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Empirical Paper

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Diversity of education systems in the European Union

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Abstract: This article explores Bruno Amable's Diversity of Capitalism approach to analyze educational systems in the European Union (EU28). The main goal is to identify the main clusters of educational systems with regard to their institutional characteristics. Second goal of the analysis is to evaluate the impact of several EU policies and initiatives on the institutional structure of European educational systems. This article identified six clusters in terms of general education and five clusters in terms of higher education systems. The clustering shows, that – with some exceptions (notably the United Kingdom and Ireland) – European education systems have similar structure to other institutional areas, in particular, it confirms the existence of post-communist (in terms of Farkas) or patchwork (in terms of Rapacki et al.) capitalism. The article shows, as well, that subsystem of higher education is much less diverse, what may have a significance for future discussions on the capitalisms in the EU. Results suggests also that there exist significant differences in performance between the clusters, something that may have a crucial importance for an educational policy.

Keywords: education systems, clustering, Diversity of Capitalism
JEL Classification: I20, I21, O17

1 Introduction

Education is widely considered as one of the key domains of a model of capitalism in a literature. However, relatively little space is devoted to this area. Most authors focus on industrial relations and aspects of welfare state. Education, even though mentioned as an important factor, usually is analyzed in terms of vocational education (VET), school-to-work transitions, and its orientation (general versus job-specific).

The aim of this article is to explore the various institutional features of education system in European Union (EU) countries and to propose clusters of countries, characterized by similar institutional aspects of education. The approach to this task is based on Bruno Amable's methodology presented in his seminal book "Diversity of Capitalism" (DoC) with some improvements of his prominent successors, in particular works of Beata Farkas, and Ryszard Rapacki and his collaborators.

This article tries to grasp a broad set of institutional aspects of education, at all levels: from pre-primary to adult education. In comparison to other works in this area, this article focuses on education itself rather than its relationship with other institutional domains, mainly labor market. This may help to emphasize main differences in countries' education systems and this can add to an understanding of the field. The existing literature, emphasizing school-to-work transitions, made a tacit assumption that employability is a main goal of education system. Focus on education itself may help in expanding DoC approach of other aspects, such as a role of education in creating civic society.

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The article also proposes a separate analysis of higher education system. Since 1999 and Bologna declaration, there are various initiatives leading to unification of higher education policies in European countries. This article is the first work highlighting this area with the use of DoC approach. This may help in an understanding the institutional changes in the EU that may influence other institutional domains as well.

Section 2 briefly describes theoretical context of this article and presents Bruno Amable's DoC approach. Section 3 shows the existing efforts to encompass education in system in discussions on the models of capitalism. Section 4 presents the methods and sources. Section 5 presents the results of empirical analyses and clustering. Section 6 describes an interpretation of the results and further steps.

2 Theoretical context: DoC approach

Varieties of capitalism as a separate subfield of New Institutional Economics dates back to Peter Hall and David Soskice's book under this title [Hall and Soskice, 2001]. There existed literature aiming at comparisons of different models of capitalisms in developed countries [the notable example is Esping-Andersen, 1990], but it was this book that influenced dozens of researchers, who further explored this area to better understand, how institutional arrangements influence economic growth.

Hall and Soskice identified two basic models of capitalism in developed countries: liberal market economies (LME) and coordinated market economies (CME). The former are represented mostly by English-speaking countries (the United States, the United Kingdom, Australia, etc.) and characterized by liberal labor markets, low levels of unionization, weak social protection, or dominance of general education. The latter are represented by continental Europe countries (France and Germany) and characterized by strong social protection, preference for VET, or high level of unionization. The most important conclusion was that economies can be successful in terms of high economic growth and low unemployment, regardless the model.

One of the most important works that followed this trend was Bruno Amable's book "Diversity of Capitalism" [Amable, 2003], where Hall and Soskice's approach was improved by incorporating a strict methodology of identifying clusters of economies. Amable's approach was based on the use of principal component analysis (PCA) of various institutional aspects of developed economies. Amable distinguished five major institutional domains: product markets, labor markets (called "The Wage-Labor Nexus"), financial systems, social protection, and education. This lead him to an identification of five basic models of capitalism, beyond traditional LME-CME distinction: Anglo-Saxon, very similar – both in terms of characteristics and typical countries – to Hall and Soskice's LME model, Continental, represented by France and Germany, as well as Benelux and Switzerland; Social-democratic capitalism, represented by Scandinavian countries; Mediterranean capitalism, represented by Greece, Italy, Spain, and Portugal; and Asian capitalism, mainly represented by South Korea and Japan. Furthermore, Amable directly stated that the most important aspect of country's institutional architecture is a complementarity between various sectors and subsystems.

Since publication of this book, there appeared a bunch of literature expanding and modifying this approach. Most notably, there appeared various works that extended analyzed to other European countries, in particular new member states. Rapacki et al. [2018] offer brief and extensive review of studies in this area. Most often, authors suggest that Central and Eastern European EU member states create separate model of capitalism, called – depending on the author – "post-communist capitalism," "hybrid capitalism," or "patchwork capitalism." The second major improvement to Amable's proposed approach is to extend or modify a number of institutional domains analyzed. For example, Jackson and Deeg [2006] proposed six domains: knowledge, finance, corporate governance and responsibility, industrial relations, industrial policy, and welfare state. Another example is Próchniak et al. [2016] who added to Amable's five domains the sixth one: housing market.

The work that deserves the separate notification is Beata Farkas' book "Models of capitalism in the EU. Post-crisis Perspectives" [Farkas, 2016]. This book is currently the most up-to-date analysis of models of

capitalism in the EU, using DoC approach. Therefore, this work serves in this article as the most important reference point in final conclusions.

3 Diversity of education: state-of-the-art

3.1 Education in varieties (diversity) of capitalism literature

As was mentioned in the introduction, literature on varieties or the DoC usually employs some kind analyses of education system. It is however clearly visible that those works significantly differ in terms of understanding, how the education system is defined. As a consequence, direct comparisons of those works are significantly limited. This section sums up their findings, with a respect to differences in approaches.

First notable work on the role of education in constitution of a capitalism model is one of the chapters in Hall and Soskice's seminal book [Estevez-Abe et al., 2001]. Approach here is however very narrow. The authors use the term "skills formation" rather than education, and this institutional domain is combined with social protection. As a consequence, their discussion focuses on VET and training. Figure 1 shows the main types of (vocational) skills formation.

Altogether, Estevez-Abe, Iversen, and Soskice distinguished four skill profiles: "Firm/industry/occupational," "Industry/occupational," "Firm/occupational," and "Occupational/general." Countries were classified in a group on a basis of four criteria: median length of tenure, vocational training share, vocational training system, and share of population with university education. There are two major limitations in this approach: this set of characteristics is obviously too narrow to fully analyze the complexity of education systems, furthermore, at least one variable –VET system – is assessed arbitrarily. Those limitation do not undermine the significance of this work.

Another notable example of typology based purely on VET is Aventur et al. [1999], who classified European countries (old EU member states) according to employers' roles in initial and continuing training. Countries differed from those weak in both categories (Spain) to strong in both categories (Denmark). Hannan et al. [1996], on the other hand, focused on a degrees of standardization and differentiations, with extreme groups of Germany and Netherlands (high in both degrees), and the United States and Canada (low in both).

Bruno Amable in his DoC book also devoted one chapter to an education. He managed to identify five clusters of education systems, briefly described in Table 1.

The most surprising case in Amable's findings is Austria. In comparative education research, it is often assumed that Austrian education system is the most similar to the German one, with relatively high share of VET students in secondary education and a significant involvement of employers in education through a dual system. What is important for further conclusions, main reason for such a difference is an impact of employment variables, in particular relative employment of tertiary education graduates. On the other hand, another interesting case – single-country cluster of Finland – confirms opinions of education researchers, who widely see this country as most specific and most effective in the EU [see, e.g., Organisation for Economic Co-operation and Development (OECD), 2011].

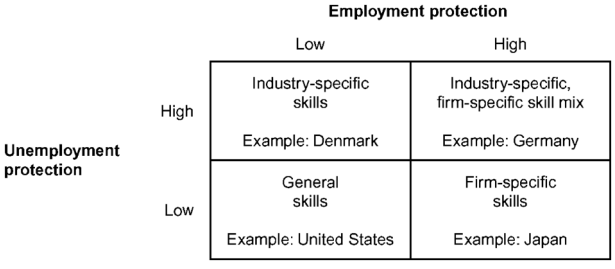

Figure 1. Skills vs employment protection: VoC approach.
Source: Estevez-Abe et al. [2001].

