DOI: 10.20472/TEC.2018.006.005

ROMANA PROVAZNÍKOVÁ
University of Pardubice, Czech Republic

DENISA CHLEBOUNOVÁ
University of Pardubice, Czech Republic

DISCUSSION ON THE QUALITY OF EUROPEAN HIGHER EDUCATION SYSTEMS USING CLUSTER ANALYSIS

Abstract:

The enormous increase in the number of students of higher education and transition from elite to mass and universal higher education are worldwide trends in recent years and further expansion is expected in the coming years. This situation, however, raises the need for higher expenditure on higher education and many countries have to deal with under-financing of their higher education. Involving or increasing student participation in funding is currently under discussion. From the point of view of financing are distinguished three basic higher education financing models in OECD countries which are characterized by none, smaller, or larger student co-financing. The aim of this paper is to choose appropriate indicators for describing quality of European higher education systems and with using cluster analysis to display similar higher education systems and discuss their funding. Findings of this paper indicate that models of higher education systems with multi-source funding achieve higher quality. However, there are other influences that affect the quality of higher education systems - contextual indicators, such as economic, demographic, or historical development.

Keywords:

higher education systems, tertiary education, quality, equity, cluster analysis

JEL Classification: I21, I23, H75

1 Introduction

Productivity and economic growth is driven by innovation which relies on research and human capital. Higher education significantly contributes to the social, cultural and environmental development of societies (OECD, 2017a). Higher education systems around the world face a growing demand for enrollment. The reason for this comes both from the supply and the demand side. On the supply side, development economics theory created the concept of human capital and stressed its importance as an important factor to accelerate economic growth. On the demand side, growing demand for enrollment is caused by growing demand among employers for skilled and professional workers and increased importance in modern economies for research and development to increase competitiveness. This leads to public policies designed to increase the access to higher education (Morley, 2003).

The expansion in higher education (name tertiary education is considered synonymous) over the generations has been significant. According to OECD (2017a), tertiary student numbers more than doubled between 1999 and 2014, from around 95 to 207 million in the world. The number of young people aged 25-34 with a tertiary qualification increased by nearly 45 % between 2005 and 2013 in OECD countries and is expected to keep increasing in the coming decade. Based on current patterns of graduation, more than half of young adults in OECD countries are expected to enter a bachelor's degree, and almost a quarter are expected to enter a master's degree or equivalent program over their lifetime. Higher education has grown quickly from an elite to a mass system. This expansion, however, raises the need for higher expenditure on tertiary education.

Acute problems in the field of higher education financing appeared in 1990s, when the number of students in some countries (especially in most Central and Eastern European countries) grew more rapidly than the amount of financing (Erina and Erins, 2015). In this regard, at that time many countries restructured their higher education financing models, reallocating a certain part of financing load to the students and graduates. As a result, the mixed financing model has facilitated the solution of the financial problems persisting in higher education.

From this perspective Chardonnier (2013) and Matějů and Barr (2005) distinguish four basic tuition models in the funding framework for higher education institutions in OECD countries (from the point of view only of the European OECD countries are three without Asian model). This framework includes the average tuition fees charged by public institutions and the existence or degree of state aid for students. First model is the Scandinavian countries model where university education is free and all university students are eligible for scholarships or student loans. The second model is the Asian model (in Japan, Korea). In this model, tuition fees are very high and students receive little aid to attend universities (in the form of scholarships or student loans). The third model is the Anglo-Saxon model. This is the model in place in many Anglo-Saxon

countries (Canada, the USA, New Zealand, Australia, the UK). Tuition fees are high and differentiated according to the fields of study. A student who begins a university education will spend a lot of money, but will benefit from numerous aids. Often, in the case of student loans, these aid systems are based on income, where reimbursement does not take place before the student has reached a certain level of remuneration in the labor market. If ever the student does not reach this level of income after a certain number of years, the study loan reimbursement will become the responsibility of the government. This system is called income-contingent repayment system. The last model is the model of other European countries. In France, Austria, Belgium, Spain, or Italy tuition fees are relatively low but state aid systems are poorly developed. No tuition fees (while meeting the standard conditions) are in Germany, Greece, Poland, Hungary, the Slovak Republic and the Czech Republic.

Some authors (Matějů and Barr, 2005; Morley, 2003) claim that tuition fees improve quality and equity in higher education. World Bank (1999) which mainly deals with financing, but it is also concerned with quality and equity in higher education, presents the positive aspects of diversification of funding sources of public universities (cost-sharing with students) and also the development of private higher education institutions. These positive aspects are: increasing the number of places in higher education, thus widening access to higher education; cost-sharing with students increase expenditure on higher education as well as quality. In addition, it is argued that a policy package that combines the use of the cost-recovery mechanism at the tertiary level, the spread of private schools to meet social demand, decentralized management, and student loans and selective scholarships (the use of subsidies for some disadvantaged groups) will lead to an increase in equality of opportunity in society (higher equity).

The aim of this paper is to choose appropriate indicators for describing quality of European higher education systems and with using cluster analysis to display similar higher education systems and discuss their funding. Based on our analysis, we have put a research question: do the clusters, created according to the qualitative characteristics, correspond to basic models of financing of education systems in surveyed countries?

Quality is assessed within public and private higher schools altogether (indicators include both types of schools altogether, except for one - annual expenditure per student; this indicator is measured only for public higher schools). The existence or introduction of tuition fees that is discussed in the individual clusters are intended only for public higher education institutions. The number of students in public higher schools dominates in the surveyed countries (76 % on average in OECD European countries), so private higher education institutions play a smaller role in the monitored indicators which cover both types of higher schools. To perform the analysis, it is first necessary to define the concept of quality in higher education because this concept is conceived differently by authors and also choose appropriate indicators of the quality of higher education systems we use.

2 Quality framework in higher education

What does quality mean in the context of education? Many definitions of quality in education exist, testifying the complexity and multifaceted nature of the concept of quality. Quality of education and higher education systems can be assessed in terms of efficiency, effectiveness, equity, and quality. According to Adams (1993), these terms are in practice often used synonymously, which is inaccurate.

