Defining typologies of universities through a DEA-MDS analysis: an institutional characterisation for formative evaluation purposes

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Abstract

Universities are organizational structures with individual activity mixes or strategies that lead to different performance levels by mission. Evaluation techniques based on performance indicators or rankings risk rewarding just a specific type of university and undermining university diversification: they usually introduce homogenising pressures and risk displacing university objectives – neglecting their socio-economic contribution and focusing on succeeding on the evaluation system. In this study, we propose an alternative evaluation method that overcomes these limitations. We produce a multidimensional descriptive classification of universities into typologies, while analysing the relation between their institutional factors (characteristics) and their (technical) efficiency performance from a descriptive perspective. To do so we apply a bootstrap DEA-MDS analysis to data on the Spanish university system, and unlike previous studies, we include data on an important dimension of the third mission of universities (specifically knowledge transfer) in their characterisation. We identify six types of (homogeneous) universities. Results indicate that to be fairly efficient, universities may focus on teaching, knowledge transfer or overall efficiency, but always have to fairly perform in research. Additionally, results confirm the relevance of the third mission as a source of institutional diversity in Higher Education. This approach could be used to address an alternative evaluation methodology for HEIs with formative purposes, evaluating universities according to their unique characteristics for the improvement of HE systems.

1 Introduction

European universities may be considered as homogeneous at the macro-level (Bonaccorsi and Daraio, 2009) in the sense that they are generally expected to develop three missions: teaching, research and third mission (Casani et al., 2014a). This approach has been termed as 'one-size-fits-all-model' and it hinders the differentiation of university systems, because these three university missions shape the structure on which institutional strategies of all universities must be developed (Sánchez-Barrioluengo, 2014). However homogeneous they may seem at the macro-level, European universities are organizational structures with individual activity mixes and characteristics that generate institutional heterogeneity at the micro-level (Bonaccorsi and Daraio, 2009).

University rankings and evaluation systems based on performance indicators have prospered in Higher Education (HE) mainly because of the increasing demands of transparency and accountability of the socio-economic impact and outreach of (at least) public universities (*value for money*), but also because the heterogeneity of institutional profiles among universities renders it difficult to assess and compare them. Notwithstanding, most university rankings and experiences of evaluation have introduced homogenising pressures in the HE landscape (de la Torre and Pérez-Esparrells, 2017) because they do not consider the diversity of universities' configurations and strategies. All universities are evaluated and ranked according to the same criteria, so only a specific type of university can succeed (Hazelkorn, 2015). They also introduce incentives for universities to focus in achieving the expected indicator level and not on the overall relevance of their activity to society or to the own university's strategy (E3M, 2012b).

This is also the case of most (DEA) efficiency analyses, which consider universities as homogeneous institutions (with the same production technology) and rank them

according to their efficiency performance. Efficiency has become increasingly relevant for Higher Education, particularly given the generalized trend towards decreasing public funds for universities among developed countries (de la Torre, Agasisti and Perez-Esparrells, 2017).

Traditionally, institutional diversity has been analysed mostly on the basis of the universities' legal status (public vs. private), size and subject mix; and hardly considered for evaluation purposes (despite a few exceptions). Still, there are additional sources of diversity that allow for a more comprehensive characterisation of universities, i.e. the relative weight that each institution assigns to teaching, research and third mission respectively (mission mix) or the mix of different activities within missions: e.g. undergraduate vs. postgraduate teaching; traditional knowledge transfer (KT) vs. life-long learning. In this perspective, it is clear that third mission or university engagement is a source of institutional diversity, and it is natural to wonder whether universities with similar characteristics would achieve similar performance.

The aim of this paper is to present an alternative for institutional evaluation that respects and supports university diversity. In so doing, we propose a multidimensional descriptive classification of universities into typologies or (homogeneous) groups, while analysing the relation between the institutional factors (characteristics) of universities and their (technical) efficiency performance from a descriptive perspective. This allows studying whether (in)efficiency is related to a particular typology of university, an interesting insight for HE systems improvement. We resort to Ordinal Multidimensional Scaling (MDS) and bootstrap Data Envelopment Analysis (DEA), performing a so-called DEA-MDS analysis. This method provides more robust results than the few extant multidimensional prescriptive classifications of universities and other Higher Education

Institutions (HEIs) in Europe, because unlike their method (i.e. cluster analysis) MDS is robust to outliers and to redundant variables.

While DEA has already been extensively used in the HE sector, MDS has still being little applied to the HE context (e.g. Adler, Raveh and Yazhemski, 2007; Mar-Molinero and Mingers, 2007; and Mar-Molinero and Portillo, 2010). Besides, the combination of both methods (DEA-MDS methodology) is quite innovative and there is still little literature (see Sagarra, Mar-Molinero and Rodríguez-Regordosa, 2014; Sagarra, Agasisti and Mar-Molinero, 2017; and de la Torre, Sagarra and Agasisti, 2016 for the HE sector), while no previous study in the HE context has combined the bootstrap variant of DEA with MDS.

This study is also innovative because we consider third mission as a further source of university differentiation: the few researchers that have previously attempted to identify groups of comparable HEIs in Europe either neglect the third mission of universities or poorly characterise it. Previous studies have proved that third mission (specifically KT) affects efficiency performance in different degrees depending on the university characteristics – subject mix, mission mix and mix of third mission activities (de la Torre, Agasisti and Perez-Esparrells, 2017).

Additionally, despite previous characterisations took into account mission mix, they did not consider it from an efficiency perspective, i.e. universities are not equally efficient in all missions but some achieve better results in specific activities; and they neither discussed the potential use of prescriptive classification for formative evaluation purposes. In fact, in this paper we do not intend to identify the best/worst performing universities, but to provide useful information for designing university policies and strategies aimed at increasing the differentiation and the overall efficiency, i.e. aiming at improving HE

systems. Our analysis offers a more comprehensive view of the HEI landscape in a country, providing opportunities for evaluating universities according to their unique characteristics.

To show the potential results of a more comprehensive characterisation of institutional diversity and a more robust method for evaluation environments, we use data from the Spanish Higher Education system, which is a decentralised system with regional governments responsible for the education policy under the coordination of the central government. Notwithstanding, and despite such decentralisation, the system is still rather homogeneous in the sense that: (i) there is just one type of HEIs, i.e. universities; and (ii) all Spanish universities are embedded in the same legal framework, which assigns the same rights and duties to all universities. This case study can be adapted a replicated for other HE systems.

This paper is organised as follows: in Section 2, we have reviewed the literature on HEIs classifications and typologies, as well as the concept of institutional diversity in the university sector and its role for performance evaluation purposes. Section 3 illustrates data and methodology, while in Section 4 we present the results of our empirical work. Finally, in Section 5 we present the discussion and draw some concluding remarks.

2 Classifying universities according to their institutional diversity

2.1 Defining typologies of universities: a review of the extant classifications of universities and their objectives

Researchers have produced various classifications of HEIs aiming at identifying typologies of institutions, i.e. more homogeneous groups of institutions within HE (supra)national systems. The characteristics of these classifications vary depending on the

objectives of the researchers that produced them. Table 1 illustrates the types of classifications of HEIs that have been produced according to their characteristics.