Table 1. Education clusters identified by Amable

Countries in a cluster	Key characteristics
Italy, Spain, Portugal, Greece, and Austria	Low number of higher education graduates
Finland	Various specific features
Netherlands, Belgium, France, Germany, and Ireland	Strong public education
Denmark, Sweden, and Norway	High expenditures per capita, high employment ratios
The United States, Japan, the United Kingdom, Australia, Korea, and Canada	Privately financed tertiary education

Source: Amable [2003].

Table 2. Education clusters identified by Farkas

Countries in a cluster	Key characteristics
Austria, Denmark, the United Kingdom, Finland, the Netherlands, Sweden, and Slovenia	High enrollment ratio and high employment rate of graduates, very large number adults in Lifelong Learning (LLL), highest expenditures per capita in relation to GDP
Italy, Spain, and Portugal	High enrollment in tertiary education and – at the same time – high proportion of low-qualified population, participation in LLL lower than in cluster 1, but higher than in 3 and 4
Belgium, Lithuania, Latvia, Estonia, France, Greece, Ireland, Luxembourg, Hungary, and Romania	Fewer participants in VET and LLL than average, spending on education below average, rates of employment slightly below average
Bulgaria, Czech Republic, Poland, Germany, and Slovakia	Smallest proportion of low-qualified people, smallest public spending on education, with highest private spending (in relation to GDP)

Source: Farkas [2016].

It is also worth to note that in Amable's work one can clearly identify LME type of education. This result is not that clear in other analyses because in Amable's set, very important role is played by the United States. Also Japan and Korea appear to have education systems more in the US style, rather than continental European one. Therefore, this very convincing result blurs in the models focusing on European countries.

Second example of clustering education systems is the one of Farkas (see Table 2).

Farkas identified four clusters, with first two clearly separate. The border between clusters 3 and 4 is less obvious, but due to a size and heterogeneity of those countries, she decided to distinguish them. Definitely, the most surprising result here is Germany in cluster 4, altogether with Poland, Czech Republic, Slovakia, and Bulgaria. Farkas suggests that this case is an aftermath of Germany's unification, but this explanation seems not very convincing. First of all, population of German Democratic Republic is relatively small and should not have that much impact 25 years after unification. Second, German Democratic Republic (GDR's) education, governed for more than 30 years by Margot Honecker, was famous for its specificity, even in comparison with other communist countries. One may suppose therefore that this case is more the effect of ambiguous choice of variables, rather than a real effect of German institutional underpinnings.

The other clusters identified by Farkas seem reasonable. It is also interesting that even though Farkas included in her model labor market characteristics (such as employment and unemployment rates), only in two clusters those variables were statistically important.

Finally, similar analysis was performed by a research team from SGH, led by Ryszard Rapacki [Karbowski, 2017; Rapacki and Czerniak, 2018]. They called this institutional domain "knowledge subsystem" and identified four clusters (see Table 3). The comparisons with this work are the most difficult, since they treat this domain more broadly, with a significant role of innovation systems. Key characteristics of clusters, shown in a table confirm, that the variables on innovation played a dominant role in final results of clustering. The authors added also some effectiveness characteristics of education system, in particular results of PISA.

Table 3. Education clusters identified by SGH research team

Countries in a cluster	Key characteristics
Germany, Austria, Denmark, Netherlands, Sweden, and Finland	High level of patent applications, high level of individuals' Internet skills, medium–high turnover from innovation
The United Kingdom, Ireland, France, and Belgium	High level of employment in knowledge-intensive services, very high turnover from innovation, relatively low share of 15-year-old pupils performing weakly in PISA
Slovenia and Italy	Medium level of large part of characteristics: patents, employment in knowledge-intensive service, share of women in VET streams, and in research
Bulgaria, Estonia, Czech, Republic, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Croatia, Greece, Spain, and Portugal	Low level of patent applications and patents granted, medium–high level of enrollment in tertiary education, comparatively low individuals' level of Internet skills

Source: Rapacki and Czerniak, [2018].

Clusters identified by Rapacki and Czerniak are the most coherent with clusters for all economy. Most of the results are convincing, and – what is perhaps most important – clearly show the difference between old and new EU member states. The latter are filled with Greece, Spain, and Portugal – this result is also predictable based on DoC literature. However, if we analyze the key characteristics of those clusters, we will grasp a conclusion that innovation system's characteristics dominate over the purely educational ones. This approach better matches the goals of authors, who aimed at grasping similarities and relationships with other institutional domains, but fails to fully describe educational systems on their own.

4 Data sources and methods used

4.1 Education: definition and distinctive features

In this work, education system is defined as an institutional domain that aims at teaching and educating people. Therefore, it is the most similar to the one of Estevez-Abe et al., who also understand education in this terms, and called it a skills formation domain. The difference is that I treat a term "skills" more broadly and assume that it is far beyond VET and on-the-job trainings.

As a consequence of those assumptions, there were no labor market characteristics analyzed, focusing directly on education system. Also a production of knowledge or innovativeness of the economies were excluded from the model. It is sometimes difficult to clearly distinguish scientific from teaching activities (in particular in tertiary education), however, for the purposes of this article such a distinction was necessary.

It should be noted that education system has few features that make it more complicated. First of all, education system in Europe is considered to be relatively heterogeneous. In that case, performing analyses based on clustering may lead to non-conclusive results.

Second, there were a number of reforms in a number of countries that hugely affected educational systems. There are also multiple initiatives to integrate educational systems within European countries. The most advanced are integrations in tertiary education. In 1999, there was established European Higher Education Area, an agreement aiming in cooperation among European universities. The most important and best known initiative was the so-called Bologna process[1] that lead European universities to establish new model of studies, with six or seven semesters of bachelor studies and three or four semesters of master studies. There was also a shift in PhD studies that became a third level of tertiary education. Main goal of such reforms was to increase the mobility among students and to ensure multilateral recognition

1 Please note that in Bologna process, much more countries participate than just European Union. For example, Belarus and Russia are the members of European Higher Education Area.

of diplomas. It was also increased by introduction of European Credit Transfer System (ECTS), a tool to accumulate and transfer learning outcomes [European Commission, EACEA and Eurydice, 2018].

There are also initiatives to integrate VET; however, they are far less advanced. Main tools in this area are as follows: ECVET (European Credit System for Vocational Education and Training), a tool analogous to ECVET and EQAVET – European Quality Assurance for Vocational Education and Training. Currently, they are under development, and so far have minor influence on actual educational systems. One should also mention the European Qualifications Framework, a tool to compare different educational and qualifications systems in Europe [Cedefop, 2012, 2015; UE, 2013]. As a consequence, this article proposes to analyze higher education separately. It will help to understand uniformization tendencies in education system in the EU.

Finally, the clustering model excludes variables on employability (contrary to Amable and Farkas). First reason was mentioned by Farkas – employment and unemployment are caused by many factors and a level of education may even be not the most important one. Furthermore, even if we would be able to precisely assess the impact of education on employability, it would bring some misleading conclusions. Education system is an institutional domain that produces strongly lagged results. To make this argument more visible, at least one-third of the labor force in CEE countries are the people who most of their education spend in real-socialist schools. Therefore, their employability adds little knowledge to the features of today's schools.

4.2 Method

The clustering is based on PCA and hierarchical clustering on principal components (HCPC). PCA is a statistical method that allows to recognize the most and the least important variables. That opens a number of further possibilities and, in context of typologies, the most crucial is clustering based on PCA.

PCA is based on geometrical representation of variables. To do so, we create the "Cloud of individuals N_I." We can define every country profile as a set of characteristics: $\{x_{ik}; k \in (1,k)\}$, which can be interpreted as a vector on k-dimensional space. A distance between two individuals, i and l: $d^2(i,l) = \sum_k (x_{ik} - x_{lk})^2$.

We can further define G_I as a center of gravity. It can be interpreted as a mean point of all the variables. Therefore, for any given individual (country profile) i, we get $d^2(i, G_I) = \sum_k (x_{ik} - \bar{x}_k)^2$. That distance is sometimes called "the peculiarity" of the individual i, since it shows, how one differs from others. Later on, those calculations allow to define a total inertia of a cloud N_I:

$$\frac{N_I}{G_I} = \sum_k \sum_i p_i (x_{ik} - \bar{x}_k)^2 = \sum_k Var[k]$$

That measure is particularly useful in statistical analysis since it allows to differentiate variables and individuals with a use of variance. Further specification of PCA method can be found in Pagès [2014].

Based on PCA results, there performed a HCPC to identify clusters [Kassambara, 2017].

All the calculations were performed in R with use of the packages "FactoMineR" [Husson et al., 2018] and "Factoextra" [Kassambara and Mundt, 2017], both designed for factor and cluster analyses.