Education is a service that has different characteristics compared to standard goods and therefore the understanding of the quality of education and its evaluation is specific. There is no universally acceptable definition of quality. Some definitions are primarily focusing on meeting a pre-defined set of standards, specifications, and requirements set by the stakeholders (Rýdl, 2002; Hoy, Bayne-Jardine and Wood 2000; Harvey and Green 1993). Windham and Chapman (1990) say that quality is often defined, synonymously with effectiveness, as the degree to which objectives are met or desired levels of accomplishment achieved. Higher quality thus typically means a real or anticipated increase in effectiveness, that is, "better" or larger input, process, output or outcome.

According to Grisay and Mahlck (1991), quality of education has a three-dimensional approach comprising quality of human and material resources available for teaching (inputs), teaching practices (process), and results (outputs). Further, according to them, there are some indicators - repetition, dropouts, promotion, and transition rates - which are frequented by planners to arrive at an approximate measurement of quality.

Other definitions are primarily stakeholder-driven, focusing on accountability to the public or providing a transformative learning experience to benefit students and employers. According to Lacovidou, Gibbs and Zopiatis (2009), Bozieva (2017) there are four groups of stakeholders that must be considered when defining quality: providers (e.g., funding bodies and the community, taxpayers); users of products (e.g., students); users of outputs (e.g., employers); and employees of the sector (e.g., academics and administrators). Goddard and Leask (1992) use the term customers instead of stakeholders. They have included different customers for education - parents, government, students, teachers, employers, and institutions - who look for different characteristics of quality. For example, students associate quality with the institution they attend, the program in which they enroll, and the course they complete. Conversely, employers are concerned with quality in terms of the final products, which can be demonstrated through a qualified employee pool. Therefore in order to define quality and attempt to establish a culture of quality in higher education, all stakeholders should be involved in the discussion to ensure that different perspectives and needs are incorporated.

Most authors (Průcha, 1994; Ashworth and Harvey, 1994; Rey and Romero, 2004; Schindler et al, 2015; Bozieva, 2017) clarify the perspectives of education quality on the basis of a conceptual framework that describes education. The most frequently used

method is to depict education as a productive system, in which, in simple terms, the inputs are transmitted to the outputs. Within this general framework, the following categories of indicators are used to describe the quality of education systems (Scheerens, Luyten and van Ravens, 2011):

- input indicators, differentiated between national system, school and teaching levels (e.g. proportion of Gross Domestic Product (GDP) spent on education, educational expenditure per student, proportion of public and private investments in education)
- process indicators, differentiated at three aggregation levels, national system, school and classroom level teaching (e.g., total hours of instruction per year, pupil teacher ratio)
- output indicators, differentiated as output and outcome indicators. While outputs are measured by quantitative indicators (e.g., achievement measures, attainment measures, graduation rates, average income for each attainment level, employment rates), qualitative indicators are associated with observation based descriptions (e.g., assessing student learning, the experience of a learning community, or the content of a mission statement). Outcomes are more difficult to measure than numerical outputs.
- contextual indicators, differentiated between national system level indicators and the school community (e.g., socio-economic status of students, demographic developments).

These indicators are central in productivity and effectiveness interpretations of educational quality, but also play an indispensable role in assessing the equity (especially process indicators), efficiency (ratio of input and output indicators), and responsiveness of schooling. The above indicators and the definition of the quality of education and education systems relate to education in general - do not distinguish degrees of education. However, we can apply them to assess the quality of higher education.

In the context of the demand for greater access to higher education, it has been paying more attention to higher education in recent decades. Government and non-governmental organizations are involved in the process of auditing and evaluation university performance across and within national boundaries.

At international level, a set of indicators used by OECD/UNESCO can be considered the most sophisticated quality assessment system for higher education. There are other institutions and organizations which examine and compare the quality of higher education systems at the international level. For example, EAU (European University Association), whose main task is measuring the quality of international programs and strategies of higher education institutions; ACA (Academic Cooperation Association), which evaluates and supports in particular the internationalization of higher education systems; European Commission published report with key recommendations on improving the quality of

teaching and learning in higher education in Europe and also published Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG); and Universitas 21 creates an annual ranking by quality of fifty national systems of higher education.

The OECD Education Indicators project uses the categorization, described on the Education at a Glance Publications (OECD, 2017b). This categorization is based on the framework of education quality outlined above. With a focus on higher education, the main categories are:

(A) The output of educational institutions and the impact of learning (e.g., first-time graduation rates by tertiary level; employment rates of 25-64 year-olds in tertiary education; relative earnings of workers in tertiary education)

(B) Financial and human resources invested in education (e.g., annual expenditure per student in tertiary education (only for public higher education institutions); expenditure on educational institutions as % of GDP in tertiary education)

(C) Access to education, participation and progression (e.g., first-time entry rates by tertiary level; international student mobility and foreign students in tertiary education)

(D) The learning environment and organization of schools (e.g., ratio of students to teaching staff in tertiary education).

All used indicators express the quality of the education system using quantitative expression.

Universitas 21 (2017) mention above, uses sets of indicators, which are in some aspects similar to those of the OECD, some are quite different. This association assesses each year the quality of fifty national systems of higher education from all continents. These systems are evaluated across 24 attributes. The measures are standardized for population size. Countries are ranked overall and on each of four modules: Resources, Policy Environment, Connectivity and Output. Within each measure the highest achieving country is given a score of 100 and scores for other countries are expressed as a percentage of this highest score. These four modules include the following indicators. Resources: public and private expenditure on higher education and research; Policy Environment: government policy and regulation, quality of information provided, share of women among teachers and students, level of the whole education system; Connectivity: international cooperation and foreign students, open access to information and documents; Output: location of the country's universities in international rankings, number of scientific articles and their quotations, graduates and their employability in the labor market. An overall ranking is derived using a weight of 40 per cent for Output and 20 per cent for each of the other three modules.

The indicator which the OECD study does not embrace is research and development results (R&D). R&D is considered as one of the important activities in quality

measurement in higher education systems. Typical indicator of quality in R&D is number of scientific articles and their quotations (Universitas 21 uses this indicator). The largest number of top 10 % most cited documents (led by domestic author) have in Netherlands, UK, Denmark, Sweden, Belgium or Finland. On the other side are Slovakia, Poland, Hungary and Czech Republic. It is obvious that the higher education systems with highest quality are also successful in this indicator.

According to the ranking of Universitas 21, the USA has the highest quality higher education system, followed by Switzerland and the United Kingdom. Scandinavian countries also have a very high quality system. The ranking of the top ten higher education systems is shown in Table 1.

