2014

ISSUE Rankings

Synthetic Indicators of Spanish Universities

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Ivie INSTITUTO VALENCIANO DE INVESTIGACIONES ECONÓMICAS

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The U-Ranking project, developed by the Ivie (The Valencian Institute of Economic Research) and the BBVA Foundation, is an essential part of a program of activities carried out by both institutions to document and analyze the role of knowledge in social and economic development. This report presents one of the basic products of the project, the ISSUE Rankings (Synthetic Indicators of the Spanish Public University System), its methodology and results for the 2014 edition, the second version presented.

The approach of ISSUE, the selection of variables on which the rankings compiled are based and the methodology used when treating the data have been thoroughly discussed by the Ivie team and a large group of experts on the assessment of universities, university information and management. We would like to thank these specialists from fourteen universities for their invaluable collaboration.

We would also like to acknowledge the support of the Valencian public universities in the initial stages of the project and the suggestions made by members of different Spanish universities after the presentation of the first results in June 2013, which have been followed with interest by many people. From then until the end of March 2014 the U-Ranking website has received nearly 110,000 hits, many of which have resulted in calculating personalized rankings, as well as more than 5,000 downloads of the first edition of the report. In addition, the project is followed with interest from abroad: 20% of the visits to the website in the 2013 edition came from outside of Spain, 9% of which were from Latin America and the US, and 3.5% were from European countries such as the UK, Germany, France, Italy and Portugal. These data provide a stimulus to maintain the continuity of the project while making improvements which have been added in this second edition.

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[1] The IUNE Observatory is the result of work carried out by a group of researchers from the universities that make up the "Alianza 4U" (Universidad Carlos III de Madrid, Universidad Autónoma de Madrid, Universitat Autònoma de Barcelona and Universitat Pompeu Fabra). The general coordinator of IUNE is Elías Sanz-Casado, professor of Documentation at Universidad Carlos III de Madrid and director of the Laboratory for Metric Information Studies.

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The results of the U-Ranking project are, therefore, fruit of the collaboration of many people and institutions that share our interest in analyzing the performance of Spanish universities and facilitating comparable and synthetic images of them. Nevertheless, the indicators presented and the resulting conclusions are the sole responsibility of the Ivie team.

1. Introduction

This report presents the results of the research undertaken by the Ivie to develop the second edition of Synthetic Indicators of the Spanish Public University System (ISSUE), based on an analysis of university teaching activities, research, and innovation and technological development.

The developed indicators provide the basis for compiling different rankings of Spanish universities: two general rankings —one on the volume of results (ISSUE-V) and the other on productivity (ISSUE-P)—, as well as more specific ones on teaching, research, innovation and technological development, and specific qualifications.

All of these rankings are approximations of university results, allowing them to be compared from different perspectives. Through such comparisons, synthetic indicators allow their performance to be assessed by answering relevant questions, such as the following:

- Which Spanish universities show the greatest volume of results? Which universities are more productive or efficient? Do the universities at the top of the rankings coincide with these two perspectives?

- Do the positions of Spanish universities in international rankings meet the criteria in terms of volume of activity or in terms of productivity? Are the positions of Spanish universities in the ISSUE Rankings correlated with the best-known international rankings such as that of Shanghai[2]?

- Do the universities with the best research results stand out for their teaching results? Are research results correlated with technological development and innovation?

- Are the positions of universities in the various general rankings sufficiently regular so as to classify them into homogeneous groups, or do their positions vary too much in some classifications to establish a typology? Do universities maintain their positions over time?

- Are the general rankings on university activities as a whole similar to those obtained when comparing specific qualifications? Is the internal heterogeneity of universities high?

Answering all these questions could be of great interest to form a vision of the Spanish public University system, identifying the strengths and weaknesses of each institution that is part of it, as well as to classify the position of universities within the university system. That is the purpose of this project and report, as noted in an earlier study by the Ivie, published by the BBVA Foundation (Pérez and Serrano dirs. 2012), the Spanish University system has greatly increased its size in recent decades but it is far from being homogenous. Not acknowledging its heterogeneity makes it difficult to assess. Thus, this assessment requires that the different specialization and changing characteristics of each university are taken into account, as well as their real possibility of competing in different areas.

Rankings as synthetic indicators of results

The performance of Spanish universities receives constant attention, and debates about the exploitation of the resources used and their results are increasingly frequent. The driving force behind this interest are the significant amount of resources currently dedicated to these activities and the recognition of the important role universities play in generating and transmitting knowledge, two key areas in the social and economic development of countries today.

[2] Academic Ranking of World Universities (ARWU).

In Spain, discussions about university results frequently focus on public universities. There are two reasons for this: the volume of their activity accounts for most of the Spanish university system and the origin of the majority of the resources used is public; the assessment of their results is therefore considered to be of general interest. There is also a more practical reason. In Spain, traditionally, it has been more feasible to assess the resources and results of public universities based on relatively homogeneous data, because until recently most of the numerous private universities (there are currently 33) did not provide the necessary data to carry out analyses. However, the participation of private universities in public statistics and information systems is increasing, and this project hopes to incorporate some of these institutions in future editions, once the problems have been solved due to the lack of data on some of the variables used.

An increasingly popular approach to exercises assessing university results in many countries, as well as in Spain, consists in compiling rankings where institutions are classified from different perspectives and with different criteria. Some of the international university rankings have found their place in debates about the quality of these institutions, becoming widely used references to assess the position of universities and national University systems. Thus, for example, the presence of only ten Spanish universities (12% of the total) among the first 500 institutions of the world according to the Shanghai Ranking, but none in the top 200, is a fact often mentioned as proof of the limited quality and insufficient international projection of our university system.

Researchers, public and private institutions, university associations, along with companies in information and media are increasingly taking more initiatives to compile rankings. The objectives and interests of such initiatives and their scope are diverse, both in terms of university activities studied (many rankings focus on research), as well as in terms of coverage (national and international), the data used and its treatment. Some recent reports (Rauhvargers 2011, 2013) stressed the importance of carefully assessing the criteria with which the rankings are compiled when demonstrating their significance and interpreting results.

Indeed, the rankings are a particular way to approach the assessment of university results and their appeal lies in the fact that they offer simple and concise information. This facilitates comparisons while simplifying them, and can make them sensitive to the criteria and procedures followed when constructing indicators. It is for this reason that the value given to the rankings should not be separated from how they are compiled or from the metric used.

These precautions are not always present when using rankings. On the one hand, the reputation of a good position in a ranking turns them into an intangible asset to universities. Therefore, some develop strategies to convey information about themselves (signaling) by advertising their more favorable results, and to improve their positioning in the rankings. Certainly, the expected return of a good position in a ranking is significant, given that it can affect areas as diverse as recruiting students, attracting researchers, obtaining resources and the social projection of institutions.

On the other hand, the growing interest in these classifications is because they are perceived as useful tools (despite being imprecise) for various purposes and different stakeholder groups in universities because:

a) The information they provide to the users of university services is easy to interpret in terms of attractiveness or quality of institutions.

b) They provide comparative information to governments, with the possibility of being used as a simple tool to assign resources or for the accountability of universities to society.

c) They complement the work of university quality assurance agencies and provide information to analysts interested in having homogenized indicators available.

Approach of the project

In Spain different university rankings are already being regularly presented, compiled with diverse perspectives and methodologies. What sets the new rankings proposed by ISSUE apart is that they are developed according to criteria that respond to many of the most recent international recommendations. One of them is that indicators should be created with the objective of studying

university activities from a broad perspective, i.e. examining teaching, research, and innovation and technological development activities.

Among the criteria used in developing ISSUE that should be noted are the following:

- Developing multiple university rankings, in which university activities are examined from a general perspective, as well as in specific fields (teaching, research, innovation and technological development), and also in terms of the total volume of results (ISSUE-V) of each university and the productivity corresponding to the relationship between total results and university size (ISSUE-P).

- Taking into account the diverse perspectives and interests that potential users of the data may have when using the rankings. In particular, special attention has been paid to the importance this can have when comparing universities in specific areas such as degrees. To deal with this concern, a web tool has been developed which enables users to create personalized rankings in terms of Bachelor's degrees. It has been designed to guide students, their families and counsellors when choosing a university in which to study. The advantage of recognizing that users have different preferences is that the following problem can be avoided when constructing synthetic indicators: their dependence on expert opinions (subjective and sometimes contentious) regarding the weights that should be attributed to teaching or research.

The project therefore offers two distinctly different products:

- A collection of rankings on Spanish universities, based on the criteria of the project's team and the experts consulted, allowing each institution to be compared with others from different points of view.

- A web tool that provides personalized rankings for different Bachelor's degrees, grouped according to area of study and which allows universities to be compared taking into account the interests and criteria of users (mainly students enrolling in universities) on their choice of studies, the communities considered and the importance given to teaching and research.

It is important to note that all products are derived from a common basis: the data correspond to the same set of variables and the same methodology has been followed when treating and aggregating variables, except obviously with regard to decisions taken by users when creating their *personalized* rankings.

Structure of the report

After this Introduction, the remainder of this report is structured in five chapters, with the following content. In Chapter 2 there is an overview of the principles that have guided the construction of synthetic indicators, identifying problems and precautions that must be taken into account when developing them. The various reference rankings are also studied, analyzing their strengths and weaknesses so as to identify the key methodological aspects that our system should consider. Following this review, Chapter 3 details extensively the methodology followed in preparing the different rankings. Chapter 4 describes the approach for the personalization of the rankings by the user and the web tool created to present the results to students. Chapter 5 provides an analysis of the main aggregated results, focusing on the comparison of the rankings ISSUE with the main international ranking of reference. Also, to assess robustness, a sensitivity analysis of our results to variations in some of the assumptions used in preparing the rankings along with a comparison of the results obtained in the two editions of Rankings ISSUE are presented. Finally, Chapter 6 summarizes the main features and results of the project.

New developments in the second edition of Rankings ISSUE

This second edition of the ISSUE project corresponding to 2014 offers, as the previous one did, both the general ISSUE-V and ISSUE-P rankings, as well as personalized rankings for Bachelor's degrees. In addition, some new features and improvements with regard to the 2013 edition that should be highlighted are presented.

First of all, this edition contains significant updates and extensions of the time series on which the information used for compiling the rankings is based. This has been made possible because over the past year there have been considerable improvements in the public databases devoted to collecting university data. Thanks to them and the collaboration of various institutions, the quality of data has improved and two new indicators have been added. These indicators were studied in the initial scheme of variables but were unavailable last year.

Secondly, this new edition also provides the values of indicators from which the rankings are derived. That is, in addition to the position in the corresponding ranking, the value of the synthetic indicator obtained for each university is also published. These indicators offer the reader an approximate cardinal value, without aspiring to be more accurate than can be expected from the methodology used. For this reason, the value of the indicator is rounded to one decimal, given that a greater quantitative accuracy does not reflect precisely real differences between universities.

Finally, information on university fees corresponding to each Bachelor's degree is provided in this edition. The project team considers that the cost of university studies and the differences in this respect between autonomous communities is becoming increasingly important given the rise in fees and the greater variety today. In order to provide the student with data that facilitates their decision on this subject, U-Ranking incorporates the public prices for course credits corresponding to the academic year 2013-2014 for the more than 2,500 Bachelor's degrees that are examined. Furthermore, as in 2013, the cut-off mark[3] for each degree has been included, with the information updated for the year 2013-2014. Users of U-Ranking can therefore learn both the cost and requirements of the degrees resulting from their personalized ranking.

[3] Mark of the last student who gained admission to a degree with limited places.

2. Limitations of rankings and possible improvements

The existence of rankings can help answer questions such as those raised at the beginning of this report and encourages universities to pay greater attention to the results of their activities so as to improve their position in the rankings. In addition, comparing the results obtained by a given university with those of other institutions helps to contextualize and relativize them, allowing potential areas for improvement to be identified and thus allocate resources accordingly.

2.1. RISKS OF THE RANKINGS

When compiling a ranking it is essential to keep in mind the risks associated with the use of synthetic measures of results which, as shown in the following list, are numerous:

a) *The risk of misusing rankings*, particularly when they are used to orient strategies focused on improvements of variables studied, ignoring that they are only proxies of results that one wants to assess and neglecting essential factors. This risk is greater in today's society, in that many issues are valued using simple but sometimes misleading indicators, and media messages which attract attention but are incomplete.

(b) *The risk of using rankings to guide actions and assessments other than those for which they were designed.* Many rankings have specific objectives (to assess the results of teaching, research, etc.) and it is misleading to make generalizations based on these objectives, using them to guide actions and behavior other than those for which they were designed.

(c) *The risk of confusing what can be measured with what is important to measure.* The availability of periodic statistical information conditions the types of variables that can be incorporated in the indices, as well as the aspects of university activity which can be studied and those which cannot due to lack of data. It is important to know what information the developed indices actually incorporate. Thus, for example, the fact that there is greater availability of comparable information on research results at international level means that the rankings which are most used focus on variables relating to these activities, leaving aside indicators concerning teaching (at its different levels) or other activities that are very important, such as innovation and technological development. If data on these variables is not used then it is not legitimate to interpret research results as if they provided information on other activities, unless the correlation between them has been tested.

(d) *The risk of using synthetic indicators that are not very robust,* with values highly sensitive to the criteria of measuring the variables and to aggregation procedures. The rankings inevitably simplify a very complex reality, which is not easy to summarize. Diverse university activities such as teaching, research, innovation and technological development are studied which are difficult to compare if suitable procedures are not available. In addition, it is difficult to capture all the results of an activity in one indicator, as well as selecting or aggregating indicators. It is also difficult to study variables together related to quantity and quality. If these circumstances are not valued properly when creating the synthetic indicator, its meaning can be very vague and inaccurate.

(e) *The risk of focusing only on the elite and forgetting the rest.* Frequently, international

rankings are incomplete and concentrate on a limited number of universities (the 500 included in the Shanghai Ranking represents less than 3% of those existing in the world), using inapplicable criteria to assess the vast majority of institutions that make up the university system of any country, including those with the most powerful university systems. But Olympic medals are not the best measure of the sports activity in a country, and nor are certain tournaments, despite their public appeal. Having a champion is important, but it is not the only factor to promote sport, assess the average level of discipline and how sport contributes to the health of the population. Similarly, for the rankings to be useful to university systems, they should be studied from a broader and more inclusive perspective than the one used by international rankings. This is often more feasible by using thoroughly the possibilities of comparison based on the best data available at national level.

