public expenditure on educational institutions as a percentage of GDP ( $X_5$ ),
- private expenditure on educational institutions as a percentage of GDP ( $X_6$ ),
- current expenditure by educational institutions ( $X_7$ ),
- foreign students in tertiary education ( $X_8$ ),
- ratio of students to teaching staff ( $X_9$ ).

The study was conducted in seventeen member states of the European Union. The study included the following countries: Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, the Slovak Republic, Spain, Sweden, the United Kingdom and France.

### **3. Results of Principal Components Analysis**

Principal Components Analysis (PCA) is one of the methods of Multivariate Analysis invented by K. Pearson and H. Hotelling (Walesiak, Gatnar (Eds.), 2004, p. 194). The method takes original variables and finds a combination of these to produce new indices. The new indices are not correlated, and their variation is the same as the variation of the original variables (Targaszewska, 2011, p. 48). Principal Components Analysis allows the reduction of the number of original variables, detection of structure as well as finding patterns and relationships between variables (Stanisz, 2007, p. 166).

At the beginning of the analysis, quality indicators of higher education were standardized. The next step was to determine the correlation matrix and eigenvalues of this matrix. The eigenvalues of the correlation matrix are shown in Table 1.

Table 1. Eigenvalues of correlation matrix

Number of eigenvalue	Eigenvalue	% total variance	Cumulative eigenvalue	% cumulative variance
1	3.581028	39.78920	3.581028	39.7892
2	2.055169	22.83521	5.636197	62.6244
3	1.005030	11.16700	6.641227	73.7914
4	0.815912	9.06569	7.457139	82.8571
5	0.695958	7.73286	8.153096	90.5900
6	0.506308	5.62564	8.659404	96.2156
7	0.188385	2.09317	8.847789	98.3088
8	0.108565	1.20628	8.956354	99.5150
9	0.043646	0.48496	9.000000	100.0000

Source: own study based on OECD data.

Eigenvalues were useful in selecting the most important principal components. There are three methods of selecting (Stanisz, 2007, p. 175):

- the Kaiser criterion,
- the percentage of total variance,
- the scree test.

The Kaiser criterion postulates to retain only factors with eigenvalues greater than 1. There are three such eigenvalues: 3.581028; 2.055169 and 1.005030. Their percentage of cumulative variance is 74%. The scree test is a graphical method – a line plot of eigenvalue. Through the plot it is possible to find a place where the line is smooth, and to the right side of this place there is “factorial scree”. The principal components lie on the left side (WWW7).

Fig. 1 shows that the line is smooth from the fourth eigenvalue. This means that the first three components should be taken into account.