4.3 Choice of variables and sources of data

Since the goal of the article is to explore the institutional diversity of educational systems, only input variables were included. As explained in Section 4.1, variables on employability were excluded from the model (contrary to Farkas and to the lesser extent Amable), as well as those analyzing innovativeness. The model excluded also all effectiveness measures, to fully focus of direct institutional underpinnings. It is perhaps considerable to add measures such as Programme for International Student Assessment (PISA) and Programme for the International Assessment of Adult Competencies (PIAAC) results in further extensions of the model.

Obviously, vast majority of the variables epitomize the features of formal institutions; however, the informal institutions are – indirectly – represented as well. Perhaps the best example is the percentage of students in VET programs. It is both the result of formal institutions (e.g., political decisions on financing the system) and informal institutions (e.g., that creates different opinions on the prestige of this path of education).

The dataset combines three sources: the enrollment to education (in various aspects) and data on compulsory education are obtained from World Bank Data Bank, data on teacher salaries are taken from OECD. All other variables are taken from Eurostat. In all cases, the latest possible data were used, usually it is 2016 or 2017. Results for Cyprus may not be precise, since relatively high number of missing values.

The complete list of variables is shown in Table A1 in Appendix A.1.

5 Empirical results

In this section, the results of two clusterings are presented: first one includes all the characteristics of the education systems and the second one focusses only on higher education.

5.1 Empirical results: education clusters

There were 38 variables included in a model. Figure 2 shows, how they influenced the clustering, in the first factorial plane. The interpretation of this figure is following: every arrow represents one variable. If a country is high performing in a given category it follows the direction of this arrow, if low performing it

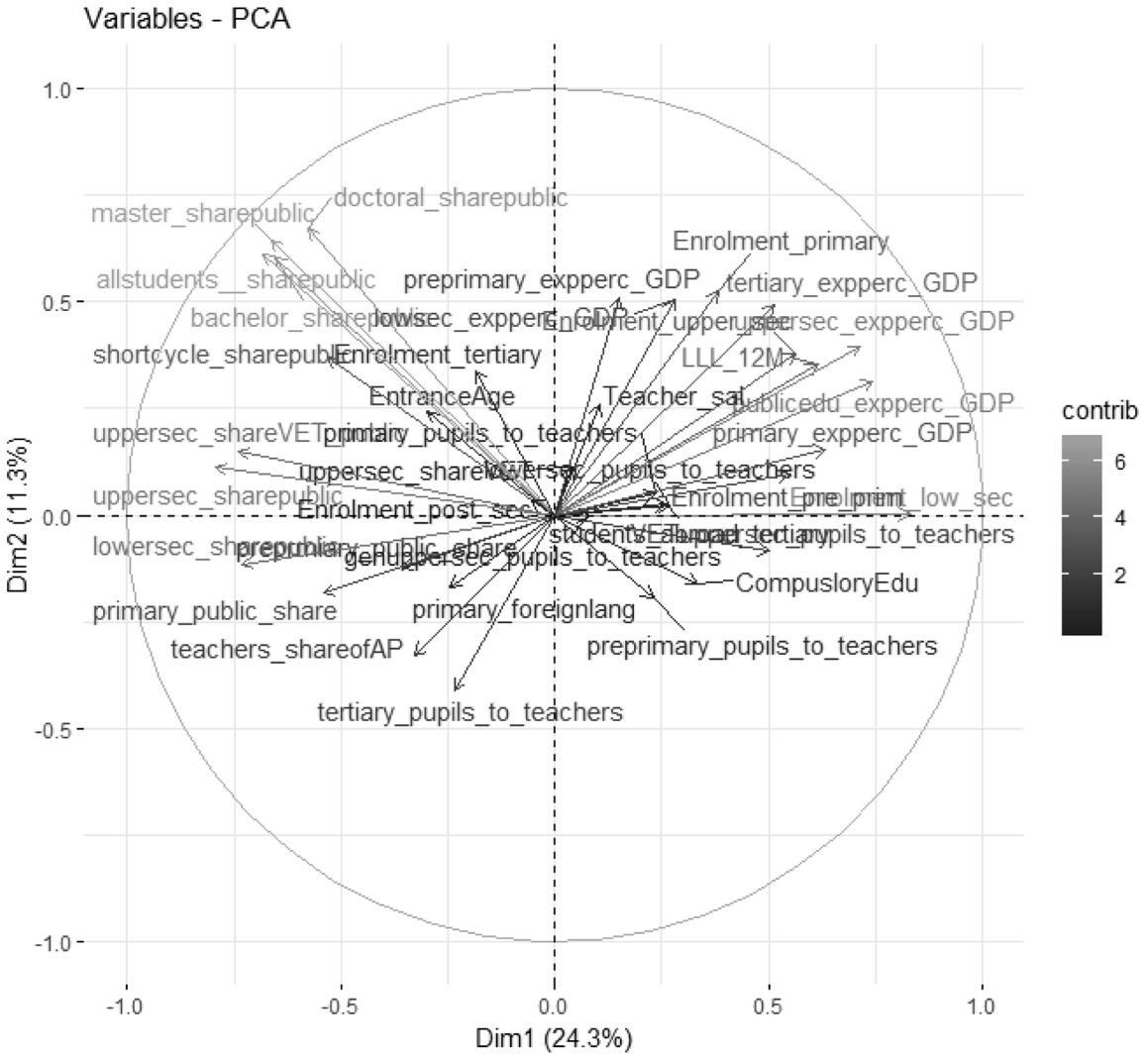

Figure 2. Active variable in the first factorial plane: total education.
Source: Own estimates.

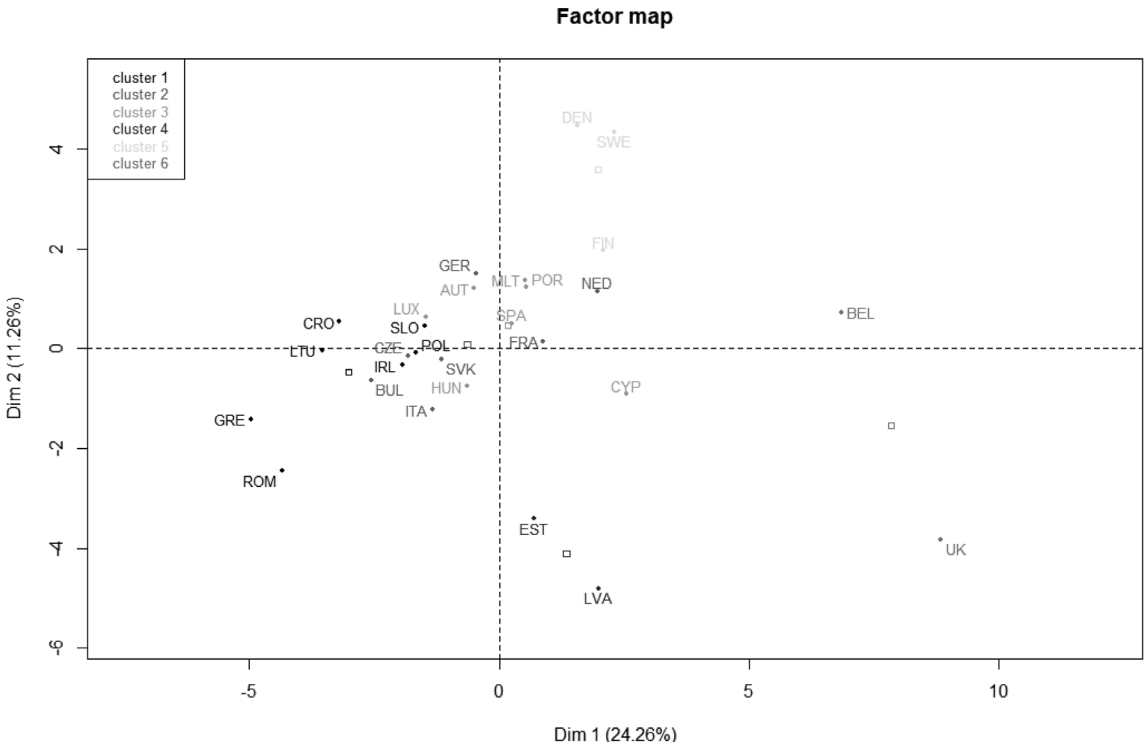

Figure 3. Countries' representation in the first factorial plane: total education.
Source: Own estimates.

goes in the opposite direction. Colors represent the importance of a given variable: those lighter are more important, and those darker have lower significance.

It is clearly visible that the variables that affect clustering the most is the share of the students in public institutions, at all levels of education. Furthermore, it seems interesting expenditures in relation to GDP go in another direction.

Figure 3 shows the countries' representation in the first factorial plane. The most obvious example here is the United Kingdom, located far in the right-down quarter. This is caused mainly by the high share of students in private institutions. Other countries appear to near the middle of the factor map. One has to be careful with interpretation of this figure – proximity of countries on the map does not directly reflect their actual institutional proximity.