Table 1: The ranking of the top ten higher education systems for 2017

Overall ranking in 2017	Country	Overall ranking in 2016
1	USA	1
2	Switzerland	2
3	UK	4
4	Denmark	3
5	Sweden	5
6	Singapore	8
7	Canada	9
8	Netherlands	7
9	Finland	6
10	Australia	10

Source: Universitas 21 (2017)

3 Data and methods

For our analysis, we chose the following typically used quantitative indicators that describe the quality of higher education systems (Table 2). Indicators have been selected to capture all aspects of this quality - input indicators, process indicators and output indicators. We obtained all indicators from the Education at a Glance studies for the years 2011 - 2015 and we used their average values due to more accurate data when potential one-off fluctuations in individual years were eliminated. The advantage of using indicators

from one study is the fact that indicators are based on the same methodology, which allows better comparability.

Table 2: Description of selected indicators of the quality

i1	Annual expenditure per student (in equivalent USD converted using PPPs for GDP) - input indicator. All spending for public educational institutions on tertiary education (including both core expenditure on instructional services and non-core expenditure on ancillary services for students and families, where these services are provided through educational institutions) in relation to the number of students enrolled at the given level of education. It is calculated by dividing total expenditure (from both public and private sources) by institutions at each level by the number of (full-time equivalent) students enrolled in the corresponding level.
i2	Total expenditure on educational institutions (% of GDP) - input indicator. All spending on educational institutions in tertiary education and by public or private sources.
i3	Public expenditure on educational institutions (% of GDP) - input indicator. Public spending on educational institutions in tertiary education. It is direct expenditure on educational institutions as well as educational-related public subsidies given to households and administered by educational institutions.
i4	Private expenditure on educational institutions (% of GDP) - input indicator. Private spending on educational institutions in tertiary education. It includes all money transferred to educational institutions from private sources, including public funding via subsidies to households, private fees for education services, or other private spending (e.g. on room and board) that goes through the educational institution.
i5	First-time entry rates into bachelor's or equivalent program (in %) - process indicator. Entry rates estimate the percentage of people who are expected to enter for the first time a specific type of tertiary education program (including short-cycle tertiary, bachelor’s degrees, master’s degrees, long first degrees and doctoral programs) at some point during their life. Entry rate is the sum of age-specific entry rates, calculated by dividing the number of entrants of a certain age into a certain education level by the total population of that age.
i6	Ratio of students to teaching staff - process indicator. This is the number of students who attend a school divided by the number of teachers in the institution.
i7	International and foreign students enrolled as a percentage of all students (international plus domestic) - process indicator. Foreign students are those who are not citizens of the country in which the data are collected. International or mobile students are those who left their country of origin and moved to another country for the purpose of study.
i8	Completion rate of full-time students (entered bachelor’s or equivalent program - in %) - output indicator.

	It describes the percentage of students who enter a tertiary program for the first time and who graduate from it a given number of years after they entered. The calculation is made taking into account the number of years usually allocated for completing the program (the theoretical duration), and an additional three years.
i9	Tertiary attainment of 25-34 year-olds (in %) - output indicator. It represents the relationship between all graduates (of the given year and previous years) and the total population. It is aimed at the 25–34-year-olds, because this is the group that best reflects the reality that those about to start their careers can expect.
i10	Employment rates of 25-34 year-olds with tertiary education (in %) - output indicator. Indicator of employment rates is defined as a measure of the extent to which available labor resources (people available to work) are being used. This indicator is calculated as the ratio of the employed to the working age population.
i11	Relative earnings of workers with tertiary education (upper secondary education = 100) - output indicator. Income data refers to those who work full-time and full-year, and these are the earnings before the deduction of income tax.

Source: Education at a Glance 2013 – 2017

Input indicators indicate how much funding (whether public or private) is available to higher education institutions in that country. They reflect the level of commitment of a government to devote financial resources to the development of its education system and the role of private funding in higher education.

Process indicators what we have chosen indicate how resources for education are allocated (indicator i6), further express equity and access to education (indicator i5) and the international dimension of higher education is expressed by student mobility (indicator i7). In terms of quality, the lowest student-teacher ratio is desirable but often have to be weighed against higher salaries for teachers, investing in their professional development, greater investment in teaching technology. Indicator i5 provides some indication on the accessibility of tertiary education and the degree to which a population is acquiring high-level skills and knowledge. High entry and enrolment rates in higher education imply that a highly educated labor force is being developed and maintained. Higher levels of mobility from neighboring countries can bring cost, quality and enrolment advantages that are more apparent to students in neighboring countries (research show that in all OECD countries in 2015, an average of 21 % of all foreign students came from countries that share land or maritime borders with the host country).

As the indicators characterizing the outputs of the educational process, we chose the success rate of higher education (indicator i8 - completion rate of full-time students), percentage of a population that has reached a tertiary level of education (indicator i9), employment rates of 25-34 year-olds with tertiary education (indicator i10) and relative

earnings of workers with tertiary education (indicator i11). This indicator shows that in all OECD countries, adults (25-64year-olds) with higher education earn considerably more than adults with upper secondary education (an average of 56 %). All output indicators relate to certain aspects of the quality of the education system. Indicator i8 can indicate the efficiency of higher education systems, as it shows how many of the students who enter a higher education program ultimately graduate from it. However, low completion rates do not necessarily imply an inadequate higher education system, as students may leave a program for a variety of reasons. They may realize that they have chosen a subject or educational program that is not a good fit for them, or they may find attractive employment opportunities before completing the program. Indicator i9, which expresses the percentage of students who enter a higher education program for the first time and who graduate from it a given number of years after they entered indicates to some extent the availability of higher education in a given country.

The average values of these indicators for each country are shown in Table 3.