The first quadrant of Table 1 characterises those classifications of HEIs that are defined *a priori* and that are built considering just one characteristic of universities (e.g. size). These are *ex-ante* classifications, i.e. the typologies of universities are defined discretionarily and afterwards universities are allocated to each category. Some examples of such classifications are the following: size (small, medium, large and very large – e.g. Van Vught et al., 2011); location (central, provincial – e.g. Seeber et al., 2012); or legal status (public, private and private HEIs dependent on public funding – e.g. Raponi, Martella, and Maruotti, 2014). These classifications are usually produced with the aim of controlling for a particular source of heterogeneity among universities that may cause significant biases and may lead to misleading results in a particular study. In other words, these are usually ad-hoc classifications build for a singular purpose and therefore cannot be extrapolated to other analysis contexts.

But some authors have also produced their ad-hoc (one-dimensional) classifications through a *descriptive* or *ex-post* approach, i.e. typologies of universities are built from the actual characteristics of universities, so universities are previously grouped according to their similarities and differences and then the various typologies are defined (bottom-left quadrant). The method most commonly used to produce these *descriptive* classifications is the cluster analysis technique. Examples of such classifications for the Spanish case are Gómez-Sancho (2005), Gómez-Sancho and Mancebón Torrubia (2008) and Vazquez and Terrones (2014).

One-dimensional classifications reduce the institutional heterogeneity to a single source of diversity, and therefore they do not identify comparable institutions (Van Vught

et al., 2011). Researchers aiming at identifying comparable universities have resorted to multidimensional (prescriptive and descriptive) classifications that provide a better characterisation of their institutional differentiation.

The most renowned multidimensional *ex-ante* classification (top-right quadrant) is the *Carnegie Classification* in the United States (1970), which currently consists in a set of parallel classifications, most of them *prescriptive* and relying on different dimensions of HEIs mainly related to their teaching activity (degrees offered, students profile) and the institutional characteristics (size, location, legal status). Since 2006, the third mission activity is categorised by the elective *Community Engagement Classification*.

Another well-known multidimensional classification is the one produced by the European *U-Map* project, which defines HEIs' profiles based on their activity on their three missions, and allows stakeholders to benchmark HEIs according to those dimensions that are more important for their purposes (van Vught et al., 2011). *U-Map* is complemented with *U-Multirank*, a tool that also allows producing customised rankings (van Vught and Ziegele, 2012). It is our opinion that these projects correspond to *ex-ante* classifications in the sense that they do not provide a theoretical framework for the interpretation of the information and for the selection of a group of institutions to be either benchmarked or ranked. A similar experience to that of *U-Multirank* is the *U-Ranking* of Spanish universities (see Pérez et al. 2017).

Finally, the European *Aquameth, EUMIDA* and *ETER* projects had as their main objective to gather basic comparable administrative data about European HEIs, being *Aquameth* the exploratory study, *EUMIDA* the pilot project, and *ETER* the resultant database launched in July 2014. However, these projects have also led to various approximations to multidimensional *descriptive* classifications (bottom-right quadrant),

being the main experiences those of Daraio and Bonaccorsi (2009) and Schubert et al. (2014). To our knowledge, the only other classification experiences with a multidimensional and ex-post approach are those of García-Aracil and Palomares-Montero (2012) and Aldás et al. (2016), both for the case of Spain.

Tables 2.1 and 2.2 present the methodology of these four typifications. They use different variants of the cluster analysis, their samples are different (in nationality and number) and use different variables to characterise HEIs. Therefore, all four studies lead to different results, although their conclusions are rather similar. Only Aldás et al. (2016) seem to portray somewhat different results. While the first three studies grouped HEIs according to their size and activity by mission, Aldás et al. (2016) employ a different theoretical framework, clustering universities according to those structural factors that influence their strategies and, consequently, their performance: characteristics of their socioeconomic context, of their inputs (researchers and students) and organizational characteristics. However, once we organise their variables according to the three missions of universities we observe that this approach leads to a characterisation of universities very teaching oriented (Table 2.2), while results are strongly influenced by the metropolitan or regional dimension of their context (Table 2.1).

As afore-mentioned, these four studies use different variants of the cluster analysis. However, the cluster methodology may not be an adequate method to define typologies of universities because: (i) it is highly sensitive to outliers, not being robust to the heterogeneity of institutions across countries and within country; and (ii) it is neither robust to redundant variables, and may lead to results influenced by the number of variables describing the different dimensions of universities. In this paper, we use an alternative methodology that overcomes these caveats: MDS.

Finally, it should be noticed that these classifications: (i) either do not consider the third mission of universities; or (ii) partially characterise it. Only García-Aracil and Palomares-Montero (2012) and Schubert et al. (2014) consider the third mission of universities in their data selection, or more specifically their KT – although in the case of Schubert et al. (2014) the third mission proxy consists on a dummy for legal status, which does not approximate the university-society interaction at least in the case of Spain, since private universities are strongly teaching oriented and hardly develop research and third mission activities (de la Torre, Gomez-Sancho and Perez-Esparrells, 2017). Actually, a descriptive multidimensional classification that identifies comparable universities and that takes into account all three missions and all sources of university diversity is still to be produced, both for the case of Europe and for the Spanish university system.

[Tables 1, 2.1 and 2.2] around here

2.2 Institutional diversity in university systems

The scientific community has studied the factors and evolution of university's (and other HEI's) heterogeneity and diversity for long. Researchers have established different categories of university diversity, more or less appropriate depending on the purpose of the study and the characteristics of universities under analysis, among others systemic, structural, programming, procedural, and reputational diversity (Birnbaum, 1983).

Daraio et al. (2011) propose a classification of these sources of institutional diversity (for European universities) into two types: horizontal and vertical diversity. The horizontal diversity refers to the horizontal product differentiation concept. It depends on the type, scope, reach and targets of the teaching, research and third mission activity of universities, being the following the main dimensions that cause horizontal diversity: the

output mix delivered, the target market aimed, the level of education offered, the subject mix, the degree of development of the third mission, the geographical scope (degree of regional/local/national commitment), and the mission mix of universities. Vertical diversity is instead related to the economic concept of vertical differentiation, which defines higher and lower quality layers depending on the overall superiority or inferiority of products rather than on their different characteristics. The main sources of vertical diversity are the universities' funding structures, the postgraduate education, the internationalisation and the scientific production.

Several authors recognise that the characteristics of universities (e.g. subject mix, socioeconomic context) entail different opportunities and resources overlap (e.g. human resources, funding and facilities), as well as different potentialities for the interaction with their communities or third mission (e.g. Thursby and Kemp, 2002; Schoen et al., 2007; Lepori, Probst and Baschung, 2010; Berbegal-Mirabent, Lafuente and Solé, 2013). In other words, the characteristics and institutional configuration of universities lead to different strategic specialisation by mission (mission mix) and/or different mixes of mission activities (Schoen et al., 2007; Wright et al., 2008; Rossi, 2014; or Mora et al., 2015).

This theoretical framework entails that the third mission is also a source of institutional diversity among universities that affects their final overall performance. Additionally, de la Torre, Agasisti and Perez-Esparrells (2017) have proved that not considering the KT on technical efficiency analyses entails a substantial bias and misleading results. Consequently, we analyse the relation between typologies of universities with different characteristics and different levels of technical efficiency performance, and unlike previous studies, we include information on the third mission performance of universities. This offers a more comprehensive view of the HEI landscape

in a country, providing opportunities for evaluating universities according to their unique characteristics.