(f) *The risk of making an inadequate comparison of institutions with different specializations*. Universities have specializations in their activities (more or less directed at teaching, research, or innovation and technological development), which sometimes makes them very different and makes it difficult to compare them. They are also specialized in different fields of science. If the rankings do not control for the effects of these different orientations they can be misleading, penalizing the position of a university to the benefit of others because of not using properly standardized indicators and thus hindering comparison.

Specialists and international organizations dedicated to studying universities have often warned about the risks mentioned (see Altbach 2006; Salmi and Saroyan 2007; Rauhvargers 2011 and 2013). Despite these warnings, the appeal of rankings (reinforced by media dissemination) seems irresistible. This is also the case in Spain, where the rankings have the same biases as in other countries, without proper precautions in their development and assessment of their results.

2.2. LIMITATIONS OF THE INTERNATIONAL RANKINGS

Part of the problem arises from the fact that the most popular international rankings show many of the above-mentioned limitations, and also tend to be overused as a reference. For example, in Spain they are used both as a way of advertising the universities which appear in them, while at the same time criticizing that none of Spanish universities appear in the top two hundred.

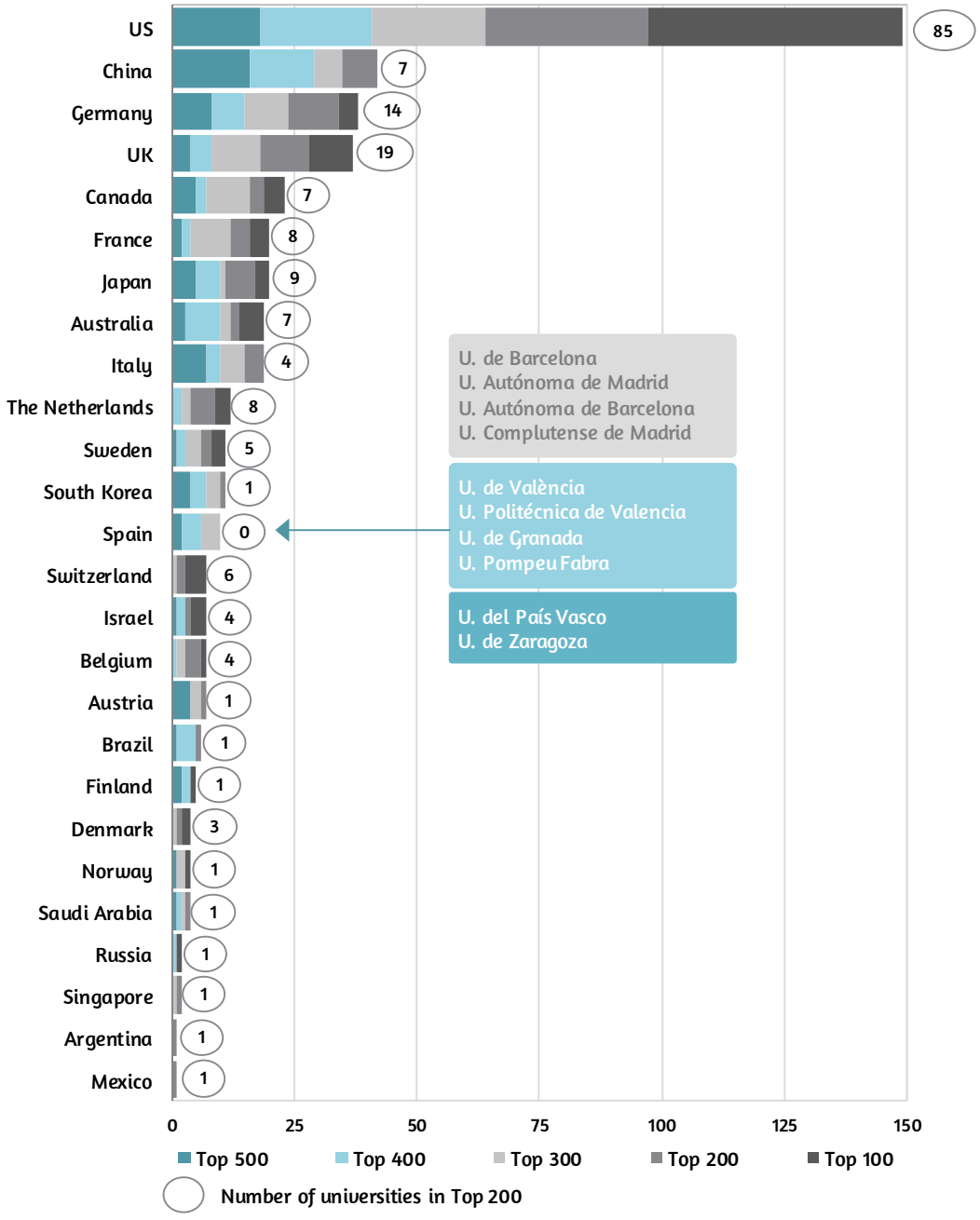
The most well-known and relevant international rankings of academic excellence have achieved great popularity, but only accurately identify the great universities which have a truly global projection. However, while they attract attention to these universities, they also highlight the positions in which the rest are placed in respect to them. Nevertheless, these rankings do not actually allow comparable information between the university systems of different countries or among the vast majority of universities in the world, due to the criteria used. As noted in the reports *Global University Rankings and their Impact* (Rauhvargers 2011-2013):

a) The majority of rankings are based on indicators focusing on research activity but there are hardly any comparable elements regarding teaching in different countries and in terms of reputation which, outside the circle of world class universities (no more than twenty), show assessments that are unreliable because of limitations and bias in regional terms, scientific fields, etc.

b) These rankings suffer from a serious problem of representativeness, given that the rating criteria and data collection efforts are directed at identifying global universities[4], leaving the majority of universities out of the classification. Thus, of the roughly 17,000 higher education institutions in the world, the best-known international rankings provide information for only some 1,000 universities, of which 500 are compared.

[4] On the unique characteristics of global universities, see Salmi (2009).

Figure 1. Spanish universities in the 2013 Shanghai Ranking



Note: Ordered from the countries' highest to lowest number of universities in the Top 500.
Source: Academic Ranking of Word Universities (ARWU, CWCU 2013).

Table 1. Number of Spanish universities in each range of results in the main international rankings. 2013-2014

	1-100	101-200	201-300	301-400	401-500	Total
ARWU - Shanghai Ranking			4	4	2	10
Times Higher Education		1	3	0	5	9
QS World University Rankings		3	2	5	3	13
SCImago[1]		1	5	3	4	13
Webometrics	1	6	5	5	9	26
4ICU-4 - Top 200	1	5				6
CTWS Leiden Ranking		1	1	5	11	18
University Ranking by Academic Performance (URAP)	1	3	2	5	3	14
NTU Ranking	1	1	4	3	5	14

[1] SCImago Global Rank 2013. Position based on the number of scientific publications. The CSIC, placed in position number 8, has not been taken into account.
Source: Own elaboration.

The number of Spanish universities present in each range of results of the major international rankings is always limited, as can be seen in Table 1: approximately a dozen of the 83 universities existing today, 50 public and 33 private.

The Shanghai Ranking, the best known of all, only includes 10 Spanish universities among the top 500 in the 2013 edition. None of them appear in the top two hundred, among which the concentration of universities from the United States (US) is huge (85), followed far behind by the United Kingdom (UK) (19) and Germany (14). Certainly, although 16 countries placed an institution among the first one hundred and 25 countries among the first two hundred, Spain does not manage to place any. This under-representation is due both to the absence of internationally renowned universities in Spain as well as the fact that the indicators on which the Shanghai Ranking is based are very questionable when evaluating universities such as ours. In fact, they hardly scored in some variables[5]. However, when discussing our university system, the question of whether this index is suitable is frequently ignored and, in fact, it is the most cited ranking in assessments of the Spanish university system.

2.3. HOW TO COMPILE A RANKING: BASIC PRINCIPLES

The fundamental question when creating a university ranking is what criteria needs to be used when compiling it. The study entitled *Principles of Berlin on University Rankings* (Centrum für Hochschulentwicklung, CHE 2006) offers valuable references when reflecting on this issue, listing eight basic principles, which are summarized as follows:

1. To indicate clearly what the target audience of the ranking is.
2. To be clear about what each indicator measures.
3. To try to use measures of outcomes rather than inputs.
4. To be methodologically scrupulous in the compilation of the ranking.
5. To specify the difficulties encountered and possible errors.

[5] The variables used are as follows: (i) graduate students who have obtained the Nobel Prize or the Fields Medal, (ii) professors from the university that have obtained the Nobel Prize or the Fields Medal, (iii) number of researchers highly cited in their field, (iv) total articles in journals listed in the Science Citation Index Expanded and in the Social Science Citation, (v) number of articles published in the journals Nature and Science, (vi) academic production regarding the size of the institution.

6. To pay attention to cultural differences when classifying institutions of different countries.

7. To take into account the potential bias in the comparison of different areas.

8. To maintain a high ethical standard, given the responsibility and impact that rankings have.

Another nine principles to be taken into account are the following:

9. To assess the relevance and importance of the different indicators.

10. To ensure transparency of the rankings and make them difficult to manipulate.

11. To structure the information clearly.

12. To be efficient following proper procedures for scientific data collection and in subsequent updates.

13. To enable the continuous improvement and permanent adaptation of the ranking, incorporating new interesting indicators as they become available.

14. To distinguish clearly between the dimensions that are being measured and the variables that are used to approximate these values.

15. To discuss the robustness of criteria used in the aggregation.

16. To specify how differences in the size and structure of institutions being ranked are taken into account.

17. To establish the relationship between everything as a whole and its different parts, providing as much information as possible, disaggregated into homogeneous units (departments, qualifications, areas of research, etc.).

On the other hand, the fundamental principles that should govern a rankings system according to the results of discussions held by the European University Association and the International Group of Experts on Rankings (CHE 2006), are:

1. *To address the multidimensional nature of universities*, taking into account their different missions.

2. *To respect the user's perspective*, enhancing web applications that allow the citizen to express their preferences and that these are taken into account.

3. *To provide a global vision,* being thorough and covering all institutions, not only a small elite.

4. *To address diversity,* taking into consideration the fact that the activities and budgets of institutions vary greatly.

5. *To recognize the variety of subjects,* in order to measure performance both of institutions as well as on a more disaggregated level, by areas of knowledge.

6. *Independence,* ensuring that the ranking is developed and implemented by an independent institution, not a public institution or university.

7. *Sustainability,* in time and financially, which does not require charging students for the use of the rankings.

2.4. INTERNATIONAL INITIATIVES FOR IMPROVEMENT

On the basis of these considerations, in 2011 the European Union (EU) proposed certain principles that university rankings should respect, with the twofold objective of addressing all the problems and moving towards a homogeneous and comparable European ranking. To do so, a pilot project, U-Multirank, has been launched in order to carry out a homogeneous ranking of a sample of European universities, identifying the difficulties in achieving homogeneous and accurate data.

On the other hand, the Organization for Cooperation and Economic Development (OECD) is developing the project AHELO to assess what students in higher education know and can do upon graduation, similar to the approach taken by PISA (Programme for International Student Assessment). In the future, AHELO could provide

useful materials to cover some of the major shortcomings in the data used in rankings, in the area of professional development results.

The rankings system carried out by the ISSUE project, developed by the Ivie and the BBVA Foundation, expressly includes all the principles which were recently discussed internationally and proposed by the EU. The following section details the many aspects that have required a distinct approach when working with these criteria.

3. Methodology

In the context raised by the shortcomings and criteria described in the previous sections, the starting point of the ISSUE project was an in-depth look at the most important national and international rankings, so as to identify possible ways of reducing their shortcomings. The most significant problems arise in the following areas: (1) university activities studied, (2) disaggregation by subject or type of studies, (3) data availability and use, (4) methodological rigor in the treatment of data and construction of indicators, (5) recognition of the user's perspective when creating and providing data, and (6) user-friendly tools to select their preferences in the rankings.

The project has studied the shortcomings in all these areas and the following section describes how they have been addressed.

3.1. ACTIVITIES STUDIED

One of the main failings of certain rankings in providing a general assessment of universities, particularly in the case of international rankings, is that the activities are examined from a very partial perspective. The problem stems from data availability on the results of teaching activities, and innovation and development technology, which are far less abundant than research.

In fact, most of the important rankings focus on analyzing research, taking little account of another significant function of universities: teaching. In the case of innovation and technological development activities, these areas are barely considered despite their increasing importance. The rankings which are biased towards research are frequently interpreted as representative of university activity as a whole.

There are three possible reasons for this: 1) the data available is used and, without a doubt, the abundance, quality and homogeneity of data on research is much greater than in the other two areas; 2) research activity is considered the most important distinctive element of higher education in the last few centuries; and 3) the opinion holds that the research quality of professors is a proxy variable for other areas, and therefore it is enough to observe these results.

The first reason is practical, but can induce bias by omission in indicators and rankings. The second needs some clarification in that it is a powerful argument regarding postgraduate studies but less so in relation to the degree, especially in mass university systems, such as those of most developed countries today. In fact, in most of these systems there is a significant concentration of research activity in a small number of universities, while in a large number of institutions there is fundamentally teaching activity. The third reason is a hypothesis, which should be compared by developing indicators for all activities and testing whether the correlation between teaching and research results is actually met. If the validity of this hypothesis is not tested, given that the intensity of university teaching specialization, research and innovation and technological development varies greatly[6], overlooking the direct indicators of teaching and innovation and technological development can bias the rankings.

Therefore, it is important to take advantage of the data available on university activity in the field of teaching, and innovation and technological development, so that the rankings reflect university activity as a whole more accurately. In addition, this also allows us to recognize the different specialization profiles of universities, as some focus more on basic research (as occurs in many of those most often included in the world rankings), others on higher education and professional development, and others on applied research, innovation and technological development.

[6] See Pérez and Serrano (dirs.) (2012, ch. 1 and 4).

Studying these three dimensions is a first step in the direction of addressing the different perspectives on university systems and the different interests that potential users of the rankings may have. Thus, a degree student probably shows a greater interest in teaching, while a postgraduate student and teachers are likely to focus more on aspects related to the quality of research. On the other hand, a company interested in signing a contract for a line of specific research, may want to identify the university with greater capacity for applied research or producing patents. If the data focuses solely on research results then these distinct approaches cannot be carried out accurately.

The ISSUE project specifically studies these three categories of university activities, analyzing the data available on each of them in Spain. The national dimension of the project ensures that reasonably homogeneous data is available with a set of variables representing the activity of Spanish public universities. It would certainly be desirable that data on private universities were available in the future with a guarantee of similar quality and homogeneity, which would improve the scope of the project.