Table 3: Average values of indicators in each surveyed country

Country	Indicators										
	i1	**i2**	**i3**	**i4**	**i5**	**i6**	**i7**	**i8**	**i9**	**i10**	**i11**
Austria	16 392	1,7	1,7	0,1	43	14,7	16,0	25	39,0	86,7	151,7
Belgium	16 004	1,4	1,3	0,1	71	22,0	10,7	42	43,7	87,3	138,7
Czech Republic	10 424	1,3	1,1	0,2	60	22,3	9,8	41	31,3	77,3	178,7
Denmark	16 514	1,7	1,6	0,1	71	14,0	10,1	52	44,0	83,0	128,7
Estonia	10 729	1,8	1,7	0,2	59	14,5	4,1	23	40,7	82,3	129,0
Finland	17 875	1,8	1,7	0,1	55	14,3	7,2	46	40,7	81,3	140,0
France	15 966	1,5	1,2	0,3	65	18,0	10,0	43	44,3	85,7	149,3
Germany	17 077	1,2	1,1	0,2	51	12,0	7,2	27	29,7	87,7	162,0
Hungary	9 181	1,1	0,8	0,4	30	15,0	6,7	22	31,3	81,7	202,3
Ireland	14 239	1,2	1,0	0,2	80	20,0	6,8	26	51,5	83,7	171,0
Italy	10 918	1,0	0,8	0,2	39	19,3	4,7	28	25,0	62,7	142,0
Luxembourg	40 112	0,5	0,5	0,1	14	8,0	44,6	9	51,3	87,7	156,7
Netherlands	19 127	1,7	1,3	0,4	63	15,3	10,4	41	44,7	90,7	151,7
Norway	20 452	1,6	1,6	0,1	66	10,0	3,5	37	48,7	86,7	127,3
Poland	9 479	1,3	1,2	0,1	69	15,0	1,9	44	43,0	87,0	164,3
Portugal	10 705	1,4	0,9	0,5	46	14,0	4,3	36	33,0	80,3	168,3
Slovak	10 211	1,1	0,9	0,2	55	13,7	5,6	42	31,3	75,7	170,3

Republic											
Slovenia	11 711	1,2	1,1	0,1	73	17,3	2,9	37	40,7	81,0	172,7
Spain	12303	1,3	0,9	0,3	48	12,7	2,6	18	41,0	75,0	148,0
Sweden	23 275	1,7	1,5	0,2	44	10,7	6,1	26	46,3	87,0	121,7
Switzerland	26 074	1,2	1,2	0,1	60	16,0	17,1	46	47,3	88,7	150,0
United Kingdom	24 875	1,8	1,0	0,9	63	17,0	17,8	45	50,3	87,3	150,7

Source: own processing according to Education at a Glance 2013 – 2017

However, when interpreting all used indicators, it is necessary to bear in mind that they are very closely related to the specific conditions and developments in a given country which can be included in a set of contextual indicators. It is the economic, demographic, or historical development. For example, the number of students enrolled in higher education institutions are influenced by the characteristics of the funding systems of higher education mentioned above.

We used cluster analysis to meet the goal of this paper. Cluster analysis allows to sort the monitored units into clusters (sets of objects) on the basis of their similarity according to defined criteria (indicators). Sorting takes place in such a way that two objects of the same cluster are more similar than two objects of different clusters (Everitt, et al, 2011).

In accordance with assumptions of cluster analysis, the correlation analysis was performed first. According to Meloun and Militký (2012), the correlation coefficients between the indicators entering the analysis must not be greater than 0.7. One indicator was excluded (i2 - Total expenditure on educational institutions). The Spearman correlation coefficients in this case reached 0.802. The remaining indicators from Table 2 enter the analysis.

Another important step before starting the analysis concerns the standardization and normalization of the data. By standardization we removed the impact of measurement units on data (because indicator values are in different units). Standardized values now have a mean value = 0 and standard deviation = 1. Normalization was then carried out to remove the effect of the different measurement range. This ensures that when evaluating similarity, each indicator has the same effect (weight) on the clustering process (Petr, 2014). Table 4 lists indicators of the quality after standardization and normalization.

After standardization and normalization follows the selection of one of the clustering methods to the evaluation the distance (similarity) of individual clusters. The literature focuses on two types; hierarchical agglomerative methods and iterative partitioning methods. Most commonly, some of the hierarchical methods are used, where the square distance matrix is used for input distances. We also used this kind of methods -

specifically the closest neighbor method. In hierarchical methods, cluster analysis involves a series of steps, whereby individual cases begin as individual clusters and step-by-step the most similar clusters are joined together, eventually resulting in one cluster containing all cases. Each step is irreversible, so clusters joined at one step cannot be separated later in the clustering process. Through examination of the computer output the researcher is required to decide on the most appropriate number of clusters to describe their data set. Regarding the closest neighbor method, beyond the distance of two clusters, the distance of their closest elements is considered for the purposes of this method (Clatworthy et al, 2005).

Table 4: Indicators of the quality after standardization and normalization

Country	i1	i3	i4	i5	i6	i7	i8	i9	i10	i11
Austria	-0,0085	0,6520	-0,3090	-0,3724	-0,0750	0,3220	-0,3827	-0,1112	0,2660	-0,0408
Belgium	-0,0277	0,1761	-0,2610	0,3798	0,7128	0,0501	0,2635	0,1422	0,2657	-0,2915
Czech Republic	-0,2774	-0,1063	0,0079	0,0923	0,6447	0,0103	0,1974	-0,4153	-0,3013	0,4304
Denmark	-0,0008	0,4551	-0,2497	0,3634	-0,1281	0,0222	0,5824	0,1522	-0,0009	-0,4681
Estonia	-0,3305	0,5951	-0,0630	0,0889	-0,0875	-0,2513	-0,4239	-0,0104	-0,0453	-0,5216
Finland	0,0832	0,7339	-0,3062	-0,0198	-0,1157	-0,1153	0,4712	-0,0112	-0,1214	-0,3111
France	-0,0541	0,1163	0,1398	0,4210	0,5274	0,0321	0,5431	0,3206	0,2972	-0,1468
Germany	0,0356	-0,0598	-0,1552	-0,1432	-0,4262	-0,1212	-0,3134	-0,6983	0,3529	0,2095
Hungary	-0,2577	-0,3062	0,2308	-0,4236	-0,0187	-0,0804	-0,2838	-0,3205	-0,0552	0,6434
Ireland	-0,1103	-0,2154	-0,0533	0,5509	0,4579	-0,1066	-0,2637	0,4921	0,0366	0,3178
Italy	-0,1701	-0,2647	-0,0724	-0,2378	0,2476	-0,1190	-0,1263	-0,4614	-0,7198	-0,1297
Luxembourg	0,4607	-0,3024	-0,0967	-0,3830	-0,2849	0,5510	-0,3243	0,1965	0,1060	0,0239
Netherlands	0,1851	0,1369	0,5601	0,2452	0,0098	0,0486	0,3095	0,2606	0,6362	-0,0466
Norway	0,1869	0,3960	-0,2358	0,2312	-0,5035	-0,2305	0,0822	0,3572	0,2030	-0,4659
Poland	-	0,0327	-	0,4090	-	-	0,4118	0,1344	0,3036	0,2675