Figure 4 shows the cluster dendrogram: most important figure in this article. The dendrogram shows the institutional proximities between countries and therefore allows identification of clusters.

Six clusters were distinguished. They are marked on the figure in dashed boxes. The first cluster, including Belgium and the United Kingdom, is the most specific and farthest from other countries. The United Kingdom confirms here being a member of LME. Ambiguous case of Belgium should be treated carefully – this country has different education systems for Flemish and French communities (and also one for German-speaking community) so the variables for this country represent the average of two subsystems and may not in fact credibly describe any of them. Nonetheless, both Flemish and French communities are characterized by relatively high number of students in private institutions and this is the main reason, why Belgium was classified in one cluster with the United Kingdom.

Interesting case is also a cluster of Estonia and Latvia. If they were to be combined with another cluster, it would be a Scandinavian one rather than more expected CEE.

The height of the lines represents the so-called cophenetic distance between countries. It can be interpreted in a following way – the smaller is the height, the more similar are given countries. This means that the two most similar countries in the pool are Czech Republic and Slovakia. It should be noted that in general heights in this dendrogram are relatively high, with cophenetic correlation of 0.52. This number confirms the high level of heterogeneity.

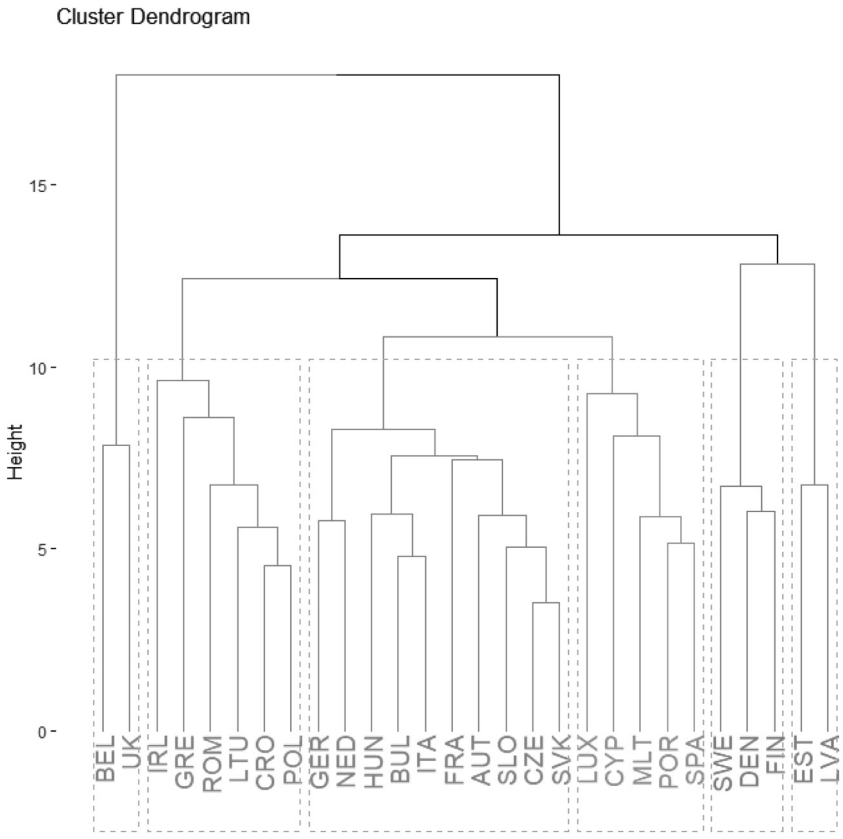

Figure 4. Cluster dendrogram: total education.
Source: Own estimates.

Further description of clusters' characteristics is shown in Section 6.

Figure 5 offers the comparison between New and Old Member States. This figure shows that old member states are much more diverse in terms of institutional underpinnings of educational systems. On the other hand, it shows, that in case of educational systems, it is difficult to talk about "post-communist" economies.

5.2 Empirical results: higher education clustering

The clustering in higher education was performed analogically to the previous one. Figure 6 presents the active variables in the first factorial plane. Again, the most important aspect in case of clustering is public versus private institutions nexus. Out of all fields of study, the most important in terms of importance for clustering appear engineering, agriculture, and services.

Figure 7 shows the countries on the map based on Figure 6. Again, the most specific is the case of the United Kingdom.

Figure 8 shows the cluster dendrogram for higher education.

There were five clusters identified in this subsystem. The first important and interesting conclusion is that in case of higher education virtually all the New Member States are included in one cluster. As a result, cluster 5 here is very similar to Rapacki's cluster 4.

Luxembourg constitutes the separate cluster mainly due to very high number of students abroad. It can be, however, merged with cluster 3. Another interesting conclusion is that, when higher education is treated separately, the uniqueness of Belgium disappears. This may confirm the intuition that this was caused mainly by the institutional ambiguity between Flemish and French communities.

One should also note that proximities between countries in case of higher education are in average smaller than in a clustering based on all the educational variables, with cophenetic correlation of 0.76.

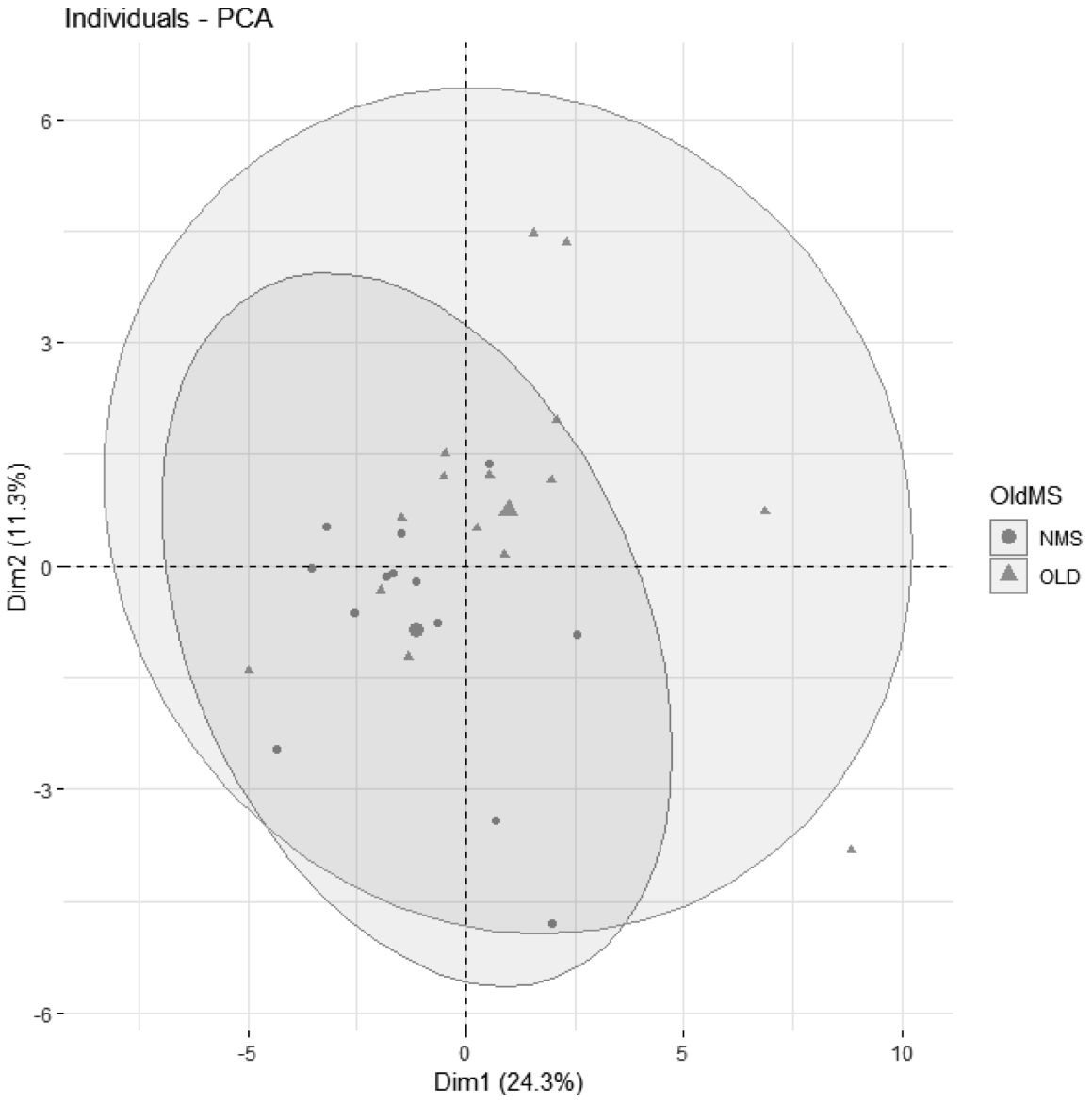

Figure 5. Old and New Member States in the first factorial plane: total education.
Source: Own estimates.