The number of public universities is sufficiently high for the data already available to allow a contrast of the hypothesis to which we referred earlier: if research results can predict correctly those of teaching or not. The project has examined this specific objective, with the results presented in Section 5.6.

3.2. DISAGGREGATION OF ACTIVITIES

A further shortcoming noticed when analyzing current rankings is that many of them deal with universities in a unitary manner, not recognizing the diversity of areas in which these institutions can offer professional development or conduct research. This problem needs little explanation: to be more useful, a ranking has to inform as far as possible the user on specific areas or scientific fields of their interest, especially if we take into account that universities may not be homogeneous in the quality of each of their areas.

It is for this reason that a ranking system can be improved if it provides data disaggregated by areas of study, fields of knowledge or specific degrees. This last level of detail could be very significant for students, given that their fundamental interest is generally linked to the quality of the specific studies that they want to pursue.

For the disaggregation, the ISSUE project had to work in several directions. Firstly, it followed the criteria that it is important to start with the most disaggregated data available, maintaining its detail whenever possible, so as not to lose the wealth of its heterogeneity. Secondly, the disaggregated data had to be dealt with rigorously in order to homogenize it properly before adding it to the indicators. And third, the problems of combining (for the construction of some of the indicators studied) the data disaggregated according to scientific fields or degrees with other data aggregated at university or branch of knowledge level had to be solved. When there is no disaggregated data, or its disaggregation makes no sense, the aggregated data has been allocated to the various elements of the set, following the criteria considered more reasonable in each case.

Addressing the above problems is not trivial. For example, in the case of the rankings on specific Bachelor's degrees of Spanish universities, to deal with data on areas with different levels of disaggregation a series of matrices have been created that connect them. In order to do this, accurate connections had to be established between university, branch of knowledge, areas of the National Commission for the Evaluation of Research Activity (CNEAI), Web of Science category, areas of the National Evaluation and Foresight Agency (ANEP) and Bachelor's degrees.

In allocating research results to each degree, the starting point was data disaggregated by the Web of Science categories (more than 250 items). Given that one classification is not perfectly nested in another, both classifications have been connected, and the two types of errors that could be made have been taken into account:

1. *Inclusion error.* That is, attributing to a given degree the research carried out by teachers from other areas. For example, attributing to the Pharmacy degree of a given university,

the research in "Hematology" that has actually been conducted by teachers from the Faculty of Medicine and who only teach in Medicine.

2. *Exclusion error.* That is, excluding research by teachers in areas that are not exactly the subject of the degree courses they teach in, as a result of being too restrictive when allocating areas to degrees. For example, if in Economy we only allocate the category "Economics", then important research may be missed in the area of "Business and Finance", theoretically closer to Business Administration degrees but also carried out by economists who teach in the degree of Economy.

These problems do not have a perfect solution and we had to choose one of the alternatives. We have opted for a more inclusive criterion: that is, when in doubt about whether to associate a category or scientific field to a degree we have chosen to include it, thus minimizing exclusion errors on the grounds that they are more serious errors.

3.3. INDICATORS, AREAS AND DIMENSIONS

The main pillar of a ranking system is, undoubtedly, the rigor of the procedure followed when dealing with existing problems so that the created classification responds to appropriate data and is treated with reasonable methodological criteria. Many of the rankings used have clear shortcomings in this aspect, which the recent international literature has analyzed in detail.

The ISSUE project considers that a university ranking seeking to study all their activities should be structured by distinguishing the three following major dimensions:

- *Teaching*
- *Research*
- *Innovation and technological development*

The assessment of each of these dimensions can take into account multiple areas of activity and indicators. However, many experts agree that an excessive number of them obscure the meaning of a ranking and complicate the construction of synthetic indices, a complex matter as it is. Following a criterion of (relative) simplicity, four areas have been studied in each of the three large dimensions aforementioned:

- *Resources* available
- *Output* obtained
- *Quality* (particularly in the results and in some cases, resources and processes)
- *Internationalization* of the activities

The main reference to assess universities should be the results, but these can be studied both from the perspective of total volume as well as the efficiency achieved in obtaining them. In economic terms, while output considers the volume or quantity of results obtained, productivity measures the link between volume of results and resources used[7].

To assess the results, it is also important to take into account their quality. If there were a market that assessed the differences in quality, then results showing a higher quality would have a higher price. These prices hardly exist in the area of public universities, but some indicators can supplement, in part, this information. Thus, for example, there are indicators on the quality of teaching and research and also on a very relevant feature today regarding the specialization (and quality) of universities: their internationalization.

Each of the four areas mentioned has been analyzed using a series of indicators. For each area, between one and three indicators have been taken into account, depending on the availability and suitability of data, and according to the dimension that is being studied.

[7] It should be clarified that the variables classified under the heading *available resources* are not used as the denominator of the calculation of productivity, dividing them by the indicators of output, quality, or internationalization. In fact, some indicators of the resources group can be considered university achievements, for example income gained in a competitive manner. Productivity is analyzed in all areas and in each dimension —teaching, research, innovation and technological development— relativizing each indicator by the appropriate variable. For example, in the area of competitive public resources for research, resources are relativized by the number of faculty members equivalent to full-time, on the grounds that this ratio measures the ability of university fundraising.

Table 2. List of indicators, areas and dimensions

Dimension	Area	Indicator
Teaching	Resources	Faculty member with PhD per 100 students
		Budget / Student
		Faculty member with PhD / Faculty members
	Production	Success rate
		Evaluation rate
		Drop-out rate
	Quality	Attractiveness index
		Percentage of postgraduate students
		Cut-off marks[1]
	Internationalization	Percentage of foreign students
		Percentage of students in exchanges programs
		Percentage of students registered in programs imparted in non-official languages
Research	Resources	Competitive public resources per faculty member with PhD
		Contracts with PhDs, research grants and technical support over total budget
	Production	Citable documents with ISI reference per faculty member with PhD
		Total *sexenios*[2] over possible *sexenios*
		Doctoral theses completed per 100 faculty members with PhD
	Quality	Mean impact factor
		Percentage of publications in the first quartile
		Citations per document
	Internationalization	European or international research funds per faculty member with PhD
		Percentage of publications with international co-authorship
Innovation and Technological Development	Resources	Income from licenses per 100 faculty members with PhD
		Income from consultancy contracts per 100 faculty members with PhD
		Income from CPD[3] courses per faculty member with PhD
	Production	Number of patents per 100 faculty members with PhD
		CPD hours per faculty member with PhD
		Number of contracts by faculty member with PhD
	Quality	Commercialized patents per faculty member with PhD
	Internationalization	Triadic patents per 100 faculty members with PhD
		Income from international contracts per faculty member with PhD

[1] Mark of the last student who gained admission to a degree with limited places. [2] Monetary compensation received for research activity based on the last six years.
[3] Continuing professional development.

Source: Own elaboration.

Table 2 shows the indicators studied, after analyzing the availability of data and discussing alternatives with the group of experts working on the project. Agreements were reached by analyzing the suitability of each indicator in capturing significant data on the area and dimension it forms part of it.[8] It is important to stress that the data used is obtained from sources allowing the project database and the rankings based on it not to require universities to provide data directly to ISSUE.

The logic underlying this selection of indicators, disclosed in summary form, is the following:

Teaching

- Teaching *resources* are characterized by budgetary allocations per student, and teaching and research staff per student, with special attention paid to faculty members with PhD
- Teaching *productivity* is measured by using results obtained by students, analyzing how many students undergo evaluation, how many succeed in those evaluations and how many drop out.
- The *quality* of teaching is very difficult to observe at present, but we studied as a proxy the ability to attract students from other provinces, the quality of students as measured by the cut-off mark of each area and the percentage of postgraduate students.
- The *internationalization* of teaching is shown by the percentage of foreign students, the percentage of students in exchange programs and by courses offered in non-official languages.

Research

- The *research* process is characterized by two types of resources: competitive public resources which are achieved, and the provision of research staff, scholarships and qualified technical support.
- *Output* is accounted for by citable papers published in each area, in the six years of research work that are achieved with these publications, as well as in the number of doctoral theses, which are an indicator of the training activity of a researcher in a given area.
- The *quality* of the research is reflected in the impact the publications have and the citations that these papers generate.
- Finally, a greater proportion of international publications, international co-authoring and the percentage of research funds from external sources indicate a greater *international* vocation in research activity.

Innovation and technological development

- The *resources* studied cover the three main activities of innovation and technological development: income from patents, income from consulting contracts and income from continuing professional development.
- In terms of measurement of gross *output* in these activities, the total number of patents, the hours of professional development and the number of contracts for services.
- As an indicator of *quality*, due to the limited availability of data, only patents that are commercialized by faculty members with PhD are included.
- The *internationalization* of the transfer of knowledge is reflected through triadic patents (valid in Europe, US and Japan) and income for international contracts.

The list in Table 2 defines an objective, which aims to be completed in the medium term, given that not all the ideal data is available today. In part, this is due to the ongoing process of adaptation of the Spanish university system to the European Higher Education Area (EHEA), which will end briefly, but there are also other data deficiencies in certain areas[9]. In fact, the project

[8] In order to ensure the transparency of the process in developing indicators, the definition of each indicator, its source and its time frame are all included in Appendix 1 and in the following website of the project: www.u-ranking.es.

[9] Specifically, the following variables are not taken into account for reasons of availability or quality of data: Index on Attraction Capacity, percentage of students in non-

includes ample space for the improvement of data, especially in the different areas of innovation and technological development.

In this sense, the second edition of *Rankings ISSUE* already contains some of these improvements thanks to the inclusion of new indicators and data sources. The 2013 version contained 23 indicators. In 2014, as shown in Table 3, two new indicators have been incorporated, making a total of 25 indicators of the 31 defined in Table 2.

Table 3. Indicators and level of disaggregation of the 2013 and 2014 ISSUE rankings

	2013 Ranking	2014 Ranking
Defined indicators	31	31
Used indicators	23	25
Degree level[1]	5	8
Area of study level	1	1
Branch of knowledge level	9	7
University level	8	9

[1] Bachelor's degree or Bachelor's degree group. The category 'bachelor's degree group' is the result of aggregating more than 2500 degrees offered by Spanish public universities for the 2013-1014 year into 126 groups.

Source: Own elaboration.

The first new feature is that we have included an indicator on innovation and technological development which measures income generated through continuing professional development per professor. This indicator takes the average result for 2008 and 2010 of the *liquidated rights which are generated from tuition fees for continuing professional development (CPD) courses (courses to improve employability)* and *own postgraduate programs per faculty member with PhD* data offered by CRUE in their 2010 and 2012 reports.

Another new development is that data on research staff contracts has been included. This addition was made possible thanks to the collaboration of the Spanish Ministry of Economy and Competitiveness which, through the General Directorate of Scientific Research and Technology (DGICT), provided information about the aid granted to universities in the calls for the period 2007-2012. Thanks to their contribution, the indicator *PhD staff Contracts, research grants and technical support over the total budget* has been added and the information regarding the indicator *Competitive public resources per faculty member with PhD* (compiled in the 2013 Ranking ISSUE with data from CRUE 2008) has been improved.

The possibility of being able to count on more up-to-date information, a more extensive time series and greater level of disaggregation has meant that another 4 indicators have come to use another data source. As a result, the indicators *Percentage of foreign students, Percentage of graduate students* and *Doctoral theses read per faculty member with PhD* have been calculated from the new information published by the Spanish Ministry of Education, Culture and Sport which in recent years has made a huge effort to develop an integrated system of information (SIIU). In addition, like the rest of the indicators on scientific output, the *Scientific papers with ISI Reference* have been updated from the data supplied by IUNE Observatory instead of CRUE.

In addition, we have studied again the inclusion of data on graduate employability as an indicator on the quality of professional development. This information would be of great interest, but does not exist at present. Although there are already numerous universities that are trying to follow their graduates through their professional lives, methodology and criteria followed are not homogeneous, and thus comparing the data is not possible. Moreover, although tax sources (AEAT and Social Security) could constitute another valuable source of information, statistical confidentiality legislation makes it difficult to obtain this data. During the last year the Spanish Ministry of Education, Culture and Sport has launched a project in order to publish a range of indicators on employability according to degree and university. As these indicators are made public, the Rankings ISSUE will be able to count on this information and it will be included within its framework of indicators.

official language programs, hours of continuing professional development, number of professor contracts and number of patents commercialized per PhD Professor. The relationship between indicators used will be adjusted as the availability of quality information increases and is consolidated.

3.4. TIME COVERED BY THE DATA

University rankings, though they aspire to offer an image of the current position of each institution, cannot be conceived of as a snapshot of a given year. Many of the indicators have the character of a flow, and as such, can present high variability from year to year, both in the quality of the information and in the distance between the reality and what the information reflects. Other indicators reflect the accumulation of results over long periods of time.

The rankings referred to usually recognize this problem by taking comparison periods longer than a single year, either taking moving averages (like the 5 or 10 years of the ISI Rankings of the Universidad de Granada) or even considering the complete history of the University (as in the case of the treatment of the Nobel Prize and Fields Medal winners in the Shanghai Ranking). This methodological approach provides greater interannual stability of the rankings and permits specific random disturbances to be smoothed out by considering a longer time range.

Our approach aims in this direction and, as information becomes available, we will converge towards a 6-year moving average for nearly all the indicators. In the ranking for 2013 most indicators linked to research and to innovation and technological development, taken from Thomson-Reuters and the OTRI network, were calculated as a mean of six years. On the other hand, in many of the teaching results only one single datum was available, taken from the report *La Universidad Española en Cifras* (2010). Thanks to the collaboration of the CRUE, which has supplied the data by university of the new report *La Universidad Española en Cifras* (2012), the ranking for 2014 also contains the data corresponding to the 2010-2011 academic year. Within two years the process of transition will have been completed, as the next report will have been incorporated and thus 6 years of university information will be covered. As further years become available, they will be incorporated into the moving average so as to finally have a chart that is completely coherent on the temporal plane.

Further, as remarked above, two indicators relating to teaching, and doctoral theses and competitive resources have been obtained from data supplied by the corresponding Ministries as they present a longer time series.

Table 4 shows the updating in terms of years and time series registered by the indicators used in the ranking for 2014 compared to those for 2013, and permits us to observe that the improvements introduced in this sense are important. One variable in which the information lag is worrying is that corresponding to the *sexenios* (monetary compensation received for research activity based on the last six years) obtained compared to the potential awards. Unfortunately the steps taken to update it have not produced results, although it would be easy —and useful— to do it annually on the basis of the information held by the CNEAI. We trust we will be able to introduce improvements in this sense in the next edition.