	0,4604		0,3232		0,0348	0,4034				
Portugal	-0,3385	-0,3423	0,5313	-0,2646	-0,1476	-0,2438	0,0622	-0,4382	-0,1819	0,3252
Slovak Republic	-0,3516	-0,3278	-0,1328	-0,0178	-0,1785	-0,1753	0,2781	-0,5086	-0,4771	0,3532
Slovenia	-0,3205	-0,1556	-0,3292	0,5417	0,2761	-0,3557	0,1148	-0,0121	-0,1564	0,4803
Spain	-0,2296	-0,2814	0,2182	-0,1962	-0,2833	-0,3050	-0,5818	0,0075	-0,5080	-0,1102
Sweden	0,3222	0,3291	-0,0528	-0,2624	-0,4409	-0,1338	-0,2615	0,2511	0,2221	-0,5685
Switzerland	0,5507	0,0289	-0,2855	0,1172	0,0851	0,3486	0,4394	0,3587	0,3805	-0,0738
United Kingdom	0,2665	-0,1427	0,8236	0,1099	0,1112	0,2126	0,2223	0,2904	0,1609	-0,0328

Source: own processing

4 Results

Based on the application of cluster analysis, three clusters were created (to a distance of 60):

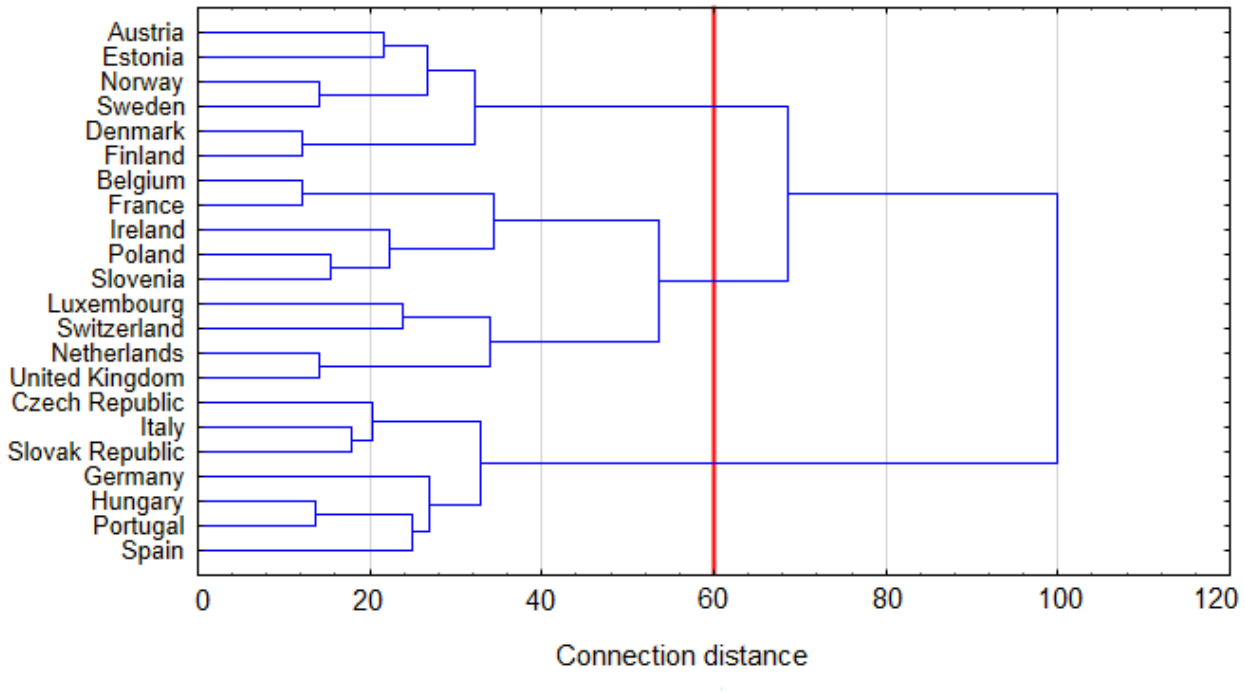
Cluster 1: Austria, Estonia, Norway, Sweden, Denmark, Finland

Cluster 2: Belgium, France, Ireland, Poland, Slovenia, Luxembourg, Switzerland, Netherlands, United Kingdom

Cluster 3: Czech Republic, Italy, Slovak Republic, Germany, Hungary, Portugal, Spain.

Figure 1 shows the dendrogram for European OECD countries. The distance to which the clustering is performed was selected 60. At this distance, there is already a certain clustering of objects into coherent units, however, these units are not too large, and so the identical characters between groups of objects can be seen. Selected distance is in the figure marked by the red line.

Figure 1: Dendrogram for European OECD countries



Source: own processing

Table 5 represents average values of indicators of the quality of higher education systems for individual clusters. Indicators are presented from the input data before standardization.

Table 5: Average values of indicators of the quality of higher education systems for individual clusters

Marking	Indicator	Cluster 1	Cluster 2	Cluster 3	Luxembourg
i1	Annual expenditure per student	17 540	17 184	11 546	40 112
i3	Public expenditure on educational institutions	1.6	1.2	0.9	0.5
i4	Private expenditure on educational institutions	0.1	0.3	0.3	0.1
i5	First-time entry rates into bachelor's or equivalent program	56.3	68.0	47.0	14.0
i6	Ratio of students to teaching staff	13.0	17.6	15.6	8.0
i7	International and foreign students enrolled	7.8	9.7	5.9	44.6