Further characteristics are shown in Section 6.

Contrary to the general clustering, the model for higher education shows more diversity for New Member States. This is however to the great extent caused by Latvia and Estonia, located far in the left-down quarter (Figure 9).

6 Interpretation of results

Table 4 sums up the clustering of countries in a model with all educational variables.

It should be noted that big share of results were clearly predictable: close proximities of Czech Republic and Slovakia or Portugal and Spain or Estonia and Latvia or Scandinavia as a separate cluster. The most surprising results are Luxembourg in group with Southern European countries and Bulgaria among Central European economies. It should be, however, noted that cluster 2 is also the most diverse of all clusters. The comparison of those clusters with those drawn by Farkas and Rapacki et al. is shown in Table A2 in Appendix A.2.

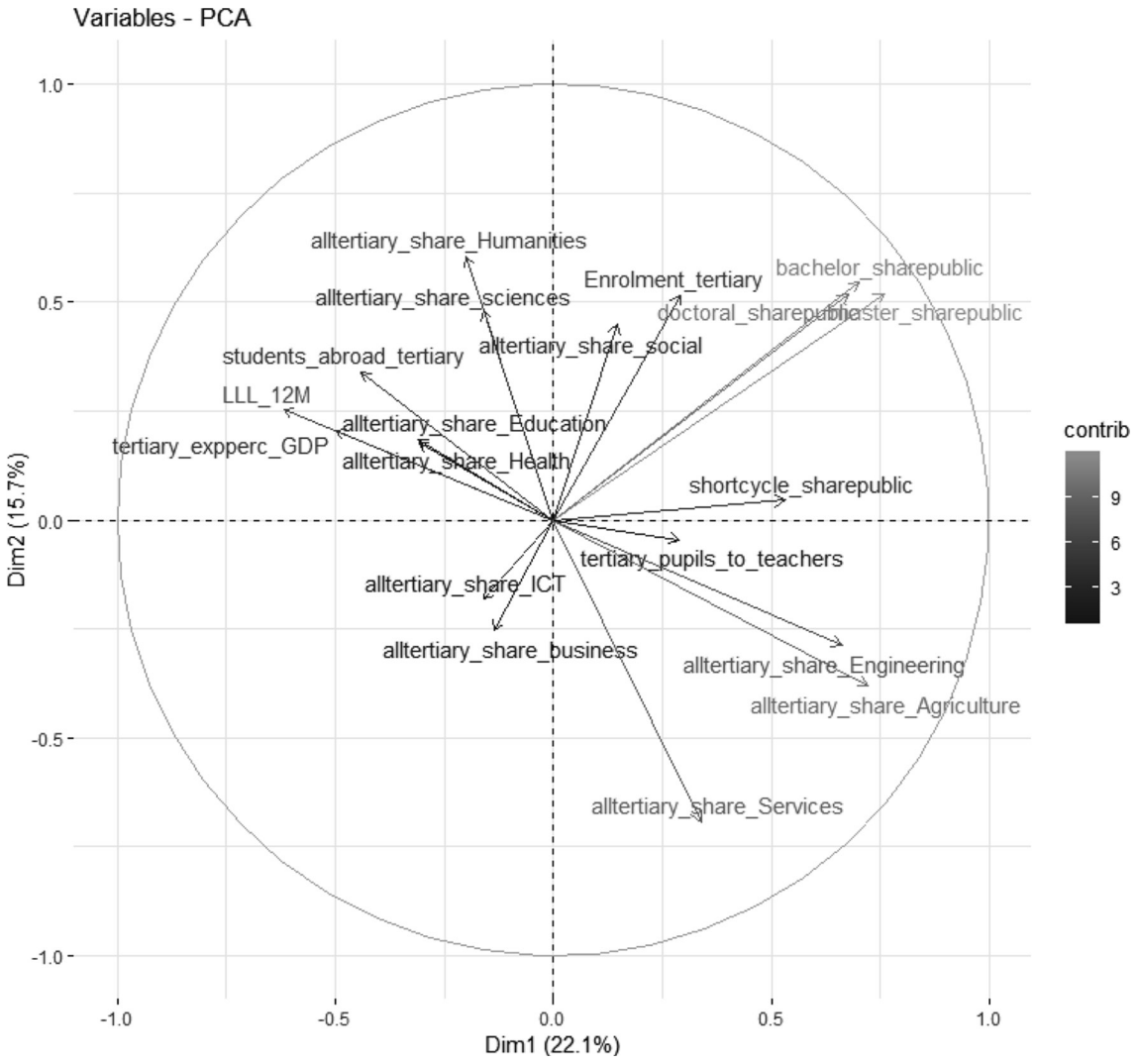

Figure 6. Active variable in the first factorial plane: higher education.
Source: Own estimates.

Table A3 in Appendix A.2 shows the detailed comparison of the characteristics of the clusters. In particular, there is a clear difference between clusters 1 and 6. The latter also significantly differs from Scandinavian cluster 5.

The clustering confirms also an intuition known from literature review that, in case of education, Ireland cannot be understood as a LME. Most striking is its structure of financing in comparison with the United Kingdom's: in Ireland, 99.5% of pupils in primary education and 100% in lower secondary education are in the public institutions. In the United Kingdom, those shares are, respectively, 79.6% and just 40.7%.

Table 5 shows the key characteristics of clustering for higher education.

Apart from cluster 1 that combines systems that can be noted as unique, the results here are very much in line with DoC literature. One can clearly distinguish continental European model from Mediterranean and post-communist ones. Table A4 in Appendix A.2 shows the detailed comparison of the characteristics of the clusters in higher education. In this case, the clearest is the difference between clusters 1 and 5, but it should be noted that the relative differences between clusters are significantly lower than those in a model using variables from all levels of education.

Another question that one may ask regarding those results is whether the clusters explain the differences in the outcomes. Table 6 shows the results of OECD's PISA 2015 survey that measures the basic skills of 15-year-old children.

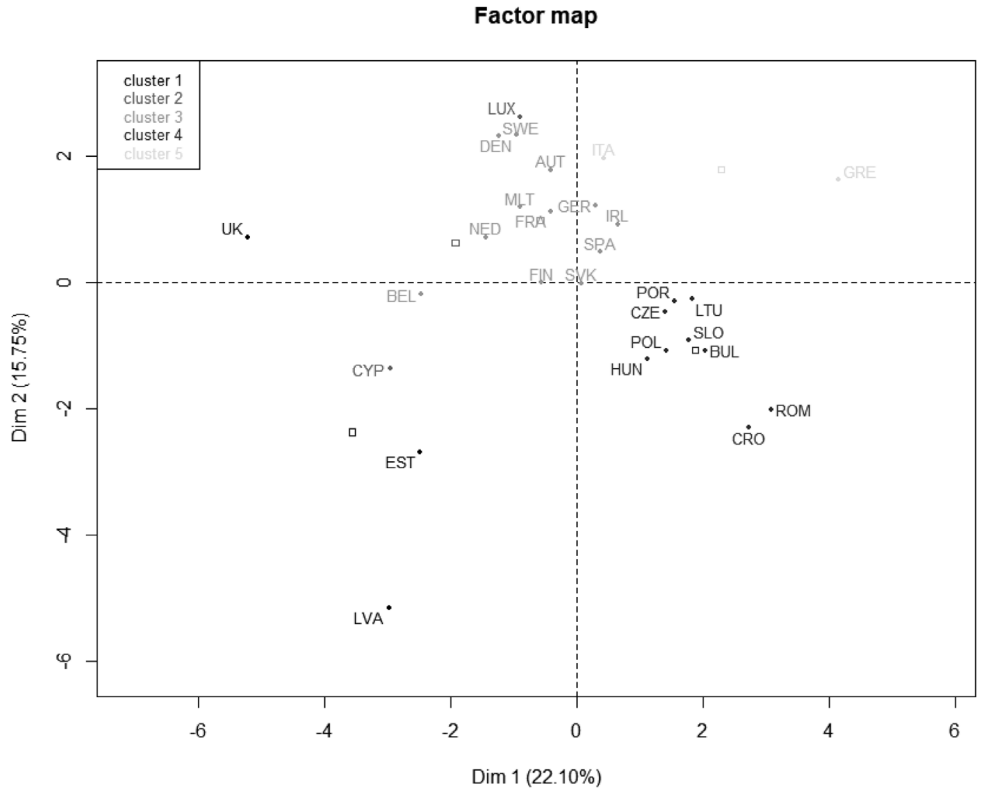

Figure 7. Countries' representation in the first factorial plane: higher education.
Source: Own estimates.