The described orientation of the methodology on which the calculation of the ISSUE Rankings is based leads one to expect that the rankings of universities will not present, from one year to another, sudden changes. The existence of a certain inertia in the rankings seems to be a desirable property of them, since the quality of university institutions does not change radically in the short term, though some of their annual results may do so.

We have tried to respect the same structure —Resources, Output, Quality and Internationalization— within each dimension, as we consider that symmetry in the conceptual approach permits greater comparability and coherence, as well as a possible identification of the strengths and weaknesses of each institution. Nevertheless, the availability of information conditions the effective achievement of this objective. Indeed, the “output and quality of Technological Development and Innovation” are found in the current version without some of their indicators. Although information is available for certain of their indicators, the quality of it is very dubious and, far from improving the results, compromises them by adding an excessive variability. To the extent that this quality increases and it is possible to incorporate the information into the results, the option of including it will be reconsidered.

Table 4. Time series used in the 2013 and 2014 rankings

Dimension	Area	Indicator	2013 Ranking	2014 Ranking
Teaching	Resources	Faculty member with PhD per 100 students	2008-09	2008-09 and 2010-11
		Budget / Student	2008	2008 and 2010
		Faculty member with PhD / University teachers	2008-09	2008-09 and 2010-11
	Production	Success rate	2008-09	2008-09 and 2010-11
		Evaluation rate	2008-09	2008-09 and 2010-11
		Drop-out rate	2008-09	2008-09 and 2010-11
	Quality	Attractiveness index	-	-
		Percentage of postgraduate students	2008-09	2009-10 to 2012-13
		Cut-off marks[1]	2012-13	2013-14
	Internacionalization	Percentage of foreign students	2008-09	2010-11to 2012-13
		Percentage of students in exchanges programmes	2008-09	2008-09 and 2010-11
		Percentage of students registered in programmes imparted in non-official languages	-	-
Research	Resources	Competitive public resources per faculty member with PhD	2008	2007-2012
		Contracts with PhDs, research grants and technical support contracts over total budget	-	2007-2012
	Production	Citable documents with ISI reference per faculty member with PhD	2008	2006-2011
		Total *sexenios*[2] over possible *sexenios*	2009	2009
		Doctoral theses completed per 100 faculty members with PhD	2008	2008-2011
	Quality	Mean impact factor	2006-2010	2006-2011
		Percentage of publications in the first quartile	2006-2010	2006-2011
		Citations per document	2006-2010	2006-2011
	Internationalization	European or international research funds per faculty member with PhD	2008	2008 and 2010
		Percentage of publications with international co-authorship	2006-2010	2006-2011
Innovation and Technological Development	Resources	Income from licenses per 100 faculty members with PhD	2006-2010	2006-2011
		Income from consultancy contracts per 100 faculty members with PhD	2006-2010	2006-2011
		Income from CPD[3] courses per faculty member with PhD	-	2008 and 2010
	Production	Number of patents per 100 faculty members with PhD	2006-2010	2006-2011
		Hours of CPD per faculty member with PhD	-	-
		Number of contracts by faculty member with PhD	-	-
	Quality	Commercialized patents per faculty member with PhD	-	-
	Internationalization	Triadic patents per 100 faculty members with PhD	2006-2010	2006-2011
		Income from international contracts per faculty member with PhD	-	-

[1] Mark of the last student who gained admission to a degree with limited places. [2] Monetary compensation for research activity based on the last six years. [3] Continuing professional development.

Source: Own elaboration.

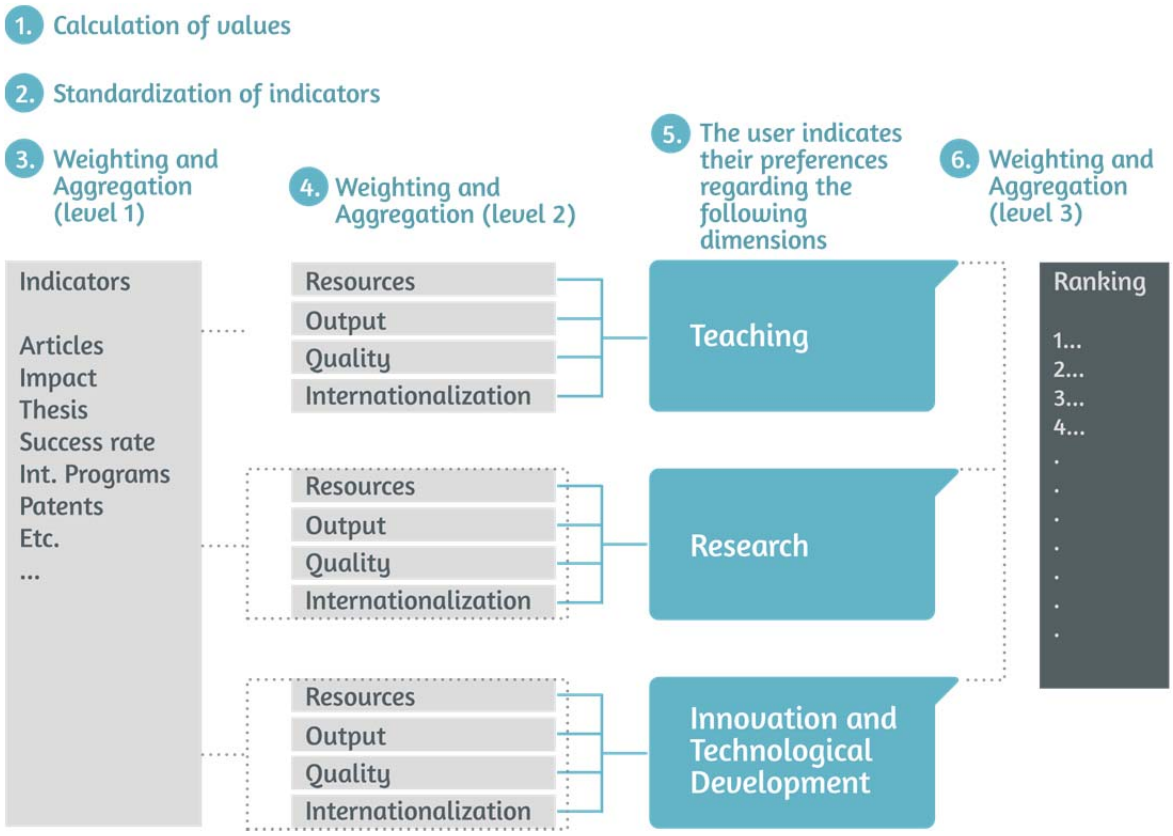
3.5. CRITERIA FOR THE CONSTRUCTION OF INDICATORS

Key to being able to trust the meaning of the rankings is that the processes on which they are based should be transparent and respect the foundations established by statistical publications for the construction of indicators. These criteria have been respected by the project team, contacting specialists in the subject and analyzing the methodological principles established in the specialized literature, especially in the *Handbook on constructing composite indicators: methodology and user guide* (OECD 2008).

The underlying process of drawing up any of the rankings of universities constructed is structured according to the following steps —the fifth step being unnecessary in the case of the partial rankings of teaching, research and innovation and technological development:

1. Preparation of the data bank and estimation and allocation of missing values
2. Standardization of indicators
3. Weighting and aggregation of indicators within the areas of each dimension
4. Weighting and aggregation of area indicators, within the dimensions
5. Weighting and aggregation of the dimensions
6. Obtaining of rankings

The following scheme graphically illustrates the time sequence of the steps. To complete each of them it is necessary to solve the corresponding technical problems, as described below and dealt with according to the approaches indicated.



3.5.1. Allocation of missing data

The starting point for any ranking is to have available the necessary information on the variables to be considered in order to construct each indicator. A first technical problem to be solved is the treatment of the data missing from certain universities in some of the variables to be used. For example, the number of theses read in the last year in a particular university may not be available. Such gaps may be due to several factors, whether technical (an error in loading the data), or of availability (the university may not have generated certain information or not done so in time) and even strategic (a university may opt not to give certain information because it is not in its interests to do so).

Not to face this problem rigorously would condition the comparability of the universities, the quality of the aggregate indices, and the final results. Specifically, to calculate the ranking ignoring such missing information would be equivalent to allocating a value for that variable equivalent to the mean of the rest of the variables forming the dimension, which is especially problematic if it is the university itself that does not reveal the information for strategic reasons, as that mean value might favor it. On the other hand, to calculate the ranking on the assumption that the real value of the missing variable is zero would be to penalize the university unfairly if there has been a technical problem of data availability or of deadlines.

To estimate and allocate the missing values of each variable we have proceeded as follows:

1. From a matrix of correlations[10] we identify, for each variable, the two variables with the highest correlation (in absolute terms) and associate them with the variable to be estimated.

2. We estimate a linear model (by minimum squares) between the variable to be allocated and the two most correlated variables —that is, those which the variable to be estimated had the highest absolute correlation. For the estimation of this model we use only the information from the same area of study, thus acknowledging the different operational situation of each subject area in the areas studied.

3. From the parameters estimated in the above model we calculate the estimated value of the missing variable, using the said parameters and the existing information for that university in the related variables.

For example, let us suppose a university for which there are no data on doctoral theses directed by a faculty member with PhD (T) in an engineering degree. After analyzing all the variables of the Spanish universities we observe that, within the engineering degrees, the theses directed are highly correlated with the research *sexenios* obtained as a proportion of the total of possible *sexenios* of its teaching staff (S) and also with the percentage of postgraduate students of that university (P). On the basis of this ratio, $T = f(S,P)$, we estimate linear model $T = a_0 + a_1S + a_2P$. Once the values of a_0, a_1 and a_2 have been estimated, the theses directed in that engineering degree of that university are estimated from the data available on *sexenios* and postgraduate students.

3.5.2. Standardization of indicators

One of the pillars upon which the construction of synthetic indicators rests is the proper standardization of the information, that is, its transformation in order to homogenize it and make possible its comparison and aggregation. There are numerous systems of standardization, such as the Gaussian (subtracting from each variable its arithmetic mean and dividing by its standard deviation), relative order (ordering the values according to their relative value), distances from the mean or the median, and the ratio between the variable and its mean or its median.

It is important to emphasize that the method of standardization chosen must be in consonance with the method of aggregation to be used subsequently. Because as a general rule the geometric aggregation method has been chosen, requiring the value of the standardized variables to be positive, we must exclude the Gaussian and

[10] The correlations matrix is constructed by calculating, for each possible pair of indicators, their linear correlation coefficient.

absolute distances from the mean and from the median, which necessarily generate negative values, as alternatives of standardization.

For this reason, the standardization method chosen is the calculation of the ratio between the variable and its median. Taking into account that the median is the value separating each distribution into two halves, the standardized results will be centered on the value 1: values below the median are bounded between 0 and 1, while those above will be greater than 1.

3.5.3. Weighting and aggregation of indicators within an area

Once the missing values have been allocated and the basic indicators standardized, we aggregated these to obtain a first synthetic indicator for each area. Thus, for example, to obtain the value of the indicator for the *quality* area in the *Research* dimension we aggregate the standardized values of the *Mean impact factor of publications* and the *Percentage of publications in the first quartile*.

As in the case of standardization, there exist numerous aggregation procedures, such as the arithmetic, the geometric or those based on factor analysis. The choice of one method or the other has implications in aspects like the substitutability of the indicators or the importance of extreme values (both large and small). So the aggregation criterion chosen implies a weighting of the indicators, which is important to bear in mind.

It must be taken into account that some universities might have zeros in some indicator of a specific area (for example, they may not possess *Triadic patents*). For this reason we have opted in this phase for an arithmetic aggregation, ruling out the geometric aggregation because the presence of a zero in the product would cause the whole area analyzed to take a nil value.

As the weighting of the indicators indicates the importance assigned to each variable when aggregating it into a synthetic indicator, we also reflect on this question. This is a classic problem in the construction of such indices and generally requires a judgment on the relative importance of each element. In the case of economic aggregates the weights are offered by prices — which reflect the market valuation of the goods, services or factors exchanged— but in many other cases there are no prices and the indicators have to be constructed following other criteria, frequently based on subjective opinions.

There are three possible approaches to weighting: 1) assignation of identical weights (which also implies a judgment, since the weight of one indicator is conditioned by the number of indicators included); 2) consultation among experts to identify the most widely held opinions (by means of surveys or methods such as the Delphi); 3) weighting according to the user's preferences. These three alternatives have been used in each case according to the level of aggregation to be achieved.

At this first level of aggregation (of simple indicators into synthetic indicators for each area) we have opted for the first system, that is, equal weighting. This is because in most cases the indicators capture different aspects of the area analyzed, but there are no clear arguments for granting one of them greater or lesser importance. Also, the nature of the information captured in each indicator is fairly homogeneous and in that case there is less interest in giving greater weight to one indicator or another, because in many cases they are correlated. This occurs, for example, in the case of the mean impact of publications index and the percentage of these in the first quartile. Consequently, the different simple indicators will enter into the calculation of the arithmetic mean with the same weight.

3.5.4. Weighting and aggregation of the area indicators within each dimension

At the second level of aggregation the indicators of the different areas are grouped into an indicator for each of the three dimensions considered: teaching, research, and innovation and technological development. At this stage there are reasons for following a different aggregation criterion, as after the arithmetic aggregation of the previous stage no area indicator presents zeros.

Table 5. Weights by area

	Resources	Production	Quality	Internationalization
Teaching	25.4	30.4	23.9	20.3
Research	20	30	30	20
Innovation and Technological Development	34.2	26.3	21.1	18.4

Source: Own elaboration.

This stage proceeds by means of a *geometric* aggregation method. Among the most interesting properties of geometric aggregation is that it limits the substitutability among the components that it aggregates. In other words, geometric aggregation penalizes those universities that have neglected any of the four transversal areas (*Resources, Output, Quality, Internationalization*) as against those that attend to them in a balanced manner.

As to the weight to be given to each area within each dimension at this second level of aggregation, we decided to carry out a survey of university experts, applying the Delphi method, instead of granting them the same weight, as in the previous stage.

One reason for changing the criterion is that if all the areas were aggregated with the same weight, this being a geometric mean the number of areas considered would influence the result. For example, if we had decided to group the indicators of quality and internationalization in a single area, their influence on the dimension would have been less than if considered separately. Another reason is that, unlike what occurred with the basic indicators, in this case there may be reasons to grant different values to each of the areas. Thus the decisions on the number of areas to be considered and their weights are relevant, and we have preferred to ask experts about the importance that should be given to each area. To make this valuation easier we followed the criterion that the number of areas should be small, and similar within each dimension.