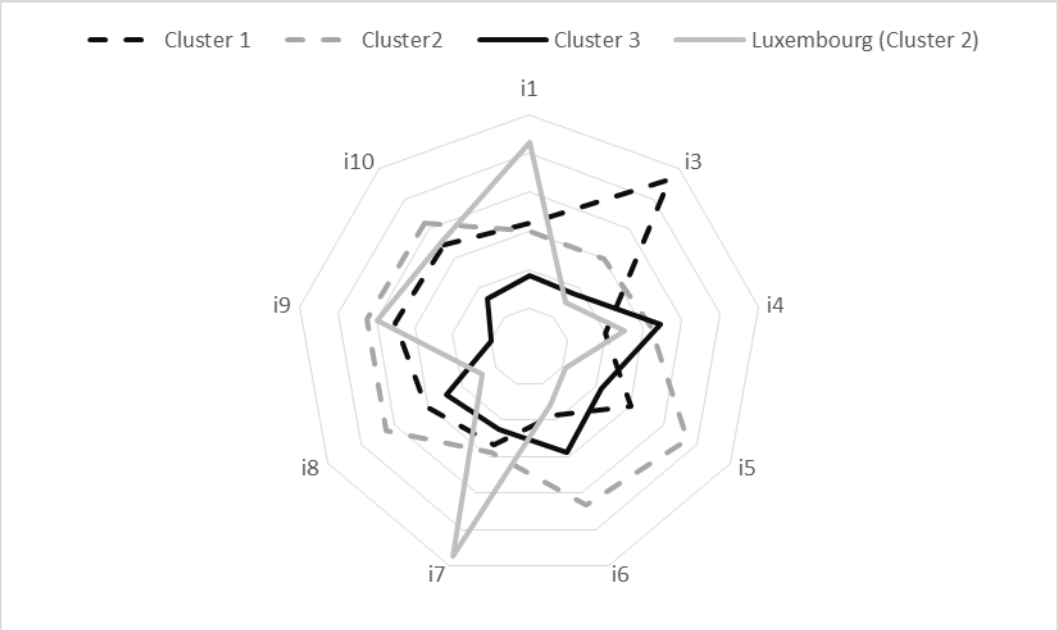
	as a percentage of all students (international plus domestic)				
i8	Completion rate of full-time students (entered bachelor's or equivalent program)	34.8	40.5	30.6	9.0
i9	Tertiary attainment of 25-34 year-olds	43.2	45.7	31.8	51.3
i10	Employment rates of 25-34 year-olds with tertiary education	84.5	86.4	77.2	87.7
i11	Relative earnings of workers with tertiary education (upper secondary education = 100)	133.1	156.0	167.4	156.7

Note: Luxembourg has been excluded from the calculated average values of the indicators from cluster 2 because of its significantly different values of the indicators due to the country's specific status (the values of the indicators for Luxembourg are shown in the last column).

Source: own processing

The following Figure 2 shows the graphical interpretation of clusters and the values of their indicators of the quality using a spider chart. The chart draws the values of each indicator along a separate axis that begins at the center of the graph and ends at the outer ring. In the center, the value of the indicator is the lowest and at the end the highest. Larger area implies better overall quality of higher education systems in clusters. As can be seen, countries in clusters 2 (gray dotted line) have the highest area, followed by cluster 1 (black dotted line) and Luxembourg (gray full line) and the lowest area occupying countries in cluster 3 (black full line). From the curve position is also visible the size of the indicator values that individual clusters achieve. Luxembourg reaches very high values in indicators i7 (student mobility) compared to other countries and i1 (annual expenditure per student). Countries in cluster 2 achieve high values of the indicator i5 (first-time entry rates) and countries in cluster 1 spend high public expenditure on their higher education system.

Figure 2: Graphical interpretation of clusters and average values of their indicators of the quality



Note: Luxembourg was removed again from cluster 2 and displayed separately.

Source: own processing

Furthermore, the similarity of countries in clusters is analyzed within their higher education systems and funding methods. Luxembourg, because of its specific position, is being discussed separately at the end.

4.1 Higher education systems of the countries in cluster 1

Cluster 1 is made up of the Nordic countries and Austria and Estonia. In Nordic countries (also in Estonia), studying at public higher education institutions is free of charge for home students (in Finland and Sweden, tuition fees are also not applicable at private higher education institutions). Scandinavian countries model is advantageous for students because they do not have to pay fees and can receive a scholarships or student loans for covering the cost of studying (food, transport, or accommodation). This model helps maintain greater social equity in accessing universities (Chardonnier, 2013). In Austria, students pay tuition fees in small amounts (below 2,000 USD per year for full-time national students). Countries in this cluster have on average the highest annual expenditure per student and public expenditure. The largest percentage of public expenditure on GDP is spent by Austria, Estonia and Finland (1.7). Nordic countries, however, high public spending compensate for higher taxation of the population. Relative earnings of workers with tertiary education are not so much higher in comparison with the earnings of high school students due to progressive taxation. There is also the lowest

ratio of student to teaching staff in these countries. This allows a more individual approach for teachers and, therefore, a higher quality of teaching. Countries in cluster 1 have high tertiary attainment and employment rates of graduates on average.

4.2 Higher education systems of the countries in cluster 2

Cluster 2 is mainly made up of countries, where there are tuition fees (except Poland). The highest tuition fee is paid in the UK, then in Ireland and the Netherlands. Income-contingent repayment system works in these countries. This model has put some pressure on governments and higher education institutions to ensure that graduates of universities are well prepared for employment in the labor market (Chardonnier, 2013). The disadvantage of this model is the steadily rising indebtedness of graduates and consequently their debt repayment problems (especially in the UK and the USA where tuition fees have increased steadily over the last few years and currently reach over 9,000 USD per year for full-time national students, resp. 8,000 USD) (Chamie, 2017). However, highly prestigious universities in the UK and the USA are considered to be the highest quality universities in the world. Switzerland is also one of the countries with the highest quality higher education system. Universitas 21 (2017) highlights the high qualification of teachers and the quality of research and development. The prestige of universities in these countries attracts foreign students from around the world. In the UK, about 18 % of foreign students are enrolled, in the case of Switzerland it is about 17 %. Despite the fees, the largest number of students enrolled into bachelor´s or equivalent program on average in countries in this cluster. In these countries state aid systems work very well and most students use it. Completion rate of bachelor students and employment of graduates are at a high level in this cluster. Countries in this cluster have on average the largest tertiary attainment. Although Polish students do not pay any fees in public higher education institutions, the membership of this cluster Poland gained in particular similar output characteristics (very high completion rate of bachelor students (44), high employment of graduates and high tertiary attainment). All countries in cluster 2 have the best completion rate of bachelor students on average, tertiary attainment and employment rates of graduates.