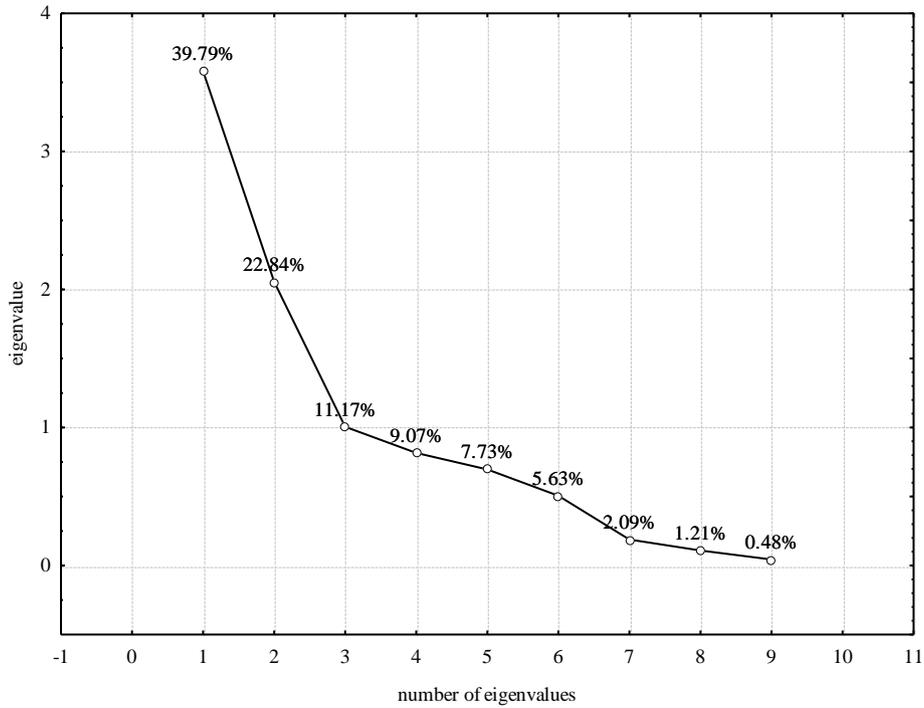


Fig. 1. Scree plot of eigenvalues

Source: own study based on OECD data.

The components are determined by the eigenvectors of the correlation matrix. The eigenvectors for the three components are presented in Table 2.

Table 2. Eigenvectors of correlation matrix

Variables	1st	2nd	3rd
Employment rates	-0.33	-0.15	-0.28
Relative earnings	0.46	0.01	-0.07
Expenditure by educational institutions	-0.48	-0.02	-0.09
Proportions of private expenditure	-0.02	0.63	0.07
Public expenditure (% GDP)	-0.37	-0.31	0.18
Private expenditure (% GDP)	-0.01	0.54	0.38
Current expenditure by institution	0.32	0.04	-0.71
Foreign students	-0.36	0.17	-0.25
Ratio of students to teaching staff	0.27	-0.41	0.41

Source: own study based on OECD data.

The first, second and third components are:

$$Z_1 = -0.33X_1 + 0.46X_2 - 0.48X_3 - 0.02X_4 - 0.37X_5 - 0.01X_6 + 0.32X_7 - 0.36X_8 + 0.27X_9,$$

$$Z_2 = -0.15X_1 + 0.01X_2 - 0.02X_3 + 0.63X_4 - 0.31X_5 + 0.54X_6 + 0.04X_7 + 0.17X_8 - 0.41X_9,$$

$$Z_3 = -0.28X_1 - 0.07X_2 - 0.09X_3 + 0.07X_4 + 0.18X_5 + 0.38X_6 - 0.71X_7 - 0.25X_8 + 0.41X_9,$$

where  $Z_i$  is  $i$  – principal components, and  $X_i$  is the value of the original variable.

Each of the principal components can be interpreted by factor loadings presenting the correlation coefficients between the original dataset and the principal components (see Table 3) (Stanisz, 2007, p. 191).

Table 3. Factor loadings for principal components

Principal components	1st	2nd	3rd
Employment rates	-0.63	-0.21	-0.28
Relative earnings	0.87	0.01	-0.07
Expenditure by educational institutions	-0.91	-0.03	-0.09
Proportions of private expenditure	-0.04	0.90	0.07
Public expenditure (% GDP)	-0.71	-0.44	0.18
Private expenditure (% GDP)	-0.02	0.76	0.38
Current expenditure by institution	0.61	0.05	-0.71
Foreign students	-0.68	0.24	-0.25
Ratio of students to teaching staff	0.51	-0.58	0.41

Source: own study based on OECD data.

Such factors as employment rates, relative earnings, expenditure by educational institutions, public expenditure (% GDP), foreign students and ratio of students to teaching staff are highly correlated with the first principal component which can be called “organization and effects of tertiary education”. The expenditure of educational institutions has the greatest influence on the similarities and differences for this component. The second principal component, called “private sources of expenditure”, is represented by the relative proportion of private expenditure on educational institutions and private expenditure on educational institutions as a percentage of GDP. The proportion of private expenditure has the biggest influence. The last principal component is “current expenditure by institution”. Different signs of factor loadings tell us about the contradirectional influence on each principal component.