Table 5 shows the weights given to the different areas by the experts consulted[11].

3.5.5. Weighting and aggregation of the dimensions to obtain the rankings

The last phase of the methodology establishes how the different rankings of the ISSUE project are drawn up. This offers university rankings of each of the three dimensions separately, but for this it is no longer necessary to take any further step beyond those described in the above sections. On the other hand, to draw up the rankings combining the three dimensions it is necessary to perform a new aggregation and, once again, decide the most reasonable criteria for doing so.

In the transition from the dimensions to the final ranking we consider that the importance attributed to each dimension can be very different depending on the interests of the people contemplating the ranking, that is, of its potential users: students, researchers, managers, society. For this reason, we have come to the conclusion that the user's perspective can be key to giving more or less importance to each of the dimensions. It could be unconvincing to impose weights from a specific standpoint —for example, that of a group of experts, who consider that research is the most important— especially for individuals with another standpoint, for example, for students or careers guidance staff who consider that it is more important to attend to the teaching aspects.

After due reflection, therefore, we have opted to consider two alternatives.

[11] Two rounds of consultation were carried out, after which a reduction of 2.1 percentage points was obtained in the mean interquantile range.

1. First, rankings of Bachelor's degrees offer the option of the system earlier described as personalized ranking, based on the user's own preferences. We understand that in this case users are more likely to seek to compare the universities with fairly closely defined interests and diverse criteria, probably different from those of the experts. For this reason, with the help of a web tool, users can state the importance for them of each of the three dimensions when placing the degrees in order, and the tool automatically offers them the ranking corresponding to the preferences revealed by the user.

   To apply this first approach we have considered various alternatives for the choice of weights by the user. We opted for the procedure known as Budget Allocation Process, that is, for the distribution by the user of 100 points among the dimensions to be valued. This method, widely used in marketing to find out a consumer's valuation of the characteristics of a product, has the principal advantage of forcing the user to adopt a more active and reflexive position by having to distribute the points, being therefore more aware of the opinion that he/she displays.

2. Second, for the general rankings, corresponding to the universities' activities as a whole, the three dimensions are weighted on the basis of the experts' opinions, according to a survey such as that mentioned above when aggregating areas into dimensions, and a Delphi process to achieve convergence among the experts' opinions.

The weights finally granted to teaching, research, and to technological development and innovation, are those corresponding to the Delphi among the experts, respectively 56%, 34% and 10%.

3.6. RANKINGS OF VOLUME OF RESULTS VS. RANKINGS OF PRODUCTIVITY

When comparing universities, it is relevant whether or not their size is taken into account. Making one choice or the other is not in itself a methodological advantage or failure, but implies adopting a particular perspective which affects the rankings and must be borne in mind when interpreting the results.

In the same way as when analyzing the activity of a firm or a country we can consider its volume of output or its productivity, and both positions are reasonable, so it occurs in the case of analysis of the results of universities. Neither of the two approaches is, *a priori*, more valid than the other, and the choice depends on the intended use of the results. Likewise the per capita GDP is more useful than total GDP when comparing the quality of life between countries or regions, but the volume or the growth of GDP are also important for explaining, for example, the employment generated. So, although in some cases productivity may be more important than output, the size may also be relevant. A very productive and large university is more beneficial for society than a very productive but small one; likewise, a very large but unproductive university is a much bigger problem than an unproductive but small one.

3.6.1. Interest of the two approaches

The existing rankings adopt on occasions an approach based on productivity and in other cases on the volume of results. For example, some of the most cited international rankings — especially, the Academic Ranking of World Universities (ARWU), known as the Shanghai Ranking— are volume rankings.

The Shanghai Ranking can be said to be one rather of volume, because most of the variables from which it is built —number of Nobel prize-winners or Fields medalists among their ex-students or staff, widely cited researchers, publications in Nature or Science, articles

published in indexed journals— are not relativized by the size of the university. Such variables form the greater part of the weight in the ranking, while only one —an indicator of academic performance— is expressed in *per capita* terms. So, the universities' positions are conditioned both by their quality and by their size, both qualities being necessary for reaching good positions in this ranking.

Other rankings, on the other hand, make their comparisons from the point of view of productivity. Such is the case of the QS World Universities Ranking, whose indicators are taken from surveys of academic reputation or are variables standardized by size. There are also examples of rankings that expressly contemplate both approaches, and make differentiated comparisons based on productivity or on the total volume of results, as does the I-UGR Ranking of research results (www.rankinguniversidades.es).

The reason for acknowledging the interest of both approaches is that the size of institutions can be relevant for valuing the contributions of the universities, but correcting the results for size permits us to compare the universities from a perspective that makes them, in a certain sense, more homogeneous. However, since it has already been pointed out that it is not the same for the university system that a university of high (low) quality is large or small, we should ask whether the universities' positions would be the same in terms of productivity as in terms of volume of results and underline the specific meaning of both rankings. To sum up:

- The rankings of volume of production are based on indicators not relativized by size, and depend on both the university's productivity and its size. Thus, a university may generate a greater volume of research results than another of smaller size, even though the second is more productive.

- The productivity rankings are based on indicators of results corrected by size, and seek to measure the output per unit of inputs or resources used. For example, scientific output is measured as a function of the number of faculty members with PhD and the teaching results are relativized by the number of students. This enables some smaller universities to obtain a better final result in the ranking than other much larger ones.

An interesting question is whether size influences productivity positively or negatively, that is, whether productivity increases or decreases with the size of the university. In the first case, the universities' positions in the rankings of volume would be favored by two factors (size and productivity). The testing of the two hypotheses is an empirical matter, which can be analyzed by drawing up both types of rankings using the same approach, as the ISSUE project does. This test will be presented later.

3.6.2. Treatment of the size of universities

The selection of simple indicators with which we started implies that all are relativized depending on the variable considered most appropriate (students, faculty members, budget, etc.), so that size does not have a direct influence on the results. Consequently, the general scheme of the methodology described leads to measuring each university's results independently of its size, so these are rankings of productivity. Therefore, to construct rankings of volume of results, the size has to be included with the indicators hitherto described. This task has been undertaken following the criteria detailed below.

The first criterion for introducing the role of size into the system of rankings defined in the rest of the project is to preserve, as far as possible, the methodological homogeneity of both rankings, calculating them on the basis of the same set of indicators and with the same aggregation criteria. This criterion makes it advisable not to draw up the ranking of volume simply by not relativizing those indicators that can be expressed in total terms —for example, reflecting the income from patents or the doctoral theses read without dividing them by the number of faculty members with PhD— as the Shanghai Ranking does.

The reason for not proceeding thus is that some variables like those cited can be presented in absolute terms but others cannot, being rates or indices —such as the percentage of publications in the first quartile or the mean impact of

publications factor—. If some variables are expressed in absolute terms and others are not, the relative importance of the size within the results would fall only on the variables that can be expressed in absolute terms. In that case, the importance accorded to size would depend implicitly on the proportion of those variables that can be expressed in absolute terms. For example, in the variables considered in our study only 13 of the 25 indicators finally used could be expressed in absolute terms, which would be equivalent to the acknowledged importance of size being 52%. This percentage would be arbitrary because it would only reflect the proportion of indicators that form part of the database and can be expressed in absolute terms.

So this solution is unsatisfactory, and we have explored other alternatives for introducing size. The option chosen consists of calculating the total volume of results of each university by multiplying the productivity index by a measure of size. We have considered three indicators of the size of a university: the number of faculty members, the number of students, and the budget. Each one has its specificities and can be a better proxy of different aspects of the university's activity that do not have the same importance in each of them. To avoid skewing the size proxy in one or other direction in the most general indices —which could favor some institutions by giving greater weight to one of the aspects— we have taken as indicator of size the standardized arithmetic mean of the three variables.

4. Rankings personalized by the user

The appropriate response to one of the problems posed by the aggregation of information and analyzed in the previous point —the importance assigned to each of the aspects of a complex problem when evaluating it— may depend on the user. Certainly, different dimensions exist in the performance of the universities, but the profiles of users interested in them are also different: undergraduate or postgraduate student, teacher, manager, member of the governing team or of the Board of Directors, head of university policy in the Public Administration, journalist, interested citizen, etc. The importance granted by each of them to the different activities of the universities may be different and also their interest may focus on one or more of their activities in particular. For example, students are likely to focus their interest on those aspects of the university related with the degree that they wish to study.

Given the high number of users that might value the universities' activity from this particular viewpoint, it makes sense to consider the possibility of drawing up personalized rankings, established taking into account the specific interest from which the user contemplates the universities. The ISSUE project considers this question for the case of Bachelor's degrees, in order to offer a tool to facilitate for students, their families and careers advisers, information on the ranking of degrees, taking into account their specific interests.

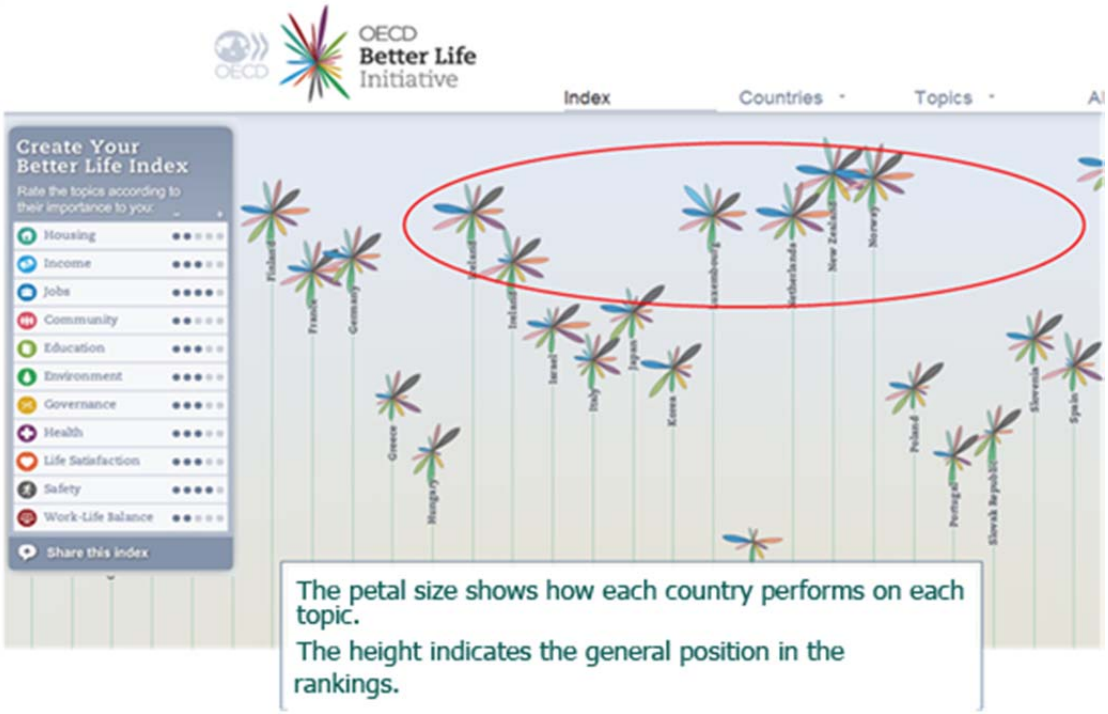
4.1. EXAMPLES OF PERSONALIZED RANKINGS

The possibility of constructing synthetic indicators acknowledging the preferences of users has been possible for a relatively short time, thanks to the interactivity permitted by web tools. Through them, the user can value for him/herself each one of the dimensions considered, indicating which areas he/she wants to consider and which are the most important for him/her. Web technology allows these preferences revealed by the users to be incorporated and combined with other elements contributed by the experts, such as the selection of variables and the combination of them in intermediate indicators according to criteria of aggregation like those described in section 3.

Two interesting examples of this approach, referring to very distinct areas, are those corresponding to the quality of life index Better Life Index, drawn up by the OECD, and the CHE Ranking, a ranking of university degrees drawn up by the German Center for Higher Education.

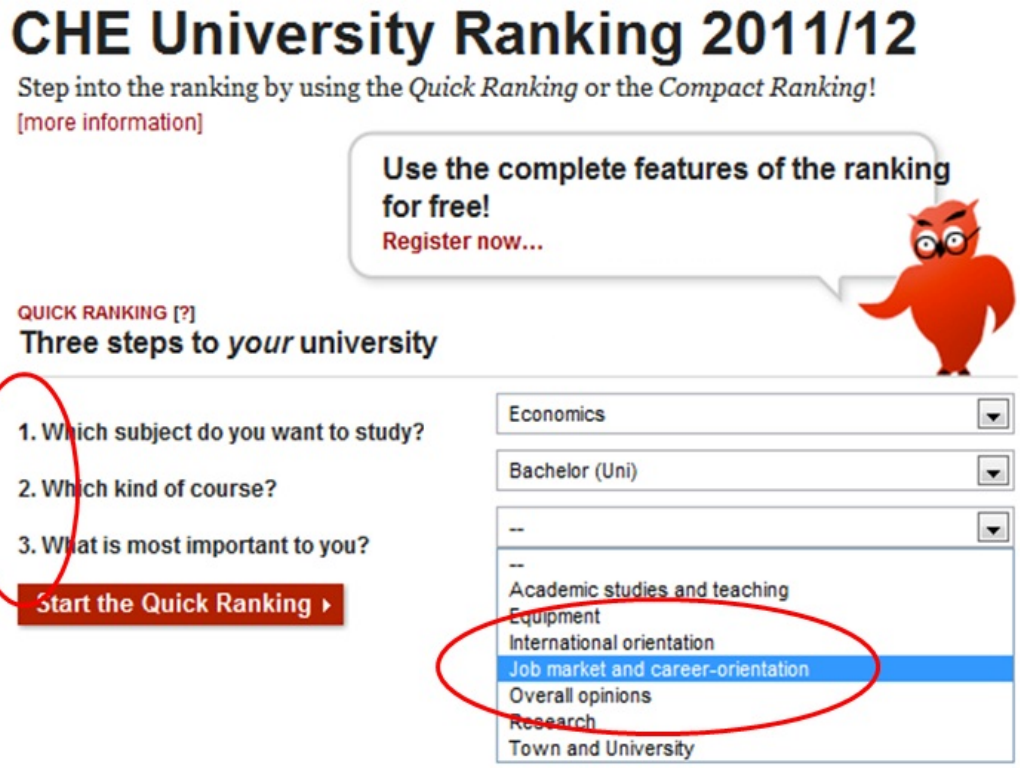
The OECD draws up a synthetic index that allows countries to be ranked according to their characteristics in various areas relevant to the quality of life (access to housing, income, education, security and safety, etc.), according to the aspects most valued by the user. These valuations are introduced through the website, on which a score must be assigned to each one of the dimensions of quality of life considered.