4.3 Higher education systems of the countries in cluster 3

Cluster 3 consists of countries where students do not pay any tuition fees in public higher education institutions (Czech Republic, Slovak Republic and Germany) and of countries where students pay tuition fees in small amounts (below 2,000 USD per year for full-time national students). That is in the case of Italy, Hungary, Portugal and Spain. In these countries, tuition fees are relatively low but state aid systems (scholarships or student loans) are poorly developed (Chardonnier, 2013). In countries in this cluster, higher education funding is largely the responsibility of the government (the share of private

expenditure on educational institutions is lower than public expenditure but relatively high = 0.3 % of GDP). This high percentage is mainly due to funding in Portugal, Hungary and Spain where private expenditure is around 0.5, 0.4 and 0.3. The percentage of public expenditure on GDP is very low in countries in this cluster (0.9) compared to other countries. The result is that total expenditure is very low in these countries. Annual expenditure per student is also the lowest in countries in this cluster. Despite no or modest fees, small number of students enrolled into bachelor's or equivalent program on average in countries in this cluster (although in the Czech Republic this indicator is about 60 %). Low quality of higher education systems in these countries (with the exception of Germany) confirms the evaluation according to the Universitas 21 ranking (2017). Completion rate of bachelor students and tertiary attainment are on average very low, as well as employment of graduates (in Germany, however, it is around 87 %). These countries also have the lowest share of international and foreign students. However, relative earnings of workers with tertiary education are the largest on average in countries in this cluster. Highest earnings have workers with tertiary education in Hungary (202.3) and in the Czech Republic (178.7).

4.4 Higher education system in Luxembourg

Luxembourg belongs to cluster 2 with characteristics of its indicators of the quality. However, this country is very specific. Luxembourg is the second smallest country in the EU, but it has the second highest GDP per capita in the world. The official languages are Luxembourgish, German and French. Of the total number of 590 700 inhabitants, 47.7 % are foreigners. From the point of view of the labor market, this is a country where high labor mobility is a common phenomenon; many people commute to work in Luxembourg from neighboring countries (Belgium, France, or Germany). Unemployment rate is among the lowest in Europe. Higher education is very recent in Luxembourg, since the university offer exists only since the beginning of the 2000s with the creation in 2003 of the University of Luxembourg. Previously, students moved abroad mainly to neighboring countries to participate in higher education. Luxembourg currently has only four higher education institutions. The most important is University of Luxembourg. The offer is completed by other institutions, which they offer higher education, such as professional associations, foreign universities, or public research centrums. A part of these institutions work together with foreign education providers in order to make programs from other countries accessible for students based in Luxembourg (European Commission, 2018). In Luxembourg, student pays tuition fees from 227 to 3,629 USD per year (no differentiation based on nationality). Annual expenditure per student is in Luxembourg double that of other countries. 44.6 % of all students are foreign students. Despite counting some of the smallest class sizes, highest teacher salaries and youngest teaching workforce, Luxembourg has very low share of students who complete bachelor´s or equivalent program (only 9 %). The reason for this failure can be the difficulty of language requirements during study (students should know learning in English, German and

French). Very low number of students per teacher causes high expenditure on higher education (especially on teacher salaries). These expenditure are driven by a large number of teachers, which are needed to serve classes with a small number of students, as well as the very high salaries of teachers (teacher salaries are highest in Luxembourg from all OECD countries with a large margin). Therefore, the results of Luxembourg are distorted and need to be taken with caution.

5 Discussion and conclusion

We can summarize that countries in cluster 2 where students pay tuition fees and countries in cluster 1 where higher education is free and at the same time state aid systems are well developed (Nordic countries) have high quality of their higher education systems. On the contrary, countries in cluster 3 where higher education is free or tuition fees are relatively low and at the same time state aid systems are poorly developed have lower quality of their higher education systems. Research question mentioned above has been answered: the clusters created according to the qualitative characteristics correspond to the model of financing. This demonstrates the importance of system of funding the higher education systems and its impact on quality. Sufficient funding from various sources is seen as an important and indispensable condition of higher quality.

Under-funded higher education in many countries is currently much debated. This problem may result in the conflict of two very different views how to increase funding in higher education. First view says that education and higher education in particular are public goods that should be provided free by the state (by taxes of all taxpayers), and the other view says that the private benefits to the students are so large, especially for tertiary education, that its cost should be supported by the student or his family. The current reality varies widely with a growing tendency in many regions of the world for a transfer of costs from the state budget to the student. Higher education finance policies have a major impact on the participation and its social equity (David, 2013).

Practice in Europe shows that in the UK and the Netherlands the income-contingent repayment system works very well. Murphy, Clayton and Wyness (2017) state that the installation of tuition fees in England have led to substantial increases in funding per head, while enrolments have continued to rise, and the participation gap between rich and poor students has narrowed. The number of participants with lower incomes in higher education has increased much more than the number of higher-income participants in the reference period. Equity and access to higher education is also demonstrated by the indicator i5-first-time entry rates into bachelor’s or equivalent program. In the UK and in the Netherlands, the value of this indicator is above average, reaching 63 % for both countries. The highest is this indicator in Ireland (80 %), in Slovenia (73 %), in Belgium and Denmark (71 %), in Poland (69 %), in Norway (66 %) or in France (65 %). It is obvious that the highest values of this indicator reach countries in cluster 2 as well as two Nordic countries in cluster 3. It therefore appears that the payment of tuition fees does

not reduce access to higher education. The reason for successful functioning of this system may also be the historical root of the existence of this system. In the UK, tuition fees were introduced in 1998, in the Netherlands in the 1950s.

Due to financial pressures as well as due to a good example of how tuition fees work, especially in the UK, tuition fees were installed in Austria and Germany. However, immediately after public protests, they were canceled (Gardner, 2013). Public apprehension concerns in particular the reduction of access to higher education. However, many studies and research (OECD, 2017a; Matějů and Barr, 2005; Murphy, Clayton and Wyness, 2017) show that with a properly set student loans, scholarship system, and increased support for low-income people, this system can work well in any European country and the introduction of tuition fees does not reduce equity and access to education.

It should be borne in mind that historical development plays a major role in the funding system. In Western European countries, higher education system evolved naturally. Gradually, due to the loan system, the differences between public and private funding of higher schools are diminishing (typically in UK) and the quality of education is at a relatively high level. The reverse situation is in post-communist countries. The communist regime prevented the natural development of higher education. After it´s falling in the early 1990s, there has been a rapid increase in the number of higher education institutions (mostly private higher education institutions). Private higher schools in these countries (typically CR) are very focus on profit and commercially oriented and the quality of education is generally criticized. Public universities often suffer from a lack of finance and political representations are still rejecting the idea of installation tuition fees and developing system of loans. An example might be the Czech Republic, Slovakia or Hungary, where has been considering introducing tuition fees, but has not received sufficient public support for this step.