We are aware that the third mission, as the university's 'relationship with the non-academic outside world' (Schoen et al., 2007, p.127), comprises at least three dimensions: technology transfer and innovation, continuing education and social engagement (see E3M, 2012). However, most of the data available for third mission refers only to KT, which is the third mission dimension better characterised (Rossi, 2014). Accordingly, and apart from a few exceptions, also governments and researchers have usually focused on the development and analysis of the KT of universities, although the socio-economic justification of HEIs through league tables, rankings (Hazelkorn, 2015), and lifelong learning and public service initiatives (Benneworth, Pinheiro and Sánchez-Barrioluengo, 2016) is gaining ground. This paper is indeed inserted in the KT stream due to the lack of data on continuing education and university outreach for the Spanish HE system.

2.3 Diversity and efficiency in university evaluation environments

The current development of the European HE system is, among others, driven by three main forces: (i) the decreasing share of public income in the budget of HEIs and the increasing allocation of those public funds in accordance with performance indicators of HEIs (Agasisti et al., 2011); (ii) the emergence of global university rankings, which have intensified the reputation race (van Vught, 2008); and (iii) the increasing managerial attitude of HEIs illustrated by Estermann and Bennetot Pruvot (2011) by their greater autonomy and accountability.

In this perspective, efficiency in the use of public resources as well as formal (university evaluation agencies) and informal (rankings) evaluation experiences are

increasingly in vogue. Opinion makers rely on rankings to make their judgement statements, governments use them as a source of information for defining HE policies and university managers and leaders base excellence claims on them (Bonaccorsi and Daraio, 2008). Additionally, society is not only interested in output performance levels, but also on the relation between input and output levels, i.e. whether universities are making the best possible use of their resources (efficiency).

In both cases, the difficulty added by the heterogeneity of universities lays on the non-comparability of the units tested (Stella and Woodhouse, 2006). Additionally, heterogeneity renders it difficult to know the HE sector in depth, as well as performing benchmarking exercises or predicting the results of institutional strategies (Van Vught et al., 2010) and public policies (Daraio et al., 2011). Notwithstanding, institutional diversity should be supported, among other reasons because it ensures that de variety of needs of the range of university stakeholders can be attended by HE systems (Huisman et al., 2015).

However, efficiency analyses and evaluation experiences often introduce incentives for homogenisation. According to Molas-Gallart (2015), performance evaluation can fulfil three main purposes: “to inform the distribution of public resources among competing objectives or performers, to help improve the implementation of policies and programmes” (formative evaluation), “and to control the use of public funds” (auditing).

Depending on the objective of the evaluation experience the method applied would be different (Molas-Gallart, 2015) but also the behaviour of the unit under evaluation (universities in our case). In the case of resource allocation and auditing purposes, the evaluator would propose methods aiming at synthesising the phenomenon and providing very specific and even comparable results (Molas-Gallart, 2015), i.e. they usually rely on (synthetic) indicators and quantitative methods. On the other side, universities may modify

their behaviour in order to achieve a good level in the indicators used to evaluate them regardless their relevance to society or to the university's strategy and in some cases neglecting the processes behind (E3M. 2012b). In other words, these evaluations may introduce incentives for objective shifts and homogenisation: universities under evaluation would aim to achieve the same type of results. In the case of formative evaluations, evaluators would focus on processes and details usually resorting to more qualitative methodologies. In this case, universities would not have incentives to show particular results because evaluation would entail a self-learning process (Molas-Gallart, 2015).

In this study, we propose a quantitative and indicator-based methodology that allows for higher balance between detailed analyses that respect diversity and the provision of synthetic information for comparability purposes. This method has high potential for synthetic formative evaluation and for the design of HE policies and institutional strategies with improvement and learning purposes.

To prove the capability of our method of acknowledging institutional diversity while allowing for a certain extent of comparability we define typologies of universities, i.e. more homogeneous groups of universities. To show the method's potential for addressing specific questions and knowledge-based learning, we specifically pose the following research question: *is (in)efficiency related to a particular typology of university*? This question addresses the increasing concern on the relation between resources (inputs) and results (outputs) in public universities. Our hypothesis is that *efficient universities show a certain degree of specialisation in a particular mission.*

In this way, we focus on describing the current institutional diversity, providing useful information on the potentialities of each group of comparable universities and

exploring what institutional features characterise efficient universities and which are the characteristics of the inefficient ones, but not aiming at identifying causalities.

3 Data and methodology

3.1 Methodology: combining Data Envelopment Analysis and Multidimensional Scaling methods

To address the above-mentioned research question and aims we conduct a cross-sectional analysis by applying the Multidimensional Scaling (MDS) method on a dataset build on: (i) efficiency scores, and (ii) ratios describing the characteristics of universities. In this section, we only include the basic methodological information to interpret results. An in depth explanation of our methodological approach is available in the technical appendix (Appendix 2).

Ordinal MDS (Kruskal and Wish, 1978) is a multivariate reduction technique. It translates similarities and differences between units into distances in a multidimensional map: the closer the universities are located in the map the more similar they are. This allows visualising the data and withdrawing its hidden structure: MDS makes results accessible to non-specialists because it produces statistical maps that graphically display the main characteristics of the data (Sagarra, Mar-Molinero and Rodríguez-Regordosa, 2014). MDS is similar to Factorial Analysis or Principal Component Analysis under certain conditions, but MDS suits better the purpose or our analysis because it is robust to outliers, to redundant variables, i.e. results are not influenced by the number of variables describing each university dimension, and it does not require an assumption of a specific population's distribution (e.g. normality).

The efficiency scores are calculated trough Data Envelopment Analysis (DEA – see Farrell, 1957; Charnes, Cooper and Rhodes, 1978), a deterministic non-parametric frontier method. DEA compares the input and output consumption of decision making units (universities in our case) to calculate the relative efficiency of each university (in relation to the rest of universities). DEA has been widely used in the (higher) education sector because it easily deals with various inputs and outputs simultaneously, with the lack of information on market prices and it does not requires to specify ex-ante a production function. However, DEA is sensitive to outliers, so following DEA literature our sample limits to 47 (out of 50) Spanish public universities: given their special characteristics, we have excluded private universities, the public university providing distance education and the two universities that directly depend from the Ministry of Education[1]. Unlike previous DEA-MDS analyses, we apply a bootstrap DEA (VRS output oriented) – see Simar and Wilson (1998), which allows for calculating confidence intervals on the estimated productivity index.

Through DEA-MDS analysis we build a multidimensional map (with *m* dimensions) that allows visualising the relation (non-linear closeness or distance) between universities' efficiency scores (by mission) and characteristics. The multidimensional map is then divided in two-dimensional scatterplots in which universities are also located as vectors through Property Fitting (Carroll and Chang, 1964; Carroll, 1972), a linear regression based method. In this way, we can identify to which universities apply each one of the identified types of efficiency-characteristics associations, i.e. to identify typologies of universities. We do so through a cluster analysis (Ward, 1963) on the coordinates of the university vectors: in this way, we identify those universities that are located close to each other in the

[1] A list of the universities included and excluded in the analysis is available in Appendix 1.

multidimensional space and avoid the unwanted effects of outliers and redundant variables on cluster analyses.

3.2 Selected indicators for the characterisation of Spanish universities

Table 3 contains the final list of the variables included in the DEA-MDS analysis. Following the extant literature, we include in the analysis the DEA scores (ratios) produced by all the possible combinations of the inputs and outputs considered. In this way, we explore the efficiency scores that universities would achieve in both partial and complete approximations of their production process, producing a picture of the efficiency of universities for each mission and for their overall activity. In our case, we consider two inputs: academic staff Full Time Equivalent (FTE) and total expenditure (excluding staff expenditure); for the production of teaching, research and KT outputs: (bachelor and master) graduates, publications and KT income respectively (Table 3) – following the methodological choices of de la Torre, Agasisti and Perez-Esparrells (2017), KT income comprises income from R&D and consultancy contracts, technical services rendered, company-sponsored chairs and non-disclosure agreements concerning agreements on intellectual or industrial property.