OECD
Better Life
Initiative
Index
Countries
Topics
Create Your Better Life Index
How do you define a better life? Use our interactive tool to see how your country performs on the topics you feel make for a better life.
Start with all topics rated equally
or set your own preferences here.
Create Your Better Life Index
Rate the topics according to their importance to you:
Housing
Income
Jobs
Community
Education
Environment
Governance
Health
Life Satisfaction
Safety
Work-Life Balance
Share this index
Belgium
Canada
Chile
Czech Republic
Denmark
Greece
Hungary
Iceland
Ireland
Mexico
Netherlands
New Zealand
Norway
Poland
Sweden
Switzerland
Turkey


OECD
Better Life
Initiative
Index
Countries
Topics
Create Your Better Life Index
Rate the topics according to their importance to you:
Housing
Income
Jobs
Community
Education
Environment
Governance
Health
Life Satisfaction
Safety
Work-Life Balance
Share this index
The petal size shows how each country performs on each topic.
The height indicates the general position in the rankings.

The experts prepare the set of relevant dimensions and variables and, after the user has introduced his/her valuation of each area, the web tool shows a synthetic index of quality of life that takes into account the weights awarded by the user.

A similar approach is used by one of the university rankings analyzed, the CHE Ranking, drawn up by Germany's Center for Higher Education for the journal *Zeit*. In this case the user considered is the student who wishes to choose a degree, and he/she is offered the possibility of choosing the subject he/she wishes to study, the type of course that interests him/her and the aspects that he/she considers most important (the teaching, the subsequent employment opportunities, research, etc.).



4.2. DESCRIPTION OF THE WEB TOOL FOR GENERATING PERSONALIZED RANKINGS OF DEGREES

This personalized rankings approach has been incorporated into the ISSUE project to arrange degrees in order, constructing rankings of universities for the different Bachelor's degrees. In the future it is intended to extend this approach to other aspects of university activities, in particular to Master's degrees, when the necessary databases are available.

The value of a tool like this depends greatly on the effort made to facilitate its use. The objective of the ISSUE project is to present the user with a simple intuitive tool to minimize the number of clicks needed to obtain the relevant information, which is above all the corresponding ranking. This ease of use must be present both when limiting the degrees to be compared and when permitting the user to declare his/her preferences in order to draw up the personalized rankings.

The opinion as to when a user-friendly procedure has been achieved must also take into account the user's point of view. Therefore, to harmonize the tool with the most frequent potential users we performed trials among students of 17-18 years, who furthermore represent a type of users less familiar with the concepts of the university world than the experts participating in the project. On the basis of these trials the necessary corrections were made to the tool in order to adapt it better to the users and make understanding of the results easier.

The tool is presented on the screen of the project's website via the *Select University* tab. When this part of the screen is clicked, it shows the three questions that must be answered in order to obtain a ranking of a university adapted to the interests of the student in three aspects:

- *What to study*
- *Where to study*
- *Study and research*

When each of the three questions are clicked, a selection box opens in which the user has to choose, respectively:

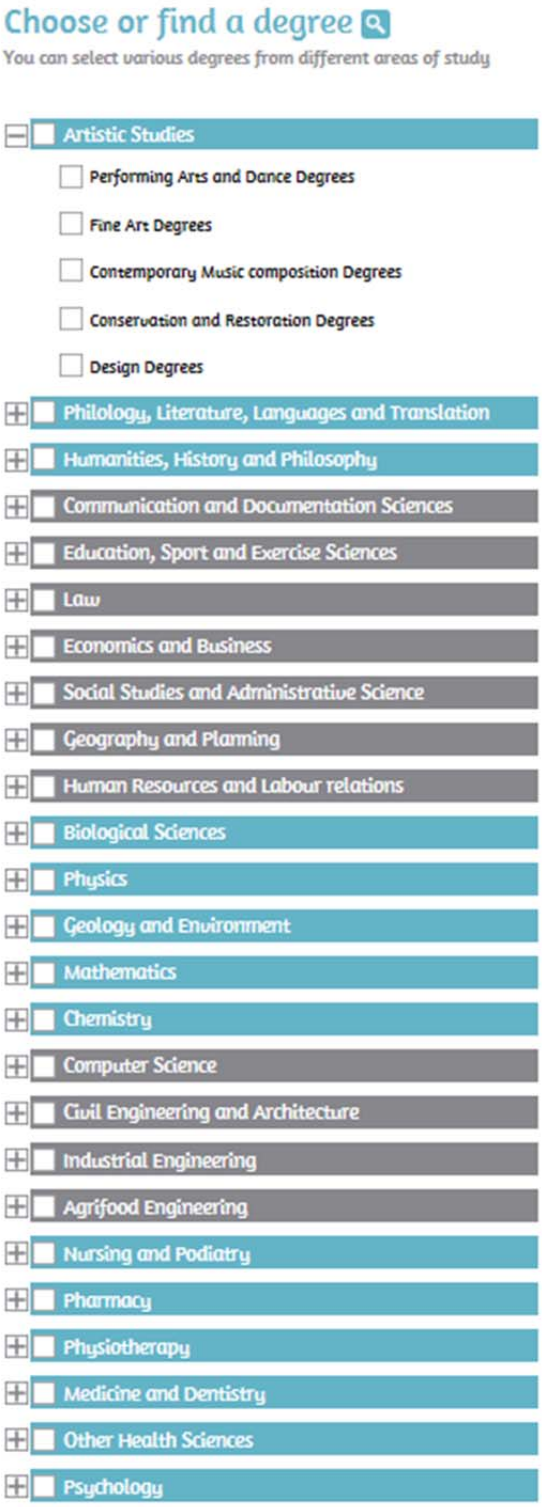
- The Bachelor's degree or degrees that he/she wishes to study
- The autonomous community or communities whose universities he/she wants to compare
- The importance for the user of the teaching, research and innovation and technological development activities.

The user can choose either one or several options in the first two questions (one or several degrees; one, several or all of the autonomous communities).

To avoid having to make the choice among the over 2,500 different Bachelor's degrees offered by Spanish universities, the first selection window shows them grouped into 25 *areas of study*.

When one of these areas is clicked, a drop-down list is displayed showing the Bachelor's degrees that it contains. Thus, when the "Artistic Studies" area of study is selected the Bachelor's degrees contained in this area of study are displayed.

The names of the degrees that appear in the drop-down list are not exhaustive or literal either, as those Bachelor's degrees with very similar names have been grouped, as for example "Humanities" and "Humanities and social studies" have been grouped under the name "Humanities Degrees". In this way the initial more than 2,500 Bachelor's degrees have been reduced to 126, to make the user's decision easier. However, irrespective of this initial reduction, the final results do show the complete title of the degree, as well as the center where it is taught whenever there are various options.



The second step is to choose the autonomous community or regions that are being considered as places in which to study. For this, the user must mark those chosen on the following table, one of the options being “Any region”. The option of restricting the search to specific autonomous communities is a response to the fact that many students do not contemplate geographical mobility as an alternative, or contemplate it restrictively. In this case, their interest will be to know which of the studies offered are valued best in the territories that he/she is considering. Anyway, complementary information is offered so that they can position their options relative to the remaining offers of the Spanish University System.

Thirdly, the user must declare his/her preferences with regard to study and research, assigning the 100 points available to him/her according to the weight he/she wishes to grant to teaching, research, and innovation and

technological development, when valuing the universities' profiles.

As the user chooses the degrees and the autonomous communities of his/her interest and distributes the 100 points among the three dimensions in such a way as to reflect his/her preferences, the decisions are registered in the boxes below. Once the user has introduced the information of the three fields, the "Create your own ranking" button appears on screen.

When this button is clicked the personalized ranking corresponding to the selection criteria introduced is displayed, showing in order the corresponding Bachelor's degrees of the universities that offer those studies in the territories considered. The user is also informed that there are other options in addition to those selected in the same area of study, in case he/she is interested. This more complete set of alternatives is offered in a pdf file.

The first column shows the position of the Bachelor's degree in the personalized ranking. The second shows the value of the index reached. As we observe in the example, various Bachelor's degrees can occupy the same position in the ranking, since the indices are rounded to one decimal because greater precision is not considered to reflect more accurately differences among the degrees.

Together with the names of the Bachelor's degrees appears a link to the web address of each university. Next the cut-off mark[12] of the last year is indicated and the price per credit on first registration, information that is completed when various centers of a university impart the same Bachelor's degree, if it is offered in one center or there is any commentary relating to the cost of the degree. The last columns at the right show the information on the environment described in the next section.

To sum up, the web tool for constructing personalized rankings is easy to use, very flexible, and is underpinned by a rigorous methodology identical to the one used for constructing the general rankings. For this reason, it is a complement to the latter that possesses a high potential for students, families and careers counsellors, as well as for the universities themselves. For this potential to be effective, however, it will be essential to keep all the supporting information up-to-date and incorporate improvements constantly, taking users' experience into account.

[12] The *cut-off mark* is the mark of the last student who gained admission to a degree with limited places. This mark is only a guideline and varies from one year to the next, depending on the number of free places and the marks of the students registered.

Ranking	Index	University	Degree		2013/2014 Minimum score	2013/2014 Cost (*)	Environment
1	1.2	Universidad Autónoma de Madrid	Grado en Ciencias Ambientales	WWW	7.13	33.00	
1	1.2	Universitat Autònoma de Barcelona	Grado en Ciencias Ambientales	WWW	8.68	35.77	
1	1.2	Universitat de Barcelona	Grado en Ciencias Ambientales	WWW	9.17	35.77	
1	1.2	Universitat Autònoma de Barcelona	Grado en Ciencias Ambientales + Geología	WWW	9.58	35.77	
2	1.1	Universitat de Girona	Grado en Biología + Ciencias Ambientales	WWW	9.02	35.77	
2	1.1	Universidad de Alcalá de Henares	Grado en Ciencias Ambientales	WWW	5.99	33.00	
2	1.1	Universitat de Girona	Grado en Ciencias Ambientales	WWW	5.73	35.77	
3	1	Universidad Rey Juan Carlos	Grado en Ciencias Ambientales	WWW	6.48	33.00	
3	1	Universidade de Vigo	Grado en Ciencias Ambientales	WWW	5.11	13.93	
3	1	Universidade de Vigo	Grado en Ciencias del Mar	WWW	5.09	13.93	

(*) The price corresponds to the cost of credit on first registration

4.3. COMPLEMENTARY INFORMATION ON THE UNIVERSITIES' ENVIRONMENTS

The geographical and social environment in which a university is situated affects users' valuations of its services. In particular, the costs of accessing the services can condition decisions affecting their demand. This seems to be indicated by, for example, the distribution of foreign students of the Erasmus Program. For this reason, it has been considered appropriate to include information about environmental variables as a complement to that offered by the rankings.

After reflecting with the experts on how to include such information, we came to the conclusion that the elements of the environment should be treated differently from the rest of the variables considered, since they represent circumstances external to the universities and not their own features that are under their control. For this reason, we decided to provide the information of the environment not integrated with the indicators computed in the ranking, but as a complement to them.

We have included four categories of environmental variables: a) climate —temperatures and rainfall— b) cost of living —housing prices—, c) accessibility —airports, railways and their connections— and d) socio-cultural environment —total activity in the sectors of art and entertainment. This information is presented by means of a system of icons (similar to that of hotel guides) to make easier the identification of the advantages of the universities in these four aspects. The web tool will offer up to four icons against each university, one for each environmental category considered, when the environment reinforces the university's attraction. The size of the icon will indicate to the user, intuitively, what university environments can offer him/her a better quality of life (see, for example, the following diagram).

To decide the size of the corresponding icons, a synthetic indicator[13] has been calculated for each of them, based on the data available, which in general is by province. After arranging the universities in order of these indices, a large icon is assigned to those situated in the tertile with highest value in the distribution (best climate, highest cost, greatest connectivity, most socio-cultural opportunities) and an identical but smaller icon to those in the second tertile (between 33% and 66%); finally, those in the third tertile are indicated with tiny icons.

It should be taken into account that three of the four environmental characteristics are more favorable the larger the icon (climate, transport and socio-cultural opportunities), while a higher cost of living must be understood as less attractive.

Finally, the 2014 edition includes as a novelty the price per credit of over 2,500 Bachelor's degrees analyzed by U-Ranking. This new information is included because the financial cost involved in university studies is more and more relevant when making this decision and the differences between degrees have increased greatly. In recent years university fees have increased considerably and unequally. These prices, despite the maximum limit set by the Spanish Ministry of Education, Culture and Sport[14], can vary depending on the autonomous community, the university, the cycle —Bachelor, Master, Doctorate— the level of experimentality of the degree and the ownership of the center[15] offering that degree. As can be appreciated in table 6, the current range of fees by Communities is considerable, even more if differences of experimentality and cycle are considered.

For this reason, and as a guide, the user of U-Ranking will be able to find the price per credit at first registration for each Bachelor's degree. The prices included in U-Ranking correspond to those established for the academic year 2013-2014.

Table 6. Public price per credit at the time of first enrolment by region. 2013-2014 academic year (euros/credit)

Region	Average price	Minimum price	Maximum price
Andalusia	12.62	12.62	12.62
Aragon	19.75	13.50	25.32
Asturias	17.13	12.11	22.03
The Balearic Islands	17.92	12.88	23.13
The Canary Islands	15.21	12.30	18.95
Cantabria	13.50	10.65	16.65
Castile and Leon	23.11	16.90	29.95
Castile-La-Mancha	15.24	12.08	18.79
Catalonia	33.52	25.27	39.53
The Valencian Community	20.39	16.31	24.89
Extremadura	14.74	10.31	18.51
Galicia	11.89	9.85	13.93
Madrid*	30.33	27.00	33.00
Murcia	15.58	14.38	16.78
Navarre	19.22	15.90	22.53
Basque Country	16.81	14.02	19.76
La Rioja	18.37	14.14	23.51
UNED	16.18	12.24	22.16

* Madrid has established a maximum public price for the public universities in this region.

Source: Spanish Ministry of Education, Culture and Sport.