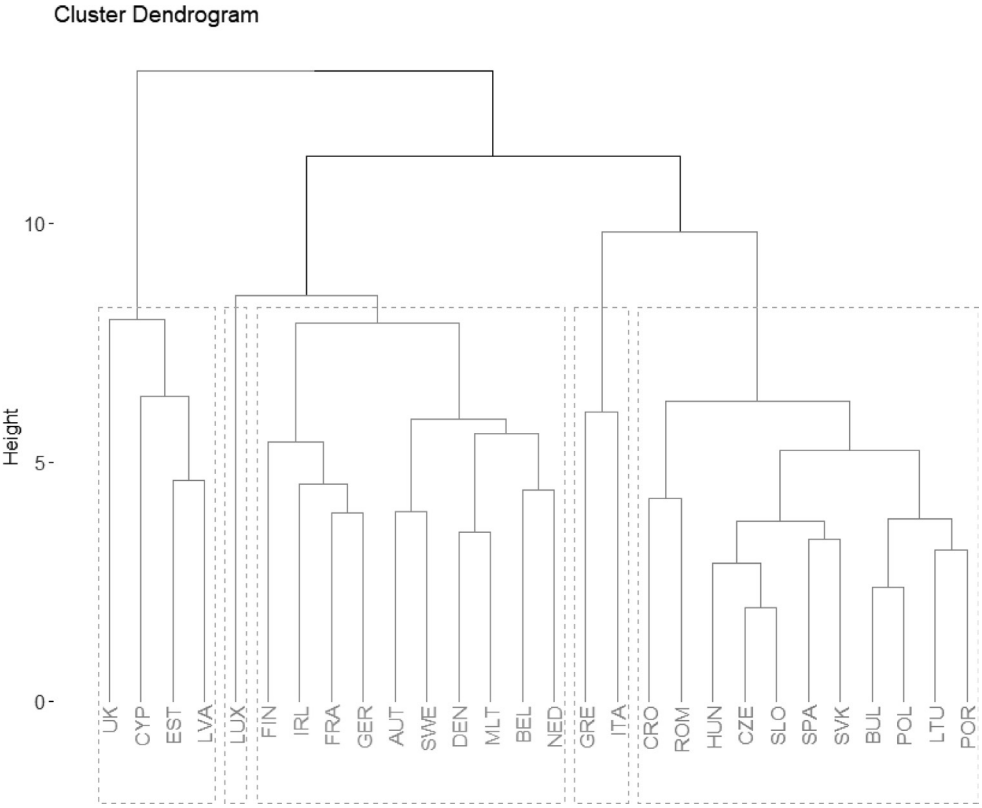

Figure 8. Cluster dendrogram: higher education.
Source: Own estimates.

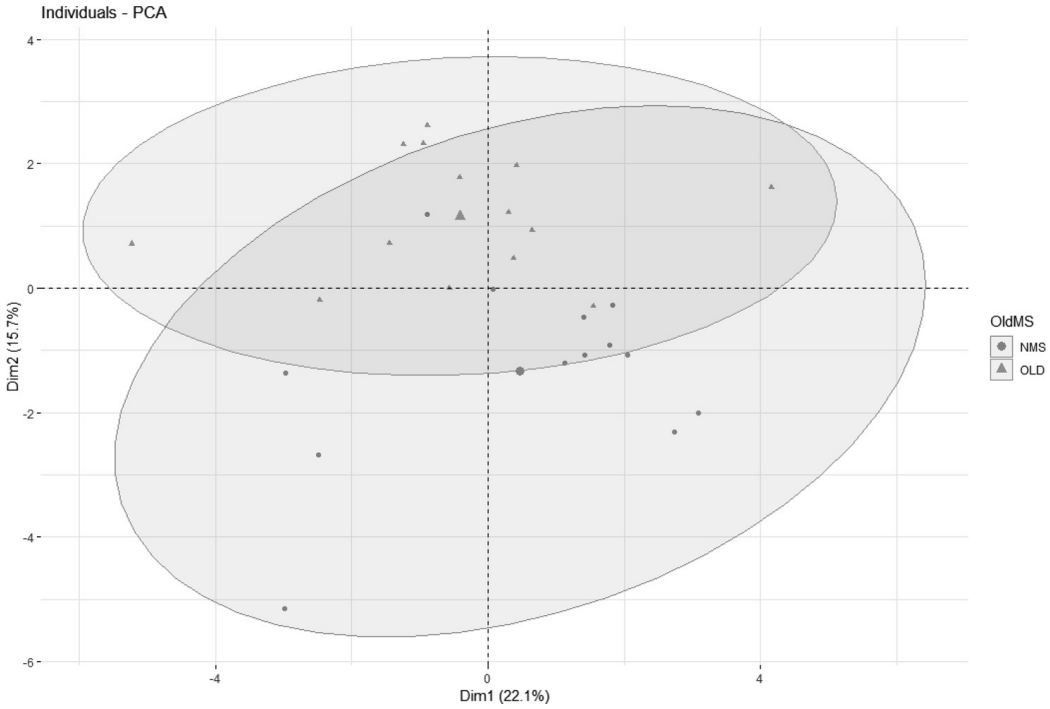

Figure 9. Old and New Member States in the first factorial plane: higher education.
Source: Own estimates.

Table 4. Education system clusters

Countries in a cluster	Key characteristics
Ireland, Greece, Romania, Lithuania, Croatia, and Poland	Higher entrance age to compulsory education Very high share of students in public institutions in secondary education High enrollment in post-secondary non-tertiary education Very low enrollment in LLL
Germany, Netherlands, Hungary, Bulgaria, Italy, France, Austria, Slovenia, Czech Republic, and Slovakia	High ratio of pupils to teachers in primary and secondary education Low expenditures on primary education in relation to GDP
Luxembourg, Cyprus, Malta, Portugal, and Spain	High number of students abroad High teachers' salaries Very low entrance age to compulsory education
Estonia and Latvia	Very low number of students in tertiary education in public institutions with most other characteristics relatively close to Scandinavian countries
Sweden, Denmark, and Finland	Very high expenditures on education in relation to GDP (at all levels, most significantly in pre-primary education) High enrollment in primary and secondary education
Belgium and the United Kingdom	Very high expenditures on secondary education in relation to GDP Very low number of students in public institutions, at all levels

Source: Own analyses.

There are three remarks to interpretation of this table:

1. PISA measures skills of 15-year-old children so may not be representative for all the education system, in particular it says nothing about effectiveness of higher education.
2. PISA is not always considered as the best estimator of the effectiveness of education.
3. There is some diversity inside the clusters (e.g., Poland is a high performer among low performers, main contribution for the high result of cluster 5 is of Finland).

Table 5. Higher education clusters

Countries in a cluster	Key characteristics
UK, Estonia, Latvia, and Cyprus	Low share students in public institutions (in doctoral programs = 0%)
Luxembourg	Very high number of students abroad Significantly above average share of students in business
Finland, Ireland, France, Germany, Austria, Sweden, Denmark, Malta, Belgium, and Netherlands	Above average expenditures on tertiary education, high number of students in health, and low number in agriculture
Croatia, Romania, Hungary, Czech Republic, Slovenia, Spain, Slovakia, Bulgaria, Poland, Lithuania, and Portugal	Very high number of students in agriculture program, high in services, and engineering programs Very low expenditures on tertiary education in relation to GDP
Greece and Italy	Very high ratio of students to teachers Significantly above average share of students in humanities and social science Above average enrollment to tertiary education

Source: Own analyses.

Table 6. Comparison of results of PISA survey and the clusters

Cluster	1	2	3	4	5	6
Countries in a cluster	IRL, GRE, ROM, LTU, CRO, POL	GER, NED, HUN, BUL, ITA, FRA, AUT, SLO, CZE, SVK	LUX, CYP, MAL, POR, SPA	EST, LVA	SWE, DEN, FIN	BEL, UK
Science	474	487.9	475	512	508.67	505.5
Reading	481.17	482.8	473	503.5	508.67	498.5
Mathematics	474.67	489.3	476	501	505.33	499.5

Source: Own estimates based on [OECD, 2018].

Regardless those limitations, it is striking that the differences in outcomes between clusters 1–3 and 4–6 are very significant.

7 Conclusions and discussion

This article proposes a typology of education systems in a spirit of Bruno Amable's DoC approach. Contrary to existing literature in this area, there are two novelties. First of all, it is the only study that limits its scope to pure education variables, rather than introducing some labor market characteristics. Thanks to that, it was able to better emphasize the characteristics of education system, what can be seen in higher number of clusters identified, and as a consequence may be more useful for comparative education research. Second novelty is distinguishing higher education in a separate clustering.