But most importantly, universities are characterised according to their main sources of diversity. The list of 38 ratios contained in Table 3 aim at characterising both, the horizontal and vertical sources of diversity (see Section 2.2) – we include only the most relevant sources of horizontal and vertical diversity because some of them are highly correlated and too many variables would hinder results interpretability. For the vertical diversity, the analyses include ratios approximating: (i) the employment structure for faculty staff (fte_hc); (ii) the structure of the student body (bach_enrol); (iii) the teaching

(grad_fte), research (pub_fte) and transfer of knowledge (KTinc_fte) productivity; and (iv) the teaching (grad_enrol), research (cit_pub) and transfer of knowledge (KTinc_inc) success. Regarding the horizontal diversity, the dimensions characterised are the subject mix in teaching (humsc_grad, sci_grad, eng_grad, med_grad) and research (humsc_pub, sci_pub, eng_pub, med_pub), and the mission mix. In this way, we will also analyse the relation between these ratios and the dimensions they approximate. Finally, we also explore possible size related effects by including in the analysis a proxy of the size of universities: their total expenditure. In order to keep the number of variables rather parsimonious and not render the interpretation of results too complicated, we are aware that we have not included all KT activities in the analysis. However, we have opted for a synthetic indicator on KT activities: KT income allows for including in just one indicator results from KT activities of different nature.

Bear in mind that subject mix is a strong source of horizontal diversity and that different fields of knowledge are related to different levels of input consumption (Daraio et al., 2011) and different output level potentials (Lepori, Probst, and Baschung, 2010). Consequently, we expect results to strongly reflect the subject specialisation of universities, as it already happens in global rankings. However, we do not build a league table, but we identify which universities could be compared (homogeneous groups), producing typologies of universities and analysing their efficiency performance with formative evaluation purposes.

[Table 3] around here

4 Results

As explained in the previous section, each variable (21 DEAs, 16 ratios and the size control variable) has been represented through a set of coordinates in our multidimensional space. Figure 2 shows a scatterplot of the first and second dimensions of the MDS analysis, and Figure 3 represents the second and third dimensions. In order to identify which variables are close in the multidimensional space we have performed a cluster analysis on the coordinates of the variables. Results of the cluster analysis are available in Figure 1, and each one of the resultant clusters have been distinguished in Figures 2 and 3 with different geometric shapes (dots, stars, squares and triangles). These clusters are related to: (i) size and overall efficiency and KT performance; (ii) human capital structure, research success and scientific and technical fields; (iii) research performance and medicine and scientific fields; and (iv) teaching performance and humanities and social sciences areas.

Figures 2 and 3 also contain the results of the ProFit analysis, i.e. the directional vectors that indicate the characteristics of each university. Table 4 shows the directional cosines for each university. These cosines are represented by a dark 'small spot' on the scatterplots. In order to not clutter the representations, only some of the vectors have been included by drawing an arrow through the origin of coordinates in the direction of each vector (i.e. in the direction of the 'small spot'). A complete list of the universities and their acronyms is available in Appendix 1.

Once the scatterplots are built, we analyse the position of the variables and the direction of the universities' vectors to interpret the information provided by each dimension. In the case of Figure 2, at the far left of the first dimension there are those ratios on the income raised through KT activities (KTinc_fte and KTinc_inc), but also the efficiency scores containing output 3 (KT income) and those variables related to

engineering and technical fields. We find in this area of the figure the polytechnic universities (UPC, UPCT, UPM and UPV). Instead, at the right side of the first dimension, we find teaching related ratios (grad_fte and grad_enrol) and efficiency scores for the traditional missions (DEA models mostly containing output 1 or outputs 1 and 2 – graduates and publications), as well as variables related to medicine and social sciences and humanities areas (humsc_grad, humsc_pub, med_grad and med_pub). The universities located at this end of the first dimension are, among others UM and USAL. This suggests that Dimension 1 could be labelled as *orientation towards KT performance vs. orientation towards the traditional missions with particular emphasis in teaching*. The scientific fields seem to be halfway between the performance on KT and on the traditional missions (sci_grad and sci_pub).

Analysing the second dimension (Figure 2), it is to be noticed that those DEA models including output 2 (publications) are located at the bottom of the 'map', together with ratios on research productivity (pub_fte) and research in health sciences (med_pub). The universities we find here are, among others: UB, UAB, UPF, UAM, UV and the more regional URV and UMH. These universities are basically metropolitan universities located in Barcelona, Madrid and Valencia. In the top quadrant, we find instead ratios related to the rest knowledge areas (humanities and social sciences, sciences and engineering) as well as ratios on the structure of the human capital of universities, which approximates the teaching burden of the academic staff. This suggests that Dimension 2 could be interpreted as *orientation towards research performance*.

Figure 3 represents the projection of the multidimensional configuration into Dimensions 2 and 3. As for the third dimension, the bottom quadrant is related to ratios (cit_pub, pub_fte, sci_pub) and efficiency scores (containing output 2 – publications) on

research performance. Although Dimension 2 also approximates research performance, the universities located in the very bottom of the quadrant in Figure 3 are different from those located in the bottom of Figure 2. According to Figure 3, the research oriented universities are basically regional universities: e.g. UCO, UNIOVI, ULL, UDG, UDL or UIB; whose high performance in research is more related to scientific fields than to health sciences areas, and is also related to humanities and social sciences fields. As for the top quadrant of Figure 3, is basically related to efficiency scores combining all inputs and outputs (overall performance), with particular emphasis in teaching and KT. Examples of the universities located in this area are UNILEON, UVA or URJC. This suggests that Dimension 3 could be labelled as *orientation towards overall efficiency vs. research performance*.

If we go a step further in the refinement of the typologies of universities, we may apply a cluster analysis to the university vectors produced by the ProFit analysis in order to obtain information on the multidimensional nearness among universities. In this way, we identify which universities belong to each typology (see Figure 4).

In Table 5 we have included the average and standard deviation of the coordinates that indicate the direction of the university vectors and the overall efficiency (DEA specification AB123) by cluster. Additionally, in Table 6 we present some characteristics of the universities from each cluster, including the subject mix. According to Figure 4 and Tables 5 and 6, the typologies of universities proposed are the following:

The first cluster is composed by 13 universities: (EHU, UA, UAL, UCA, UCO, UDC, UHU, UJAEN, UJI, ULPGC, UMA, UPO and USC). These are regional, medium-size/small and mostly young universities. They are not strongly oriented towards efficiency in any mission, but are fairly *oriented towards efficiency in the traditional missions*

(particularly teaching). They are not strong in humanities and social sciences but also in science publications and perform low in KT.

As for Cluster 2 (UAB, UAM, UB, UMH and UPF), it basically gathers those universities oriented towards efficiency in research with the strongest specialisation in health sciences – this cluster shows the highest levels of activity in health sciences fields and all universities are associated to, at least, one university hospital. They have a stronger orientation towards the traditional missions than towards knowledge transfer or overall efficiency, and they are specialised in HUMSOC fields and health sciences. These are mostly big universities located in metropolitan areas (Barcelona and Madrid), with the exception of UPF and UMH.

The universities included in Cluster 5 (UCM, UGR, UM, USAL, UV), they are *big*, mostly old *universities oriented towards the efficiency in the traditional missions*, all of them with at least one university hospital. Their teaching activity is strongly specialised in humanities and social sciences and their research performance relies on experimental sciences and medicine.