[13] The synthetic indicators were constructed, for those environmental variables with more than one indicator, by first standardising each indicator with respect to its distance (ratio) from the median and then applying a geometric mean to those indicators. Next, each sample was divided into three sets bounded by the tertiles of each distribution in order to subsequently assign them to each group.

[14] The price of the official degrees is established by Law of the Autonomous Community. The amount corresponding to each year is established by decree of the Community itself within the limits established by the Government at the proposal of the General Conference on University Policy.

[15] U-ranking also includes Bachelor's degrees imparted by private centres attached to public universities. In general, the price of these degrees includes an extra cost above public prices.

5. Main results

This chapter gives the principal results obtained in this second edition of the ISSUE Project, corresponding to 2014, in which both the general rankings and the personalized rankings of Bachelor's degrees have been updated. Both rankings are available in full on the project website www.U-ranking.es.

The 2014 rankings will be analyzed from three different perspectives in order to emphasize the contribution made by the project and its methodology: a) comparing them with other rankings already known in order to evaluate their similarities and differences; and b) evaluating the sensitivity of the results to changes in some of the hypotheses put forward; and c) analyzing the results obtained in the first edition of 2013 as against those of 2014. The second question has been considered from two perspectives: the importance of considering, or not, the size of the university, and the implications of granting more or less weight to research or teaching.

5.1. ISSUE RANKING OF PRODUCTIVITY (ISSUE-P)

Table 7 offers the ranking of Spain's 48 public universities after homogenizing them taking into account their size, that is, what we call *productivity ranking* (ISSUE-P Ranking). The order of the ranking is based on the value of the synthetic indicator obtained by each university, offered in the second column. This indicator has been rounded to one decimal as a greater detail of the index would not reflect more accurately the differences among universities, given the set of decisions adopted in the process of construction of indicators already described.

As the table shows, various universities obtain the same index and therefore present the same position in the ranking. As a result of this criterion, the forty-eight universities are grouped into ten levels of productivity. Those universities

Table 7. ISSUE-P Ranking of the Spanish public universities

Ranking	Index	University	Ranking	Index	University	Ranking	Index	University
1	1.6	Universitat Pompeu Fabra	6	1.1	Universidad de Zaragoza	8	0.9	Universidad de Huelva
2	1.5	U. Politècnica de Catalunya	6	1.1	Universidad Pública de Navarra	8	0.9	Universidad de León
3	1.4	Universidad Autónoma de Madrid	6	1.1	U. de Santiago de Compostela	8	0.9	Universidad de Málaga
3	1.4	Universitat Politècnica de València	6	1.1	Universitat de Lleida	8	0.9	Universidad de Oviedo
4	1.3	U. Autònoma de Barcelona	7	1	Universidad de Alicante	8	0.9	Universidad de Sevilla
5	1.2	Universidad Carlos III	7	1	Universidad de Almería	8	0.9	Universidad de Valladolid
5	1.2	Universidad de Cantabria	7	1	Universidad de Granada	8	0.9	Universidad del País Vasco
5	1.2	U. Miguel Hernández de Elche	7	1	Universidad de Murcia	8	0.9	Universidad Rey Juan Carlos
5	1.2	Universidad Politécnica de Madrid	7	1	Universidad de Salamanca	9	0.8	Universidad de Burgos
5	1.2	Universitat de Barcelona	7	1	Universidad Pablo de Olavide	9	0.8	Universidad de Extremadura
5	1.2	Universitat de les Illes Balears	7	1	U. Politécnica de Cartagena	9	0.8	Universidad de Jaén
5	1.2	Universitat de València	7	1	Universidade de Vigo	9	0.8	Universidad de La Laguna
5	1.2	Universitat Rovira i Virgili	7	1	Universitat de Girona	9	0.8	U. de Las Palmas de Gran Canaria
6	1.1	Universidad Complutense	7	1	Universitat Jaume I	9	0.8	Universidade da Coruña
6	1.1	Universidad de Alcalá de Henares	8	0.9	Universidad de Cádiz	10	0.7	UNED*
6	1.1	Universidad de Córdoba	8	0.9	Universidad de Castilla-La Mancha	10	0.7	Universidad de La Rioja

* The National Distance Education University.
Note: Universities are ordered from the highest to the lowest index value. Universities with the same index value are ordered alphabetically.
Source: BBVA Foundation-Ivie.

with the same index have been ordered alphabetically within their group. Only those cardinal and ordinal aspects of the universities that make notable differences will be commented upon.

Each column of table 7 brings together one-third of the universities according to the order provided by this ranking, but, since there are universities with the same level of productivity, in this case the classification system arranged in tertiles is not precise.

An aspect worth mentioning is that the range of the index from which this ranking is derived shows significant differences of productivity among the Spanish universities, the most productive ones doubling the results of those in the last positions.

In the productivity ranking the leading group is formed by twenty universities occupying the first to the sixth positions. These universities are: Pompeu Fabra in first place and Politècnica de Catalunya in the second; joint third are the Autónoma de Madrid and the Politècnica de València; the Autònoma de Barcelona occupies the forth place, followed in fifth position by a group formed by eight universities: Carlos III, Cantabria, Miguel Hernández (Elche), Politécnica de Madrid, Barcelona, Illes Balears, València, and Rovira i Virgili. The first twenty in productivity are completed by the group formed by the following universities: Complutense, Alcalá de Henares, Córdoba, Zaragoza, Pública de Navarra, Santiago de Compostela and Lleida.

Other groups of universities with similar levels of productivity are found in the following positions: ten universities share the seventh position, ten others the eighth position, six share the ninth and two share the tenth position.

5.2. ISSUE RANKING OF VOLUME OF RESULTS (ISSUE-V)

Table 8 shows the index and the ranking of Spain's 48 public universities according to their volume of results (Ranking ISSUE-V), which differs from that of productivity because it is obtained without correcting for the size of each university.

As in table 7, each column contains one-third of the Spanish universities according to their order in the ranking. The first column contains the 16 universities forming the first tertile. Standing out in first place is the Universidad Complutense, with an index (4.3) one point higher than the university in second place, that of Barcelona (3.3). In third position are the Polytechnics of Madrid and València and the Universitat de València. The universities of Granada and of the Basque Country stand in fourth and fifth place. In sixth position, the group formed by Autónoma de Barcelona, Politécnica de Catalunya, and the Universidad de Sevilla. The Autónoma de Madrid occupies, together with the UNED (National Distance Education University), the seventh position. The Universities of Zaragoza and of Santiago are in eighth place and those of Málaga and Salamanca in ninth.

Following are the rest of the universities grouped in most cases by the same level of results. The number of different positions in this order is twenty-one, much more than in the case of productivity.

5.3. VOLUME RANKING VS. PRODUCTIVITY RANKING

The comparison of the above two tables indicates that the differences between the ISSUE-V Ranking and the ISSUE-P Ranking are substantial. But both approaches can be useful, one or the other being suitable depending on the question to be answered.

The differences in the values of the indicators are much greater in the volume ranking due to the importance of size. The indicator of total results ranges from 4.3 to 0.2, very much wider than for the indicator of productivity, which goes from 1.6 to 0.7.

Figure 2 combines the two types of rankings and facilitates the comparison of the position of each university in both. On the vertical axis it shows the results of the ISSUE-V Ranking —which depends on the size— while on the horizontal axis it shows the ISSUE-P Ranking —which corrects the effects of size. The universities are ordered from top to bottom on the first and from right to left on the second. In each case the scale

Table 8. ISSUE-V Ranking of the Spanish public universities

Ranking	Index	University	Ranking	Index	University	Ranking	Index	University
1	4.3	Universidad Complutense	10	1.3	Universidad de Alicante	15	0.8	Universidad Rey Juan Carlos
2	3.3	Universitat de Barcelona	10	1.3	Universidad de Murcia	15	0.8	Universitat Rovira i Virgili
3	2.8	Universidad Politécnica de Madrid	11	1.2	Universidad Carlos III	16	0.7	Universidade da Coruña
3	2.8	Universitat Politècnica de València	11	1.2	U. de Castilla-La Mancha	16	0.7	Universitat Jaume I
3	2.8	Universitat de València	11	1.2	Universidad de Oviedo	16	0.7	U. Miguel Hernández de Elche
4	2.7	Universidad de Granada	11	1.2	Universidad de Valladolid	17	0.6	Universidad de Almería
5	2.6	Universidad del País Vasco	12	1.1	Universidad de Alcalá de Henares	17	0.6	Universitat de Girona
6	2.5	U. Autònoma de Barcelona	12	1.1	Universitat Pompeu Fabra	17	0.6	Universidad de Jaén
6	2.5	U. Politècnica de Catalunya	13	1	Universidade de Vigo	18	0.5	Universitat de Lleida
6	2.5	Universidad de Sevilla	14	0.9	Universidad de Córdoba	18	0.5	Universidad de Huelva
7	2.2	Universidad Autónoma de Madrid	14	0.9	Universidad de La Laguna	18	0.5	Universidad Pública de Navarra
7	2.2	UNED*	15	0.8	Universidad de Cádiz	18	0.5	Universidad de León
8	1.9	Universidad de Zaragoza	15	0.8	Universitat de les Illes Balears	18	0.5	Universidad Pablo de Olavide
8	1.9	U. de Santiago de Compostela	15	0.8	U. de Las Palmas de Gran Canaria	19	0.4	U.Politécnica de Cartagena
9	1.5	Universidad de Málaga	15	0.8	Universidad de Extremadura	20	0.3	Universidad de Burgos
9	1.5	Universidad de Salamanca	15	0.8	Universidad de Cantabria	21	0.2	Universidad de La Rioja

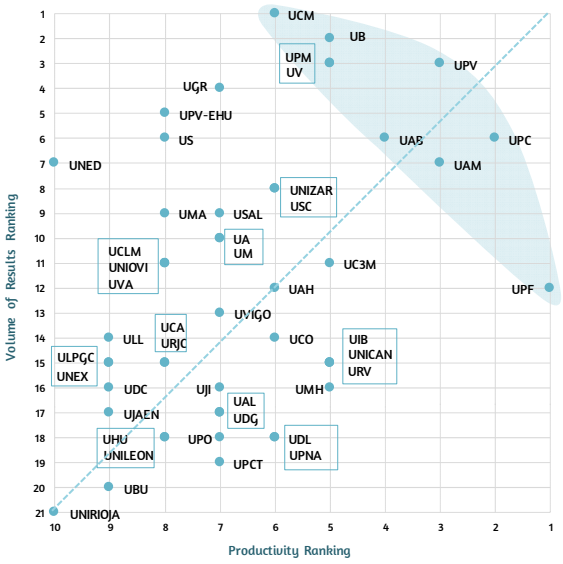
* The National Distance Education University.

Note: Universities are ordered from the highest to the lowest index value. Universities with the same index value are ordered alphabetically.
Source: BBVA Foundation-Ivie.

is different, to reflect the fact that each ranking establishes a different number of positions due to the existence of groups of universities with the same index.

Figure 2. ISSUE-V vs. ISSUE-P of the Spanish public universities

Position in each ranking



See appendix 2 for a list of the University abbreviations used.
Source: BBVA Foundation-Ivie.

As can be observed, the dispersion of points in the figure is significant and reflects that there is no definite correlation between the two rankings. Therefore, size does not seem, in general, to have any positive or negative influence on productivity.

In the top part of the figure are the universities with the highest output: Universidad Complutense, Universitat de Barcelona, Universitat de València, Universidad Politécnica de Madrid, Universitat Politècnica de València, Universidad de Granada, Universidad del País Vasco, Universitat Autònoma de Barcelona, Universitat Politècnica de Catalunya, Universidad de Sevilla, Universidad Autónoma de Madrid, UNED, Universidad de Santiago de Compostela, Universidad de Zaragoza, Universidad de Málaga and Universidad de Salamanca.

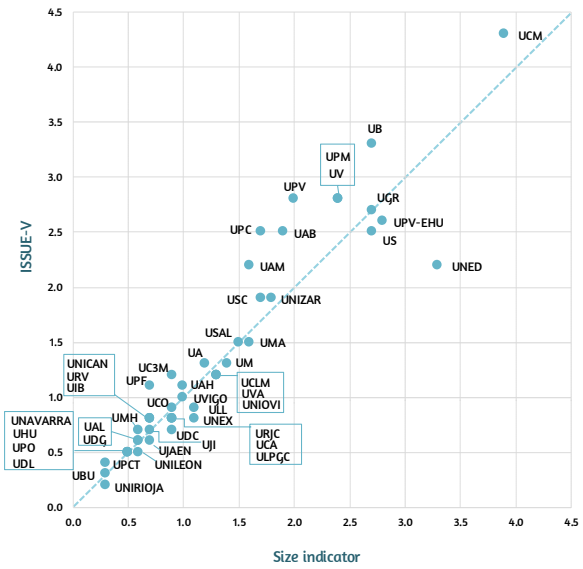
However, not all of these large universities are among the most efficient and, on the other hand, other smaller ones stand out in this regard. This is the case of the Universitat Pompeu Fabra, which obtains the highest productivity in the ISSUE-P Ranking, and of other medium- or small-sized and very productive universities, such as the Universidad Carlos III, the Universitat de les Illes Balears, the Rovira i Virgili, the Universidad de Cantabria and the Universidad Miguel Hernández.

With the aim of highlighting the universities that present simultaneously the best results in both rankings we have shaded an area containing nine universities that stand out because for each of them there is almost no university with simultaneously greater productivity and greater volume of results. In consequence, it can be said that their position is hardly ever *dominated* by any other university. For the rest, on the other hand, there are several universities that present at the same time better results in both rankings.

The universities situated in the shaded zone form the *frontier of best practice in volume of results-productivity of Spanish universities.* It is formed by the Universidad Complutense, Universitat de Barcelona, Universitat de València, Universidad Politécnica de Madrid, Universitat Politècnica de València, Universitat Autònoma de Barcelona, Universitat Politècnica de Catalunya, Universidad Autónoma de Madrid and Universitat Pompeu Fabra. If we draw a line joining the positions of the universities that dominate all the rest, this outer frontier would have a negative gradient. It could therefore be said that, even among the best, the larger universities gain volume of results at the expense of a certain loss of relative productivity. Nevertheless, the extent of this size effect is very limited, as nearly all those situated at the frontier are large universities and can be considered examples of good practice or university *benchmarking* in Spain.