Six clusters of education systems in EU28 and five clusters of higher education systems were identified. What is important, the research confirms, that higher education systems are far more homogeneous among EU countries. This result suggests that EU policies may lead to actual institutional convergence among member states.

This clustering opens a space for future research. First step may be to analyze internal institutional complementarities of education systems. This however requires far more advance data set, in particular inclusion of qualitative data and therefore lies beyond the scope of this study.

The clustering for higher education proves that this type of education is somehow diverse from general education, so may be further investigated. It would be valuable, for example, to make a model of higher education with all the countries European Higher Education Area to grasp the effects of EU policies. Another interesting option would be to compare European higher education systems with the American one that has some very specific issues.

It is also crucial to extend analyses of the outcomes of education systems for given clusters. This research brings an extremely important policy recommendations regarding institutional arrangement of education systems; however, pure PISA results are not sufficient to draw any decisive conclusions.

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Appendices

A.1 Appendix

Table A1. List of variables in a model

Name	Source	Year	Definition
Enrollment_low_sec	World Bank	2016	Gross enrollment ratio, lower secondary, both sexes (%) – percentage of students to respective age population, may be more than 100%
Enrollment_post_sec	World Bank	2016	Gross enrollment ratio, post-secondary non-tertiary, both sexes (%) – percentage of students to respective age population, may be more than 100%
Enrollment_pre_prim	World Bank	2016	Gross enrollment ratio, pre-primary, both sexes (%) – percentage of students to respective age population, may be more than 100%
Enrollment_primary	World Bank	2016	Gross enrollment ratio, primary, both sexes (%) – percentage of students to respective age population, may be more than 100%
Enrollment_tertiary	World Bank	2016	Gross enrollment ratio, tertiary, both sexes (%) – percentage of students to respective age population, may be more than 100%
Enrollment_upper_sec	World Bank	2016	Gross enrollment ratio, upper secondary, both sexes (%) – percentage of students to respective age population, may be more than 100%
CompusloryEdu	World Bank	2017	Duration of compulsory education (years)
EntranceAge	World Bank	2017	Official entrance age to compulsory education (years)
preprimary_public_share	Eurostat	2016	Share of pupils in pre-school education in public institutions
primary_public_share	Eurostat	2016	Share of pupils in primary education in public institutions
lowersec_sharepublic	Eurostat	2016	Share of pupils in public institutions – lower secondary
uppersec_sharepublic	Eurostat	2016	Share of pupils in public institutions – upper secondary
uppersec_shareVET	Eurostat	2016	Share of pupils in vocational programs – upper secondary
uppersec_shareVET_public	Eurostat	2016	Share of pupils in public institutions in vocational programs – upper secondary
shortcycle_sharepublic	Eurostat	2016	Share of students in public institutions – short-cycle tertiary
bachelor_sharepublic	Eurostat	2016	Share of students in public institutions – bachelor
master_sharepublic	Eurostat	2016	Share of students in public institutions – master
doctoral_sharepublic	Eurostat	2016	Share of students in public institutions – doctoral
LLL_12M	Eurostat	2016	Participation in education and training last 12 M
students_abroad_tertiary	Eurostat	2016	Share of students from abroad in all tertiary
teachers_shareofAP	Eurostat	2016	Classroom teachers working full-time and part-time in primary, lower-secondary and upper-secondary education – as% of total active population [Czechia, Denmark, and Ireland NA]
preprimary_pupils_to_teachers	Eurostat	2016	Pupils to teachers ratio – preprimary [Denmark, UK 2014, Estonia 2015]
primary_pupils_to_teachers	Eurostat	2016	Pupils to teachers ratio – primary [Denmark 2014, Ireland 2014]

(*Continued*)

Table A1. Continued

Name	Source	Year	Definition
lowersec_pupils_to_teachers	Eurostat	2016	Pupils to teachers ratio – lower secondary [Denmark 2014, Ireland NA]
genuppersec_pupils_to_teachers	Eurostat	2016	Pupils to teachers ratio – general upper secondary [Ireland, Portugal 2013]
VETuppersec_pupils_to_teachers	Eurostat	2016	Pupils to teachers ratio – vocational upper secondary [Ireland, Portugal NA]
tertiary_pupils_to_teachers	Eurostat	2016	Pupils to teachers ratio – tertiary [Denmark, Portugal, UK 2014]
publicedu_expperc_GDP	Eurostat	2015	Public expenditure on education as percentage of GDP
preprimary_expperc_GDP	Eurostat	2015	Public expenditure on pre-primary education as percentage of GDP
primary_expperc_GDP	Eurostat	2015	Public expenditure on primary education as percentage of GDP
lowsec_expperc_GDP	Eurostat	2015	Public expenditure on lower secondary education as percentage of GDP
uppersec_expperc_GDP	Eurostat	2015	Public expenditure on upper secondary education as percentage of GDP
tertiary_expperc_GDP	Eurostat	2015	Public expenditure on tertiary education as percentage of GDP
primary_foreignlang	Eurostat	2015	Foreign languages learned – primary
lowsec_foreignlang	Eurostat	2015	Foreign languages learned – lower secondary
Teacher_sal	OECD	2017	Teachers' statutory salaries after 10 years of experience, average of primary, lower secondary and upper secondary, as a percentage of average salary in the economy Estonia and Latvia – author's estimates on a basis of starting salaries. Bulgaria, Croatia, Romania, Cyprus, and Malta – missing and found in local statistical offices, so may not be fully comparable
Only in a set for Higher education:			
alltertiary_share_Education	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of education
alltertiary_share_Humanities	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of arts and humanities
alltertiary_share_social	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of social sciences, journalism, and information
alltertiary_share_business	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of business, administration, and law
alltertiary_share_sciences	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of natural sciences, mathematics, and statistics
alltertiary_share_ICT	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of information and communication technologies
alltertiary_share_Engineering	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of engineering, manufacturing, and construction
alltertiary_share_Agriculture	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of agriculture, forestry, fisheries, and veterinary
alltertiary_share_Health	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of health and welfare
alltertiary_share_Services	Eurostat	2016	Share of all tertiary students, who are enrolled in programs in the field of services

A.2 Appendix: Comparison of clusters of education systems in EU

Bolded countries appear in all typologies. For example, all authors place Czech Republic in the same cluster with Bulgaria.

Table A2. Comparison of clusters of education systems in EU

	Farkas	Rapacki and Czerniak	Żurawski
Austria	DEN, FIN, **NED**, SLO, SWE, UK	DEN, FIN, GER, **NED**, SWE	BUL, CZE, FRA, GER, HUN, ITA, **NED**, SLO, SVK
Belgium	EST, FRA, GRE, HUN, IRL, LTU, LVA, LUX, ROM	CRO, FRA, IRL, UK	UK
Bulgaria	**CZE**, GER, POL, SVK	**CZE**, EST, GRE, HUN, LTU, LVA, POL, POR, ROM, SPA, SVK	AUT, **CZE**, FRA, GER, HUN, ITA, NED, SLO, SVK
Croatia	NA	BEL, FRA, IRL, UK	GRE, IRL, LTU, POL, ROM
Cyprus	NA	NA	LUX, MLT, POR, SPA
Czechia	**BUL**, GER, POL, **SVK**	**BUL**, EST, GRE, HUN, LTU, LVA, POL, POR, ROM, SPA, **SVK**	AUT, **BUL**, FRA, GER, HUN, ITA, NED, SLO, **SVK**
Denmark	AUT, **FIN**, NED, SLO, **SWE**, UK	AUT, **FIN**, GER, NED, SWE	**FIN**, **SWE**
Estonia	BEL, FRA, GRE, HUN, IRL, LTU, **LVA**, LUX, ROM	BUL, CZE, GRE, HUN, LTU, **LVA**, POL, POR, ROM, SPA, SVK	**LVA**
Finland	AUT, **DEN**, NED, SLO, SWE, UK	AUT, **DEN**, GER, NED, **SWE**	**DEN**, **SWE**
France	BEL, EST, GRE, HUN, IRL, LTU, LVA, LUX, ROM	BEL, CRO, IRL, UK	AUT, BUL, CZE, GER, HUN, ITA, NED, SLO, SVK
Germany	BUL, CZE, POL, SVK	AUT, DEN, FIN, NED, SWE	AUT, BUL, CZE, FRA, HUN, ITA, NED, SLO, SVK
Greece	BEL, EST, FRA, HUN, IRL, **LTU**, LVA, LUX, **ROM**	BUL, CZE, EST, HUN, **LTU**, LVA, POL, POR, **ROM**, SPA, SVK	CRO, IRL, **LTU**, POL, **ROM**
Hungary	BEL, EST, FRA, GRE, IRL, LTU, LVA, LUX, ROM	BUL, CZE, EST, GRE, LTU, LVA, POL, POR, ROM, SPA, SVK	AUT, BUL, CZE, FRA, GER, ITA, NED, SLO, SVK
Ireland	BEL, EST, FRA, GRE, HUN, LTU, LVA, LUX, ROM	BEL, CRO, FRA, UK	CRO, GRE, LTU, POL, ROM
Italy	POR, SPA	SLO,	AUT, BUL, CZE, FRA, GER, HUN, NED, SLO, SVK
Lithuania	BEL, EST, FRA, **GRE**, HUN, IRL, LVA, LUX, **ROM**	BUL, CZE, EST, **GRE**, HUN, LVA, POL, POR, **ROM**, SPA, SVK	CRO, GRE, IRL, POL, **ROM**
Latvia	BEL, **EST**, FRA, GRE, HUN, IRL, LTU, LUX, ROM	BUL, CZE, **EST**, GRE, HUN, LTU, POL, POR, ROM, SPA, SVK	**EST**
Luxembourg	BEL, EST, FRA, GRE, HUN, IRL, LTU, LVA, ROM	NA	CYP, MLT, POR, SPA
Malta	NA	NA	CYP, LUX, POR, SPA
Netherlands	**AUT**, DEN, FIN, SLO, SWE, UK	**AUT**, DEN, FIN, GER, SWE	**AUT**, BUL, CZE, FRA, GER, HUN, ITA, SLO, SVK
Poland	BUL, CZE, GER, SVK	BUL, CZE, EST, GRE, HUN, LTU, LVA, POR, ROM, SPA, SVK	CRO, GRE, IRL, LTU, ROM
Portugal	ITA, **SPA**	BUL, CZE, EST, GRE, HUN, LTU, LVA, POL, ROM, **SPA**, SVK	CYP, LUX, MLT, **SPA**
Romania	BEL, EST, FRA, **GRE**, HUN, IRL, **LTU**, LVA, LUX	BUL, CZE, EST, **GRE**, HUN, **LTU**, LVA, POL, POR, SPA, SVK	CRO, GRE, IRL, **LTU**, POL