As for Cluster 3, it consists of eight universities: UBU, UCLM, UNEX, UNILEON, UNIZAR, URJC, US and UVA. It gathers those universities *oriented towards overall efficiency*. These are regional, medium-size/small universities mostly young with a rather balanced profile between humanities and social sciences, and technical and experimental sciences. Consistently, these are also the universities with a highest average efficiency (value closest to 1) in the efficiency model considering all inputs and outputs (AB123).

Cluster 4 (UC3M, UPC, UPCT, UPM, UPV and UVIGO) is clearly the group of universities *oriented towards KT*. The group includes the four polytechnic universities as

well as other universities particularly efficient and/or active in knowledge transfer activities.

Finally, Cluster 6 is composed by eight universities (UDG, UDL, UIB, ULL, UNAVARRA, UNICAN, UNIOVI and URV) not strongly oriented towards efficiency in any mission but fairly performing in research thanks to their accomplishments in experimental and technical sciences. They also show some degree of activity in KT. These are regional, big/medium-size and mostly old universities. Consequently, this cluster has been labelled as *regional universities oriented towards efficiency in research and KT*.

[Figures 1, 2, 3 and 4] around here

[Tables 4, 5, 6 and 7] around here

Despite García-Aracil and Palomares-Montero (2012) use the same sample as our study, our results are more complex and refine because of their simplistic characterisation of universities through just thee variables (one for each mission - see Table 2.2). Not surprisingly, they produce three clusters: research oriented universities, teaching oriented universities and knowledge transfer oriented universities. As for Aldás (2016), their seven clusters (see Table 2.1) include private universities as well as universities providing distance education so results are not comparable. However, our clusters provide more balanced results across missions, thanks to the robustness of the MDS technique and the thorough characterisation of diversity sources.

5 Conclusions

By and large, evaluation of public policies and efficiency in public expenditure is increasingly demanded. In the case of HE, global and regional rankings have become key tools of informal evaluation that leads public opinion in the sector, as well as policies and

institutional strategies. However, this type of ranking would only properly characterise the research oriented universities, channelling the international competition in this direction, penalising those universities with relative stronger orientation towards teaching and/or third mission and fuelling their social disapproval (Hazelkorn, 2015). In the case of efficiency analyses, they usually derive in rankings of universities according to their efficiency levels also assuming homogeneity among universities. In this sense, we may assert that rankings are limited when used as evaluation tools.

In this paper, we have identified typologies of universities based on their institutional diversity (38 variables) and efficiency performance by mission (21 efficiency measures). Our aim was to propose an alternative for institutional evaluation that respects and supports university diversity and provides useful information for designing university policies and strategies to improve HE systems – not to build a ranking of the best/worst performing universities. In so doing, we propose an innovative combination of methods that ensure robust results: bootstrap DEA and MDS. This analysis also provides information on the institutional factors related to the differences in technical efficiency by mission among Spanish universities.

We have identified six typologies of universities with different characteristics and mission mixes. Despite these typologies are specific of the Spanish case, this experience can be extrapolated to other university systems. Additionally, the following results may be applicable to other cases.

Our six typologies indicate that to be fairly efficient, universities may focus on teaching, KT or overall efficiency, but always have to fairly perform in research. These results, not only confirm our hypothesis, but may hint that research could entail scope

economies with teaching (as demonstrated by De Witte et al., 2017) and also with third mission, an interesting field for future research.

Unlike previous studies, KT have played a fundamental role in the identification of at least two of the groups: cluster 6 or the *regional universities oriented towards efficiency in research and KT*; and cluster 4 or those *universities oriented towards efficiency in KT* – see Table 7. In other words, KT is a relevant source of diversity, even in cases such as the Spanish one, where the share of KT income in universities' total budget is rather marginal. Additionally, not considering the KT (and the whole third mission) of universities when analysing their performance means to disregard part of their contribution to society (outcomes), and it would penalise particularly those universities with a production structure and process strongly oriented towards third mission activities.

Likewise, our contribution may be relevant beyond the Spanish case because our technique presents a different and novel window contributing to the generation of a more comprehensive view of the HEI landscape in a country. We have identified typologies of universities by grouping them in homogeneous clusters, i.e. groups of universities with rather homogeneous subject mix, mission mix and efficiency results by mission. Belonging to a specific group does not entail to be a better/worse university, it just provides policy makers and university leaders and managers at least with information on: (i) which universities are similar (benchmarking); and (ii) the combination of types of social contribution the university is relying on (teaching, research and knowledge transfer and innovation). In this way, universities may not be considered as homogenous.

Taking into account this information as formative evaluation entails at least two sources of improvement in the definition of HE policies and university strategies. First, more nuanced objectives can be defined. For example, HE policies may use these results to

encourage higher efficiency in a particular group of universities in a specific mission, i.e. reinforcing a specific type of university contribution to society. But polities could also aim at helping universities to achieve a more balanced mission mix. Depending on the scope of the policy, the design of the university programmes and university funding systems would vary, but empirical evidence in the institutional and performance diversity of the sector would always be necessary. The method is also relevant to university leaders and managers because it identifies groups of peers and provides productivity and efficiency information for benchmarking exercises among them. This method has the potential of providing clear information on the current position of universities in the HE landscape that should be used in the definition of institutional strategies.

Second, all university missions are made visible and recognised – including the third mission, which introduces a sign of its relevance. Our results confirm the relevance of making the third mission (or at least the KT) of universities observable for the in depth knowledge of the complexity of university systems, and for the proper definition of HE policies and institutional strategies. This suggests the need of fully developed databases on third mission, including information on continuing education and societal engagement in order to: (i) reach a comprehensive understanding of the third mission and its contribution to universities' performance; and (ii) fully support its development. Indeed, despite the greater accuracy of our results, it is necessary to highlight that our analysis is still biased in the sense that we did not include information for the whole third mission or engagement of universities because of lack of data on lifelong learning and outreach activities. Such data would allow for a more refined association between subject mix, mission mix and efficiency results. This is an interesting field for future research for which our theoretical framework is an already usable contribution.

Universities are organizational structures with individual activity mixes or strategies. These individual activity profiles generate the strong heterogeneity of the European university landscape. In this sense, despite their common legal duties, Spanish universities are not only heterogeneous in terms of legal status, size or subject mix, as traditionally recognised, but our study demonstrates that they are also heterogeneous in their production structures, which leads to different efficiency levels. Our approach could be used to address an alternative evaluation methodology for HEIs and their heterogeneous roles despite their homogeneous starting point: the macro scope never allows for detailed perceptions. We need a micro approach to characterize institutional behaviours and our analysis provides opportunities for evaluating universities according to their unique characteristics. In this perspective, evaluation can work as a tool for designing public policies and institutional strategies, not as a policy itself.

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Tables

Table 1. Types of HEIs' classifications.

	Unidimensional	*Multidimensional*
Ex-ante or prescriptive	Ad-hoc classifications (I)	Classifications of institutions
Ex-post or descriptive	Ad-hoc classifications (II)	Classifications of 'comparable' institutions

Table 2.1. Comparison of the cluster analyses performed by Bonaccorsi and Daraio (2009), García-Aracil and Palomares-Montero (2012), Schubert et al. (2014) and Aldás et al. (2016).