The relationship between each of the principal components can also be graphically presented. Fig. 2 shows the plots of seventeen European Union countries for the first three principal components.

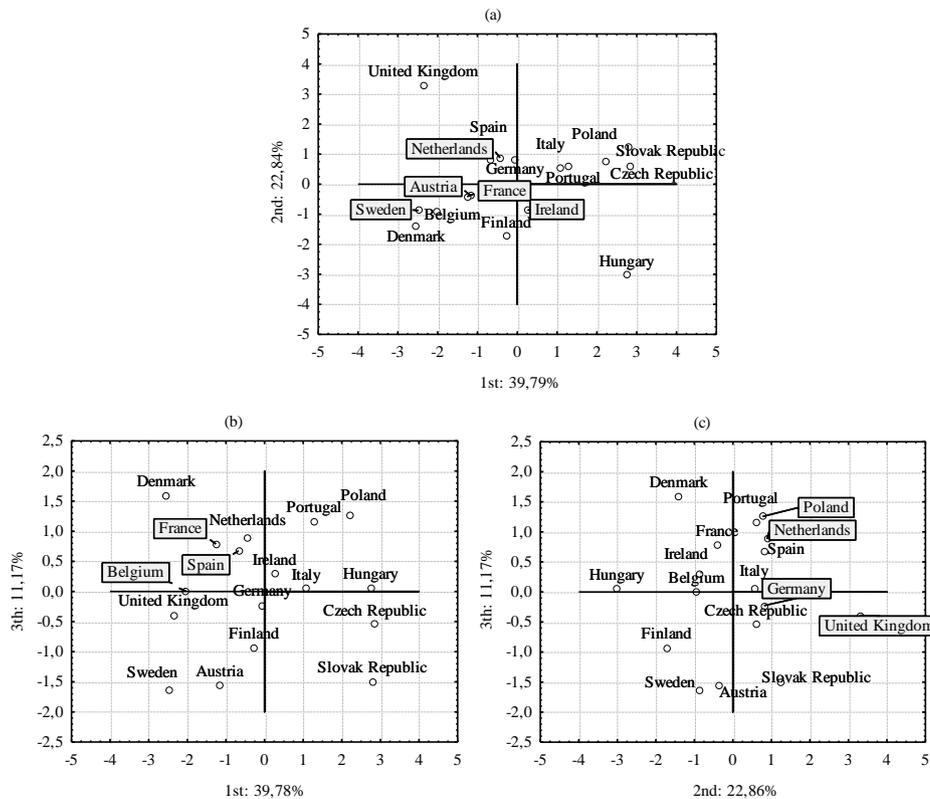


Fig. 2. Plots diagrams according to scores for:  
 (a) first and second principal components, (b) first and third principal components,  
 (c) second and third principal components

Source: own study based on OECD data.

As visible in Fig. 2, the distances between the European Union member states for each combination of principal components are differentiated. However, it is possible to mention a few clusters. Between the first and second principal components there exist groups, such as:

- Poland, the Slovak Republic, the Czech Republic;
- Italy, Portugal;
- Spain, the Netherlands, Germany;
- Austria, France;
- Sweden, Belgium, Denmark.

Countries in the first group are similar because of the low levels of employment rates and high level of relative earnings. Each of these countries has low public expenditure, including academic institutions. Also, the mobility of foreign students is low. In spite of the fact that public tertiary education in these countries is free, there is high private expenditure on education.<sup>1</sup> The next three groups have average levels for the first and second principal components. Sweden, Belgium and Denmark have the same results in private sources of expenditure and organization, and the effects of tertiary education. Each of them has very high employment rates, but on the other hand, the range of earnings in these countries is small. Hungary and the United Kingdom are separate. This results from the very high private expenditure for the United Kingdom (almost 65% of all expenditure on education) and very low for Hungary. Moreover, the United Kingdom has a low ratio of students to teaching staff.