(*Continued*)

Table A2. Continued

	Farkas	Rapacki and Czerniak	Żurawski
Slovenia	AUT, DEN, FIN, NED, SWE, UK	ITA	AUT, BUL, CZE, FRA, GER, HUN, ITA, NED, SVK
Spain	ITA, **POR**	BUL, CZE, EST, GRE, HUN, LTU, LVA, POL, **POR**, ROM, SVK	CYP, LUX, MLT, **POR**
Slovakia	**BUL**, **CZE**, GER, POL	**BUL**, **CZE**, EST, GRE, HUN, LTU, LVA, POL, POR, ROM, SPA	AUT, **BUL**, **CZE**, FRA, GER, HUN, ITA, NED, SLO
Sweden	AUT, **DEN**, **FIN**, NED, SLO, UK	AUT, **DEN**, **FIN**, GER, NED	**DEN**, **FIN**
UK	AUT, DEN, FIN, NED, SLO, SWE	BEL, CRO, FRA, IRL	BEL

Source: Author's estimates.

Table A3. Mean values of the valuables for the clusters: general education

Cluster	1	2	3	4	5	6
Countries in a cluster	IRL, GRE, ROM, LTU, CRO, POL	GER, NED, HUN, BUL, ITA, FRA, AUT, SLO, CZE, SVK	LUX, CYP, MAL, POR, SPA	EST, LVA	SWE, DEN, FIN	BEL, UK
preprmiary_public_share	0.75	0.81	0.67	0.93	0.83	0.50
primary_public_share	0.97	0.94	0.80	0.92	0.91	0.63
lowersec_sharepublic	0.97	0.92	0.78	0.88	0.83	0.42
uppersec_sharepublic	0.95	0.87	0.80	0.90	0.87	0.30
uppersec_shareVET	0.39	0.56	0.32	0.50	0.50	0.56
uppersec_shareVET_public	0.98	0.86	0.88	0.94	0.86	0.23
allstudents__sharepublic	0.90	0.86	0.61	0.56	0.81	0.21
shortcycle_sharepublic	0.99	0.63	0.60	1.00	0.70	0.20
bachelor_sharepublic	0.89	0.86	0.60	0.59	0.77	0.22
master_sharepublic	0.92	0.87	0.57	0.50	0.92	0.20
doctoral_sharepublic	0.98	0.96	0.72	0.50	0.97	0.28
LLL_12M	22.22	48.74	44.28	46.05	56.10	48.65
students_abroad_tertiary	0.04	0.08	0.09	0.27	0.08	0.15
teachers_shareofAP	2.77	2.69	2.38	2.60	2.17	1.60
preprimary_pupils_to_teachers	12.50	13.45	13.58	10.05	8.70	16.25
primary_pupils_to_teachers	11.85	15.37	12.74	11.85	12.77	14.85
lowersec_pupils_to_teachers	9.12	11.71	9.18	10.40	10.80	11.90
genuppersec_pupils_to_teachers	11.75	12.68	8.30	10.50	13.30	12.40
VETuppersec_pupils_to_teachers	9.22	12.42	11.05	13.65	16.50	15.45
tertiary_pupils_to_teachers	19.98	15.78	14.80	10.75	12.07	16.60
publicedu_expperc_GDP	3.82	4.61	5.22	4.38	6.90	6.06
preprimary_expperc_GDP	0.37	0.58	0.51	0.46	1.10	0.48
primary_expperc_GDP	1.04	0.95	1.51	1.24	1.76	1.72
lowsec_expperc_GDP	0.76	0.95	0.98	0.69	1.06	0.87
uppersec_expperc_GDP	0.65	0.96	1.02	0.78	1.53	1.57
tertiary_expperc_GDP	0.93	1.11	1.15	0.97	2.04	1.42

(*Continued*)

Table A3. Continued

Cluster	1	2	3	4	5	6
primary_foreignlang	1.00	0.77	0.94	1.45	0.90	0.40
Enrollment_low_sec	101.14	102.46	113.95	105.16	112.60	165.28
Enrollment_post_sec	42.67	20.75	10.38	21.12	22.39	52.52
Enrollment_pre_prim	78.25	96.38	98.66	94.95	91.10	113.49
Enrollment_primary	98.89	100.50	103.61	98.16	109.03	102.37
Enrollment_tertiary	76.19	66.80	55.63	76.00	77.20	67.65
Enrollment_upper_sec	107.01	108.38	110.11	121.60	170.91	151.73
CompusloryEdu	9.33	10.80	10.40	10.00	9.67	11.50
EntranceAge	6.50	5.50	5.20	6.00	6.33	5.50
Teacher_sal	0.90	0.96	1.17	1.26	1.00	1.04

Source: Own estimates.

Table A4. Mean values of the valuables for the clusters: higher education

	1	2	3	4	5
	UK, EST, CYP, LVA	LUX	FIN, IRL, FRA, GER, AUT, SWE, DEN, MLT, BEL, NED	CRO, ROM, HUN, CZE, SLO, SPA, SVK, BUL, POL, LTU, POR	GRE, ITA
shortcycle_sharepublic	0.17	1.00	0.70	0.84	0.00
bachelor_sharepublic	0.16	0.96	0.81	0.85	0.94
master_sharepublic	0.09	1.00	0.83	0.88	0.95
doctoral_sharepublic	0.18	1.00	0.95	0.95	0.98
LLL_12M	47.93	48.10	50.15	36.39	29.10
students_abroad_tertiary	0.13	0.47	0.10	0.05	0.04
tertiary_pupils_to_teachers	16.95	7.60	13.56	14.75	29.90
tertiary_expperc_GDP	1.33	0.51	1.58	0.94	0.75
Enrollment_tertiary	50.12	80.60	73.05	65.06	94.70
alltertiary_share_Education	7.90	11.00	8.52	8.10	4.40
alltertiary_share_Humanities	11.00	12.70	11.77	9.03	14.55
alltertiary_share_social	8.55	10.70	8.94	9.71	12.15
alltertiary_share_business	28.35	34.60	21.64	22.92	21.05
alltertiary_share_sciences	6.80	6.40	6.67	4.89	8.60
alltertiary_share_ICT	5.48	5.60	5.14	4.15	2.35
alltertiary_share_Engineering	12.98	9.10	13.46	18.00	18.85
alltertiary_share_Agriculture	1.45	1.00	1.37	2.98	3.45
alltertiary_share_Health	12.23	7.10	16.29	12.85	12.10
alltertiary_share_Services	4.75	1.70	3.28	6.53	1.40

Source: Own estimates.