	Bonaccorsi and Daraio (2009)	*García-Aracil and Palomares-Montero (2012)*	*Schubert et al. (2014)*	*Aldás et al. (2016)*
Study approach	Structure of universities	University strategy	Activity profile of HEIs	Strategic groups of universities
Methodology	- Across-country level cluster analysis	-	- Across-country level model based clustering and specialisation ratios.	-
	- Single-country level cluster analysis (for Italy and UK)	- K-means and fuzzy cluster analysis for Spanish universities	- Single-country level: specialization ratios	- Hierarchical cluster on Spanish universities. Graphical representation through ordinal MDS + property fitting
	- Elimination of the country effect: each variable is normalised by dividing them by their standard deviation	-	- Elimination of the country effect: each variable is normalised by deducting the country specific mean	-
	- Stability test of clusters over time: repetition of the cluster analysis for several years (1995-2004)	-	-	-
Data	*Aquameth*: year not specified	Source not specified: 2006	*EUMIDA*: year(s) not specified	*CRUE (2013), INE (2013, 2014, a.y. 2014-15), IUNE (average 2011-13), SIIU (a.y. 2014-15*
Countries considered	(8) Finland, Italy, Netherlands, Norway, Portugal, Spain, Switzerland, UK	Spain	(27) EU-27 (except France and Denmark) + Norway and Switzerland	Spain
Types of HEIs considered	(271) Universities	(47) public universities	(Not specified) HEIs	(48) public and (15) private universities
Results	- No structural differentiation at the European level but high institutional heterogeneity. - 3 clusters: research intensive universities, teaching intensive universities, and teaching-research universities	- 3 clusters: research oriented universities, teaching oriented universities and knowledge transfer oriented universities	- There is a common European HE model with strong differentiation. - 2 cluster: undergraduate teaching oriented HEIs and teaching-research oriented HEIs	- 7 clusters: distance universities, private universities, highly specialised universities, big metropolitan universities, young research universities, comprehensive regional universities, public teaching universities

Source: author's elaboration based on Bonaccorsi and Daraio (2009), García-Aracil and Palomares-Montero (2012), Schubert et al. (2014) and Aldás et al. (2016).

Table 2.2. Comparison of the variables considered in the cluster analyses performed by Bonaccorsi and Daraio (2009), García-Aracil and Palomares-Montero (2012), Schubert et al. (2014) and Aldás et al. (2016).

	Bonaccorsi and Daraio (2009)	*García-Aracil and Palomares-Montero (2012)*	*Schubert et al. (2014)*	*Aldás et al. (2016)*
Income	- Total revenue per year (1,000 €)	-	-	-
	-	-	-	- Total revenue / bachelor and master enrolment
	-	-	-	- Total revenue / academic staff FTE
Staff	- N. academic staff	-	-	-
	- N. full professors	-	-	-
	-	-	-	- % PhD academic staff
	- N. technical and administrative staff	-	-	-
	-	-	-	- Average age of the academic staff
Teaching activity	- Enrolled students	-	- N. undergraduate (ISCED 5) + PhD students (ISCED 6)	- Master and bachelor enrolment
	-	-	- % international undergraduate students (ISCED 5)	- % international (bachelor and master) students
	-	- N. bachelor students/academic staff FTE	- N. undergraduate students (ISCED 5) /staff	- N. bachelor and master students / academic staff FTE
	-	-	- N. graduate students (ISCED 6)/staff	-
	-	-	-	- % master students (over bachelor and master)
	- Graduates per year (all degrees)	-	-	-
	-	-	- N. fields of knowledge covered	-
	-	-	-	- Gini index - bachelor and master enrolment by subject mix
	-	-	-	- N. of bachelor degrees
	-	-	-	- Minimum grade required to enrol at each university
Research activity	- Publications per year	- ISI publications/academic staff FTE	-	-
	-	-	-	- % publications with co-authors from various countries
	-	-	- Research active institution: yes/no	-
	-	-	- N. graduate students (ISCED 6)/N. undergraduate students (ISCED 5) – used in substitution of the variable 'research active' in order to check the consistency of the results	-
	-	-	- % international PhD students (ISCED 6) – used in substitution of the variable 'research active' in order to check the consistency of the results	-
3rd mission	-	- National patent applications / 100 academic staff FTE	- Private: yes/no	-
Context	-	-	-	- GDP per capita
	-	-	-	- 18 year old population in the province / N. universities in the province
	-	-	-	- 18 year old population in the province

Source: author's elaboration based on Bonaccorsi and Daraio (2009), García-Aracil and Palomares-Montero (2012), Schubert et al. (2014) and Aldás et al. (2016).

Table 3. Definition of the variables included in the DEA-MDS analysis.

Dimension		*Ratio*	*Ratio description*	
Structure of faculty staff	1	**fte_hc**	Academic staff (FTE) / Academic staff (HC)	
Structure of the student body	2	**bach_enrol**	Bachelor enrolment / (Bachelor and master) enrolment	
Teaching subject mix	3	**humsc_grad**	(Bachelor and master) Grads. in Social Sciences & Humanities / Total grads.	
	4	**sci_grad**	(Bachelor and master) Graduates in Sciences / Total graduates	
	5	**eng_grad**	(Bachelor and master) Graduates in Engineering / Total graduates	
	6	**med_grad**	(Bachelor and master) Graduates in Medicine / Total graduates	
Research subject mix	7	**humsc_pub**	Publications (Social Sciences & Humanities) / Total publications	
	8	**sci_pub**	Publications (Sciences) / Total publications	
	9	**eng_pub**	Publications (Engineering) / Total publications	
	10	**med_pub**	Publications (Medicine) / Total publications	
Teaching productivity	11	**grad_fte**	(Bachelor + Master) graduates / Academic staff (FTE)	
Research productivity	12	**pub_fte**	Publications / Academic staff (FTE)	
KT productivity	13	**KTinc_fte**	Income from R&D and consultancy contracts, technical services rendered, company-sponsored chairs and agreements on IIP / Academic staff (FTE)	
Teaching success	14	**grad_enrol**	(Bachelor and master) Graduates / (Bachelor and master) enrolment	
Research success	15	**cit_pub**	N. citations / N. publications	
KT success	16	**KTinc_inc**	Income from R&D and consultancy contracts, technical services rendered, company-sponsored chairs and agreements on IIP / Total income	
Size	17	**size**	Total expenditure	
DEA efficiency scores		*Model*	*Inputs*	*Outputs*
	18	**A1**	A (academic staff FTE)	1 (graduates)
	19	**AB1**	A, B (expenditure)	1
	20	**B1**	B	1
	21	**A2**	A	2 (publications)
	22	**AB2**	A,B	2
	23	**B2**	B	2
	24	**A3**	A	3 (KT income)
	25	**AB3**	A,B	3
	26	**B3**	B	3
	27	**A12**	A	1,2
	28	**AB12**	A,B	1,2
	29	**B12**	B	1,2
	30	**A13**	A	1,3
	31	**AB13**	A,B	1,3
	32	**B13**	B	1,3
	33	**A23**	A	2,3
	34	**AB23**	A,B	2,3
	35	**B23**	B	2,3
	36	**A123**	A	1,2,3
	37	**AB123**	A,B	1,2,3
	38	**B123**	B	1,2,3

Note: data about academic staff, student numbers and university expenditure is published by the Spanish Ministry of Education (Integrated University Information System – SIIU), the number of publications is produced by the IUNE Observatory and data on KT is gathered by the RedOTRI (the Spanish network of Technology Transfer Offices).

Table 4. Results of ProFit analysis.