For organization and the effects of tertiary education and current expenditure by institutions, three groups of similar countries can be observed:

- the United Kingdom, Belgium;
- Spain, France, the Netherlands;
- Portugal, Poland.

The rest of the European Union members are very different. The biggest current expenditure by academic institutions, including spending on institution resources used each year to operate (WWW6), is in the Slovak Republic. The lowest level is represented by Belgium and the United Kingdom. Between the last combination of principal components (private expenditure and current expenditure by institutions) four clusters can be noticed. These groups have almost the same level of both principal components:

- Spain, Portugal, the Netherlands, Poland;
- the Czech Republic, Germany, Italy;
- Belgium, Ireland;
- Sweden, Austria.

The first group has both private sources of expenditure and current expenditure by academic institution at a high level.

#### **4. Results of linear ordering**

Pattern recognition methods based on the concept of linear ordering is another method of Multivariate Analysis, which was used to compare the European Union members. The method allows to place the countries in

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<sup>1</sup> See: *Paying for education. What is the role of private spending* at (WWW5).

order from the best to the worst. The ordering criterion is the level of complex phenomena – quality of higher education (Dziechciarz (Ed.), 2003, p. 287). All the variables which were used for ordering are stimulants. At the beginning of the research, all the variables were also standardized. Next, each of the variables was multiplied by the appropriate weight. The weights were calculated by using Principal Components Analysis. Their scale depends on cumulative proportion for the first three principal components, namely 0.54 for every variable connected with the organization and effects on tertiary education, 0.31 for private sources of expenditure, and 0.15 for expenditure by institutions. Then the pattern and anti-pattern were set (Stanimir, 2006, p. 121). For the studies the following variables were obtained:

$$z_0 = [0.34; 1.25; 0.87; 0.94; 1.06; 0.56; 0.29; 1.16; 1.01],$$

$$z_{-0} = [-1.13; -0.76; -0.90; -0.40; -0.97; -0.59; -0.23; -0.69; -1.44],$$

where:  $z_0$  is pattern and  $z_{-0}$  is the anti-pattern.

The similarities between the European Union member states and the abstract pattern, as well as measures of development, were defined by using the Euclidean distance (Stanimir, 2006, p. 121). The results of the analysis are presented in Table 4.

Table 4. Results of linear ordering

Country	Measure of development	Rating
United Kingdom	0.672	1
Austria	0.549	2
France	0.502	3
Sweden	0.483	4
Belgium	0.469	5
Germany	0.458	6
Netherlands	0.417	7
Finland	0.417	8
Portugal	0.416	9
Denmark	0.414	10
Spain	0.377	11
Italy	0.358	12
Ireland	0.355	13
Czech Republic	0.334	14
Slovak Republic	0.326	15
Poland	0.311	16
Hungary	0.239	17

Source: own study based on OECD data.

The best country out of the European Union members in terms of education quality is the United Kingdom, which has the highest employment rates and educational attainment, rate of foreign students in tertiary education, and also the relative proportion of private expenditure on educational institutions. In spite of the mainly private sources, the United Kingdom has also one of the highest rates of public expenditure on educational institutions as a percentage of GDP. The UK has also the lowest ratio of students to teaching staff. However, the country is not a role model for other countries to follow because its outcome is far from 1, which is the pattern. The worst scores were obtained by the youngest European Union members: Hungary, Poland, the Slovak Republic and the Czech Republic. All of these countries have a very similar system of higher education. Their educational expenditure, employment rates and mobility are low.

## 5. Conclusions

The present studies have shown that there are three components that have an impact on the quality of higher education:

- organization and effects of tertiary education,
- private sources of expenditure,
- current expenditure by institutions.

The received components are helpful in an assessment of the similarities and differences between the European Union member countries. The countries were also grouped together in small clusters. Each of these clusters consists of only two or three members. The small size of the groups is the result of the big differences between the structures of the higher education systems. Linear ordering was helpful in building the ranking, which shows that the best country – in addition to the three principal components – is the United Kingdom.

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