Within the higher education financing models, it is clearly understood that the balance between private and public funding on the one hand, and the ability of countries to provide various forms of state aid to higher education institutions on the other hand, are two factors that help explain the wide disparities in funding approaches. Some countries have managed to find new private sources of funding, while others have increased their public funding, whereas those who have not chosen any of these options experience increasingly important difficulties to reconcile development and quality. It turns out that economic, historical and cultural developments in individual countries need to be taken into account when trying to improve quality of higher education systems.

Acknowledgement

This contribution was supported by the scientific research project No. SGS 480025/20/40530, “Transparency and competitiveness of municipalities and regions in the context of developing the concept of smart cities and regions”.

References

Adams, D. (1993). Defining Educational Quality. *Educational Planning*, 9(3): 3-18.

Ashworth, A., and Harvey, R. (1994). *Assessing quality in further and higher education*. London: Jessica Kingsley Publishers Ltd.

Bozieva, A. M. (2017). *Education quality criteria within the competence model of the graduate*. In " Quality Management, Transport and Information Security, Information Technologies"(IT&QM&IS), 2017 International Conference (pp. 645-647).

Chalmers, D. (2008). *Teaching and learning quality indicators in Australian universities*. Programme on institutional management in higher education (IMHE). Outcomes of higher education: quality, relevance, and impact.

Chamie, J. (2017). Student Debt Rising Worldwide. [online] YaleGlobalOnline: Yale University. Available at: https://yaleglobal.yale.edu/content/student-debt-rising-worldwide [Accessed 16. 7. 2018].

Charbonnier, E. (2013). *University Tuition Fees: "To be or not to be?"* [online] IAU Horizons, 19(3): 17-20. Available at: https://www.iau-aiu.net/IMG/pdf/iau_horizons_vol.19_no.3_2013_en.pdf [Accessed 16. 7. 2018].

Clatworthy, J., Buick, D., Hankins, M., Weinman, J., and Horne, R. (2005). The use and reporting of cluster analysis in health psychology: A review. *British journal of health psychology*, 10(3): 329-358.

David, M. (2013). *Equity and diversity: towards a sociology of higher education for the twenty-first century?* In The Sociology of Higher Education (pp. 29-44). Routledge.

Erina, J., and Erins, I. (2015). Assessment of Higher Education Financing Models in the CEE Countries. *Procedia-Social and Behavioral Sciences*, 177: 186-189.

Everitt, S., B., Landau, S., Leese, M., and Stahl, D. (2011). *Cluster analysis*. Chichester: Wiley.

Gardner, M. (2013). Bavaria to scrap tuition fees. [online] University World News, Issue 261. Available at: http://www.universityworldnews.com/article.php?story=20130228121351682 [Accessed 16. 7. 2018].

Goddard, D., and Leask, M. (1992). *The search for quality: Management in education*. London: Paul Chapman.

Grisay, A., and Mahlck, L. (1991). *The quality of education in developing countries*. IIEP, Paris: A Preview of Some Research Studies and Policy Documents.

Harvey, L., and Green, D. (1993). Defining quality. *Assessment & evaluation in higher education*, 18(1): 9-34.

Hoy, C., Bayne-Jardine, C., and Wood, M. (2000). *Improving Quality in Education*. London: Routledge.

Iacovidou, M., Gibbs, P., and Zopiatis, A. (2009). An exploratory use of the stakeholder approach to defining and measuring quality: The case of a Cypriot higher education institution. *Quality in higher education*, 15(2): 147-165.

Matějů, P., and Barr, N. A. (2005). *České vysoké školství na křižovatce: investiční přístup k financování studia na vysoké škole v sociologické reflexi*. Praha: Sociologický ústav Akademie věd ČR.

Meloun, M., and Militký, J. (2012). *Interaktivní statistická analýza dat*. Praha: Karolinum.

Morley, L. (2003). *Quality and power in higher education*. Berkshire: McGraw-Hill Education.

Murphy, R., Scott-Clayton, J., and Wyness, G. (2017). The end of free college in England: implications for quality, enrolments, and equity. *National Bureau of Economic Research*. No. 23888.

OECD (2017a). *Benchmarking higher education system performance: Conceptual framework and data*, Enhancing Higher Education System Performance, OECD Paris.

OECD (2017b). *Education at a Glance 2017: OECD Indicators*. [online] OECD Publishing, Paris. Available at: http://www.oecd-ilibrary.org/education/education-at-a-glance-2017_eag-2017-en [Accessed 17. 7. 2018].

Petr, P. (2014). Metody *Data Miningu: Část I*. Pardubice: Univerzita Pardubice.

Průcha, J. (1996). *Pedagogická evaluace: hodnocení vzdělávacích programů, procesů a výsledků*. Brno: Masarykova univerzita.

Rey, E. D., and Romero, L. (2004). *Competition between public and private universities: quality, prices and exams* (No. we046423). Universidad Carlos III de Madrid. Departamento de Economía.

Romainville, M. (1999). Quality Evaluation of Teaching in Higher Education. *Higher Education in Europe*, 24(3): 414-424.

Rýdl, K. (2002). K pojetí kvality ve školství a jejímu hodnocení. *E-Pedagogium*, 2(1): 104-123.

Scheerens, J., Luyten, H., and van Ravens, J. (2011). *Measuring educational quality by means of indicators*. Dordrecht: Springer.

Schindler, L. A., Puls-Elvidge, S., Welzant, H., and Crawford, L. (2015). Definitions of quality in higher education: A synthesis of the literature. *Higher Learning Research Communications*, 5(3): 3-13.

Universitas 21 (2017). U21 Rankings. [online] Available at: https://universitas21.com/network/u21-open-resources-and-publications/u21-rankings/comparison-table [Accessed 17. 7. 2018].

Windham, D. M., and Chapman, D. W. (1990). *The evaluation of educational efficiency: constraints, issues, and policies*. Greenwich, CT: JAI Press.

World Bank (1999). *Education Sector Strategy*. Washington, DC, World Bank Human Development Group.