University	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Dim5*	*Dim6*	R^2
EHU	.007	.385	-.236	-.052	.573	.243	.594
UA	.350	.319	.228	-.421	.262	.195	.561
UAB	.273	-.852	-.072	.101	.117	-.026	.830
UAH	-.500	-.408	.202	-.027	-.173	-.096	.497
UAL	.312	.655	-.213	-.437	-.128	-.078	.786
UAM	-.046	-.675	-.381	.119	.064	.151	.644
UB	.056	-.842	-.108	.276	.193	-.107	.849
UBU	.107	.619	.169	.463	-.403	-.023	.801
UC3M	-.322	.272	.154	-.513	-.406	.060	.633
UCA	.369	.659	-.168	-.385	.254	.017	.812
UCLM	.404	.281	.360	.700	-.040	-.091	.871
UCM	.602	-.200	.266	.394	.368	.073	.769
UCO	.097	-.024	-.295	-.633	.326	-.005	.604
UDC	.130	.686	.042	-.243	.151	-.073	.576
UDG	.121	-.195	-.768	.160	-.143	-.241	.747
UDL	.005	-.183	-.545	.156	-.294	-.503	.694
UGR	.632	.031	.186	.002	.504	.392	.843
UHU	.273	.702	-.493	-.039	-.301	-.014	.903
UIB	.252	-.063	-.772	.069	-.211	.096	.723
UJAEN	.335	.581	.141	-.503	-.050	-.084	.733
UJI	.283	.207	-.442	-.425	-.501	.133	.768
ULL	.133	.254	-.671	.485	.079	.280	.853
ULPGC	.257	.598	-.390	-.279	.125	-.277	.746
UM	.823	.029	.234	.078	.209	-.244	.843
UMA	.037	.214	-.281	-.573	.413	-.233	.678
UMH	.223	-.578	.356	-.381	-.041	-.276	.734
UNAVARRA	-.195	.154	-.289	.319	-.484	-.260	.548
UNEX	.033	.591	-.011	.020	.233	-.461	.618
UNICAN	-.671	-.246	-.303	.209	-.239	.224	.754
UNILEON	.410	.235	.690	.161	-.208	-.014	.770
UNIOVI	-.075	.181	-.581	.275	.065	.340	.571
UNIRIOJA	-.083	.026	.035	.464	-.022	.033	.226
UNIZAR	-.165	.153	-.219	.532	.316	-.297	.570
UPC	-.953	-.061	.189	-.046	.088	.017	.958
UPCT	-.845	.260	-.102	-.164	-.116	-.098	.843
UPF	.356	-.629	.252	-.305	-.340	.162	.822
UPM	-.942	.020	.217	.058	.093	-.047	.949
UPO	.499	.140	-.303	-.470	-.273	.003	.656
UPV	-.841	-.023	.342	-.153	.151	.175	.901
URJC	.373	.101	.718	.141	.071	.019	.690
URV	-.432	-.628	-.325	.101	-.316	-.251	.860
US	-.316	.032	.451	.184	.592	-.044	.691
USAL	.618	.087	.395	.114	.081	.315	.664
USC	.050	-.126	-.293	-.555	.468	.086	.639
UV	.621	-.479	.250	.074	.324	.234	.844
UVA	.072	.256	.569	.637	-.056	-.064	.808
UVIGO	-.515	.003	.192	-.351	-.127	.302	.532

Table 5. Mains statistics on the coordinates for the university vectors and overall efficiency by cluster.

Clusters		*DIM_1*	*DIM_2*	*DIM_3*	*DIM_4*	*DIM_5*	*DIM_6*	*AB123*	*N*
1	*Mean*	0.231	0.384	-0.208	-0.386	0.101	-0.007	1,746	
	SD	0.152	0.285	0.219	0.186	0.329	0.150	0,199	13
2	*Mean*	0.172	-0.715	0.009	-0.038	-0.001	-0.019	1,216	
	SD	0.164	0.125	0.297	0.288	0.208	0.184	0,068	5
5	*Mean*	0.659	-0.106	0.266	0.132	0.297	0.154	1,252	
	SD	0.092	0.236	0.078	0.152	0.160	0.252	0,117	5
3	*Mean*	0.115	0.284	0.341	0.355	0.063	-0.122	1,247	
	SD	0.270	0.215	0.337	0.258	0.314	0.168	0,186	8
4	*Mean*	-0.736	0.079	0.165	-0.195	-0.053	0.068	1,393	
	SD	0.258	0.148	0.146	0.207	0.208	0.148	0,251	6
6	*Mean*	-0.108	-0.091	-0.532	0.222	-0.193	-0.039	1,342	
	SD	0.312	0.289	0.203	0.135	0.191	0.312	0,144	8

Table 6. Main characteristics by cluster.

Clusters	*N*	*Univ. hospital*	*% enrol. ING*	*% enrol. MED*	*% enrol. SCI*	*% enrol. HUMSOC*	*% pubs. ING*	*% pubs. MED*	*% pubs. SCI*	*% pubs. HUMSOC*
1	13	7	21.59	12.81	6.27	59.33	27.02	23.05	58.25	17.55
2	5	4	8.38	21.56	10.71	59.34	12.02	41.17	52.42	14.07
5	5	5	7.86	19.21	8.88	64.05	17.41	31.64	55.00	18.80
3	8	7	24.01	13.22	5.36	57.41	32.55	23.29	54.55	16.94
4	6	1	74.91	1.19	2.22	21.68	54.01	7.90	55.06	11.39
6	8	7	22.19	16.47	6.44	54.90	25.43	22.34	60.37	16.10

Table 7. Typologies of Spanish public universities.

Typology	*University*	*Typology*	*University*
Cluster 1	EHU	*Cluster 3*	UBU
Universities oriented towards	UA	*Universities oriented towards*	UCLM
efficiency in the traditional	UAL	*overall efficiency*	UNEX
missions (particularly	UCA		UNILEON
teaching)	UCO		UNIZAR
	UDC		URJC
	UHU		US
	UJAEN		UVA
	UJI	*Cluster 4*	UC3M
	ULPGC	*Universities oriented towards*	UPC
	UMA	*efficiency in KT*	UPCT
	UPO		UPM
	USC		UPV
Cluster 2	UAB		UVIGO
Universities oriented towards	UAM	*Cluster 6*	UDG
efficiency in research	UB	*Regional universities*	UDL
	UMH	*oriented towards efficiency in*	UIB
	UPF	*research and KT*	ULL
Cluster 5	UCM		UNAVARRA
Universities oriented towards	UGR		UNICAN
the efficiency in the traditional	UM		UNIOVI
missions	USAL		URV
	UV		

Figures

Figure 1. Dendrogram for cluster analysis of variables.

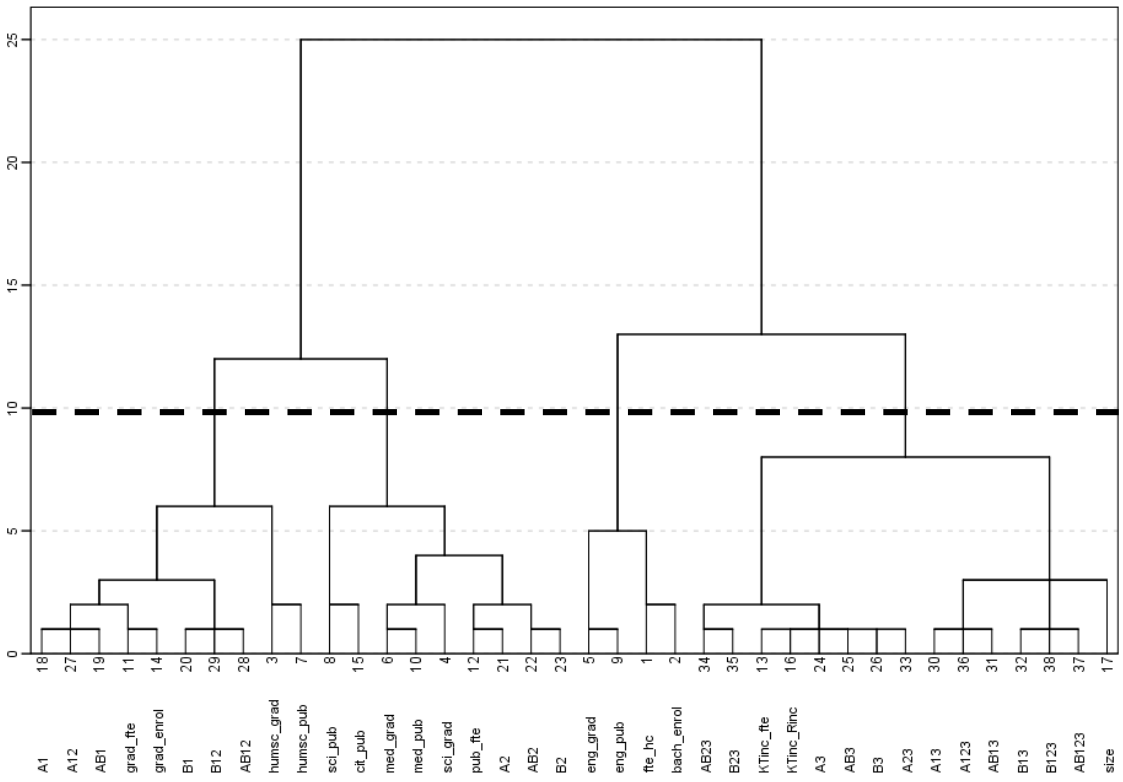

Figure 2. Multidimensional Scaling configuration in Dimensions 1 and 2.

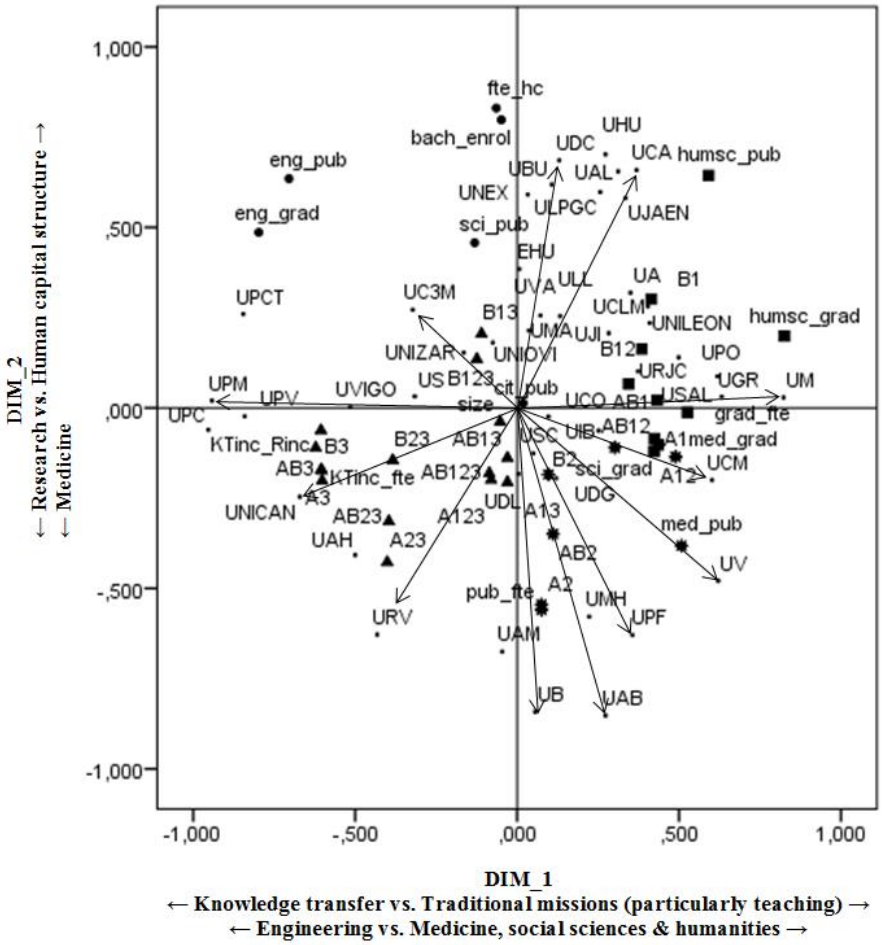

Figure 3. Multidimensional Scaling configuration in Dimensions 2 and 3.

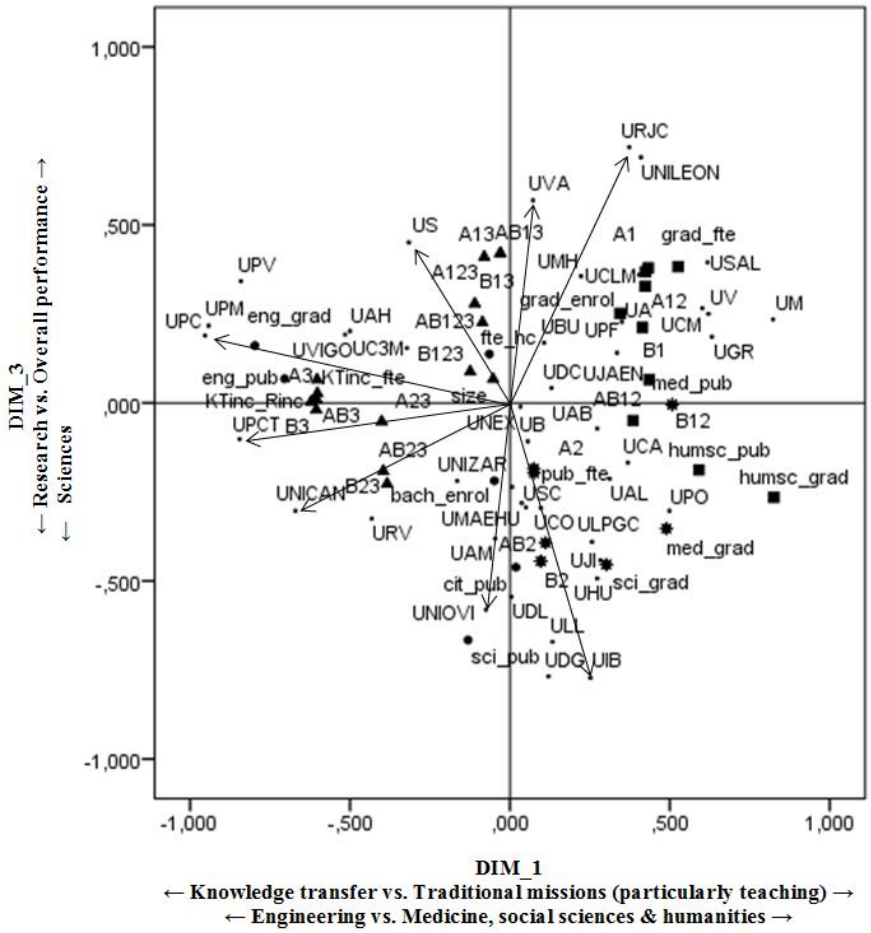

Figure 4. Dendrogram for the cluster analysis on the university vectors.