In fact, examples of higher or lower productivity can be found among universities of very different sizes.[16] Figure 3 shows this by representing the size indicator on the horizontal axis and the volume index ISSUE-V of each university on the vertical axis. Those situated above the diagonal achieve results higher than the average productivity, the gradient of the vector radius joining each position to the origin being the measure of its productivity. It is visually evident that size is not a determinant of the universities' productivity. There are institutions of large size like the Universities of Barcelona and València, the Polytechnics of Madrid, Valencia and Catalunya or the Autonomous Universities of Barcelona or Madrid, which productivity is high. However, some universities of smaller size such as Universitat Pompeu Fabra, Carlos III de Madrid or Universidad Miguel Hernandez, Illes Balears, Cantabria or Rovira i Virgili also present high productivity indices.

Figure 3 . ISSUE-V indicator vs. Size indicator*



(*)The Size indicator is a standard arithmetic mean of the teachers, students and budget of each university.

See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie.

5.4. ISSUE RANKING VS. SHANGHAI RANKING

Given the popularity attained by some international rankings, many universities are interested in being compared with the best in the world. For this reason, it is obligatory to ask to what extent the ISSUE rankings constructed offer results different or similar to the former. As external reference for comparison we will consider especially the Shanghai Ranking, which without a doubt has become the most widely known to date.

As we have commented in previous sections, only ten Spanish universities appear in the latest list of the top 500, and all of them are below the 200th place (see figure 1). Nevertheless, a recent study (Docampo 2013) offers a version of the

[16] The indicator of size is the result of calculating the standardized arithmetic mean of the number of students, faculty members and income of each university.

Shanghai Ranking adapted to the Spanish universities that includes all the public universities.

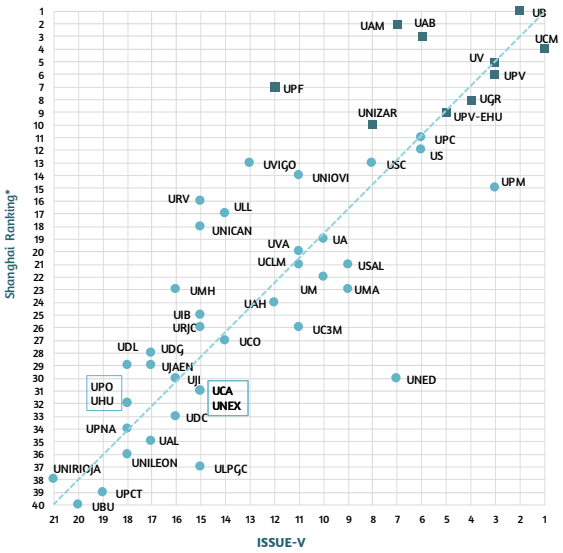
The results of the ISSUE-V Ranking and the Shanghai Ranking are much more similar than those of our two ISSUE rankings with each other, as shown by the following figures. The first of them (figure 4) represents on the horizontal axis the position of the Spanish universities in the ISSUE-V Ranking, while the vertical axis represents the Shanghai Ranking. Regardless of the different number of levels that each ranking sets, both offer a fairly similar order, and therefore the universities are mostly grouped around the main diagonal of the graph. However, in cases where the distance to the diagonal is greater the resulting positions in both rankings for these universities are much different.

The universities located below the diagonal are comparatively better situated in our ranking. The case of the UNED stands out, occupying a clearly better position in the ISSUE-V Ranking than in that of Shanghai. The universities above the diagonal, on the contrary, are comparatively better placed in the adaptation for Spain of the Shanghai Ranking. The common denominator in many cases is that these are small but more productive universities, such as Pompeu Fabra or Miguel Hernández, whose greater productivity was already manifest in the Productivity Ranking.

In the figure 4 we have highlighted with dark squares the universities that are expressly mentioned among the top 500 of the Shanghai Ranking —not only in the adaptation for Spain. As can be observed, they are all at the top in the adaptation by Docampo (2013), and the majority form part of the first tertile of our ISSUE-V Ranking: Universitat de Barcelona, Universidad Autónoma de Madrid, Universitat Autònoma de Barcelona, Universidad Complutense, Universitat de València, Universitat Politècnica de València, Universidad de Granada, Universidad del País Vasco and Universidad de Zaragoza. The remaining one is the Universitat Pompeu Fabra, situated in the second tertile of the ISSUE-V Ranking.

Figure 4. ISSUE-V vs. Shanghai Ranking*

Position in each ranking



(*) Results correspond to our adaptation of the Shanghai Ranking by Docampo (2013) for Spanish universities ('Shanghai Ranking expanded'). In order to compare only the public universities the Universidad de Navarra, a private institution positioned in the 28th place of Docampo's ranking, has been excluded.

■ Universities in the Shanghai Ranking Top 500.

See appendix 2 for a list of the University abbreviations used.

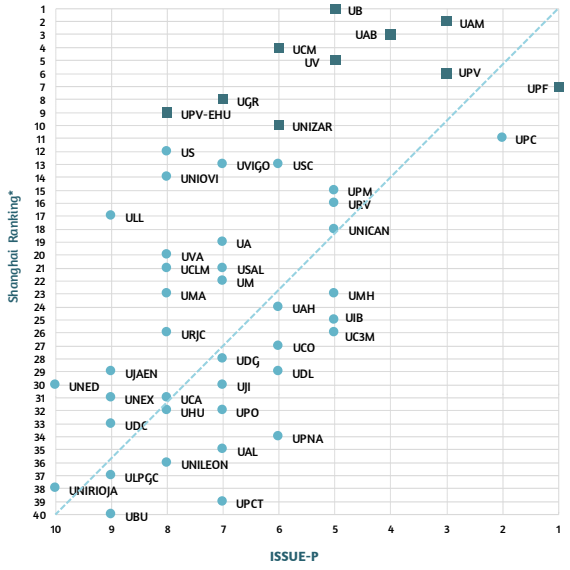
Source: BBVA Foundation-Ivie and Docampo (2013).

Up to what point the comparison between the Shanghai Ranking adapted to Spain and the ISSUE-P Ranking offers conclusions different to the above is shown in figure 5. In it, almost half of the universities change tertile between one ranking and the other.

In short, the differences with Shanghai are much more substantial in the case of the ISSUE-P Ranking than in that of ISSUE-V, which agrees with the characteristic of the Shanghai Ranking already pointed out: it scarcely corrects the indicators used to take into account the size and, therefore, it is more a ranking of volume of results than of productivity.

To illustrate at the same time the extent to which the three rankings compared generate different groupings of the universities a Venn diagram can be used, representing the universities that form part of the first tertile in each of the classifications and the intersections among the three.

Figure 5. ISSUE-P vs. Shanghai Ranking*
Position in each ranking



(*)Results correspond to our adaptation of the Shanghai Ranking by Docampo (2013) for Spanish universities ('Shanghai Ranking expanded'). In order to compare only the public universities the Universidad de Navarra, a private institution positioned in the 28th place of Docampo's ranking, has been excluded.

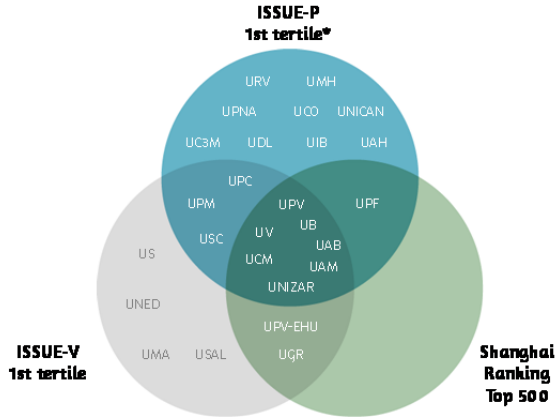
■ Universities in the Shanghai Ranking Top 500.

See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie and Docampo (2013).

In the center of the diagram (figure 6) appear the seven universities situated in the first tertile in the three rankings. They are Universidad Complutense de Madrid, Universitat de Barcelona, Universitat de València, Universitat Autònoma de Barcelona, Universitat Autónoma de Madrid, Universitat Politècnica de València and Universidad de Zaragoza. Six other universities are in the first tertile of two of the rankings: Universitat Pompeu Fabra in Shanghai and ISSUE-P; Universitat Politècnica de Catalunya, Universidad Politécnica de Madrid and Universidade de Santiago de Compostela in ISSUE-V and ISSUE-P; and Universidad del País Vasco-EHU and Universidad de Granada, in Shanghai and ISSUE-V. Finally, thirteen other universities stand out in only one of the possible criteria. These results show important coincidences between the rankings when identifying the universities that stand out, but also significant differences that reflect the different approach of each ranking. It is especially interesting to observe that of the ten universities that the Shanghai Ranking places in its Top 500, seven also appear in the first tertile of our two rankings, in the intersection of the three circles of the diagram; another, Universitat Pompeu Fabra, heads our ranking of productivity, and two more belong to the first tertile of the ISSUE-V Ranking, Universidad de País Vasco-EHU and Universidad de Granada.

Figure 6. ISSUE Rankings vs. Shanghai Ranking



(*)The ISSUE-P Ranking includes 20 universities in the 1st tertile instead of 16 in order to include all the universities that belong to group 6.

See appendix 2 for a list of the University abbreviations used.

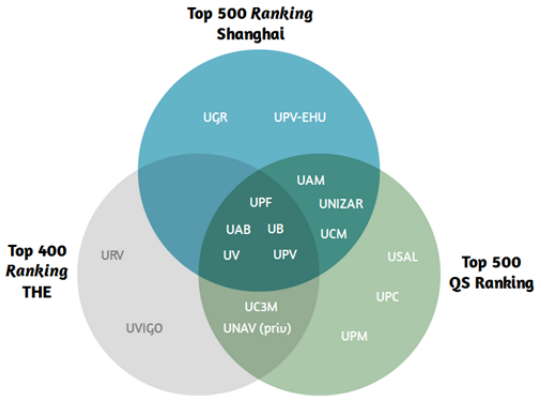
Source: BBVA Foundation-Ivie and Docampo (2013).

In sum, it can be said that, of the ten Spanish universities included in the Top 500 of the Shanghai Ranking, nine are to be found in our tertile with greatest volume of results according to the ISSUE-V Ranking and eight among our most productive universities according to the ISSUE-P Ranking. Consequently, our classifications present a substantial harmony with those of the Shanghai Ranking, which strengthens their interest as instruments for identifying best practice. They also allow us to see that there may be differences in the rankings according to the perspective with which they were drawn up, and at the same time indicate that some universities are well positioned from any perspective.

5.5. COMPARISON OF RESULTS OF OTHER INTERNATIONAL RANKINGS

Although the Shanghai ranking is consolidating its influence as the most cited international indicator, there exist other initiatives of high international repute, such as the Times Higher Education (THE) or the QS-Ranking. The principal differences between these two initiatives and the Shanghai ranking are that they (i) try to measure the role of teaching and (ii) incorporate subjective valuations based on surveys of international employers and experts. The results for the Spanish universities in the three initiatives present similarities but also some differences, as shown in figure 7.

Figure 7. Comparison of the results of three international rankings. 2013-2014



See appendix 2 for a list of the University abbreviations used.

Source: ARWU (CWCU 2013), THE (2013) and QS (2013).

In the intersection of the three rankings we find a set of five universities (UAB, UB, UPF, UV and UPV) which appear systematically in the top positions of our rankings and also belong to the group of universities at the *frontier* of figure 2 — that is, those universities that are not dominated by hardly any other university. Finally, among the universities at this frontier, the UCM and the UAM do not figure in the Top 400 of the THE, and the UPC and the UPM do not belong to the Shanghai Top 500 or the THE Top 400.

These results again confirm the presence of a group of Spanish universities in the top positions within our university system, regardless of the prism with which it is analyzed.

5.6. RESEARCH *VS.* TEACHING: SENSITIVITY ANALYSIS

One of the biggest problems inherent to any composite indicator is the effect of the relative weight of the different elements composing it. The ISSUE project expressly considers that teaching and research can have different importance for each user of the universities' services. This is acknowledged to the point of allowing a web tool to draw up personalized rankings that take into account the user's preferences in this sense.

The question now posed is how much the general rankings of the universities would change if the weights allocated to teaching and to research were to change. In the results presented above the weights used to calculate the rankings were those obtained from the Delphi survey capturing the opinions of the experts who collaborated in the project.[17] But other experts or other users could give different valuations. Consequently, we should analyze whether the results are highly sensitive or insensitive —in the latter case we will say that they are *robust*— to changes in the weights of these dimensions.

The previous question is important for valuing to what extent we can rely on the results of the rankings, given the possible arbitrariness of the attribution of one weight or another to research or any other university activity. Specifically, would the results change much if a greater weight was granted to research, as in other well-known rankings? Can any university occupy a high place in a ranking if the weights of teaching and research change to suit its interests?

Studying the sensitivity of rankings to changes of the weights of teaching and research permits us to analyze also whether the universities' results

[17] The weights used are, respectively, 56%, 34% and 10%. The weights were established on the basis of the opinion of the experts consulted, and agree practically with the distribution of resources among the teaching, research and transfer activities in the universities' budgets. It also reflects an intensity of research activity in accordance with the results of the Spanish universities: if we consider that in the top universities of the world by their research results these activities had a weight of 85-90%, the corresponding figure for the Spanish universities would be 35%.

in these two activities are correlated. Most rankings place great emphasis on research because the information on the results of this activity is abundant and seems more precise and reliable. But, although it is often argued that teaching and research are highly correlated, this hypothesis has barely been tested for lack of indicators of teaching results. We will revisit this question in a later section.

That the research dimension is easier to measure should not be an argument for not measuring the quality of teaching. Likewise, the existence of a positive correlation between the quality of teaching and that of research should not hide the fact that disparity is also possible: if for the same level of research quality there are different teaching results between universities, ignoring this information biases the results in favor of one and against the other.

To value the effect of the selection of the weights given to teaching and to research we performed an analysis of sensitivity to their variations on the ranking of productivity. For this, we calculated three rankings that are differentiated by the very different relative weights of research and of teaching, as indicated below:

- Option 1: Teaching 70 / Research 20 / Innovation 10
- Option 2: Teaching 45 / Research 45 / Innovation 10
- Option 3: Teaching 20 / Research 70 / Innovation 10

We opted to leave the weight of innovation and technological development with a fixed value of 10 points so as not to hinder comparisons of the effect of a greater or lesser relative weight of the other two variables. If together with a reduction of the weight of research we applied a reduction of the weight of innovation (or vice versa), we could not know to which of the two variations the changes in the ranking were due [18].

Figure 8 shows the effect on the position in the ranking of each of Spain's 48 public universities when the weight of research is increased, according to the three weightings chosen.

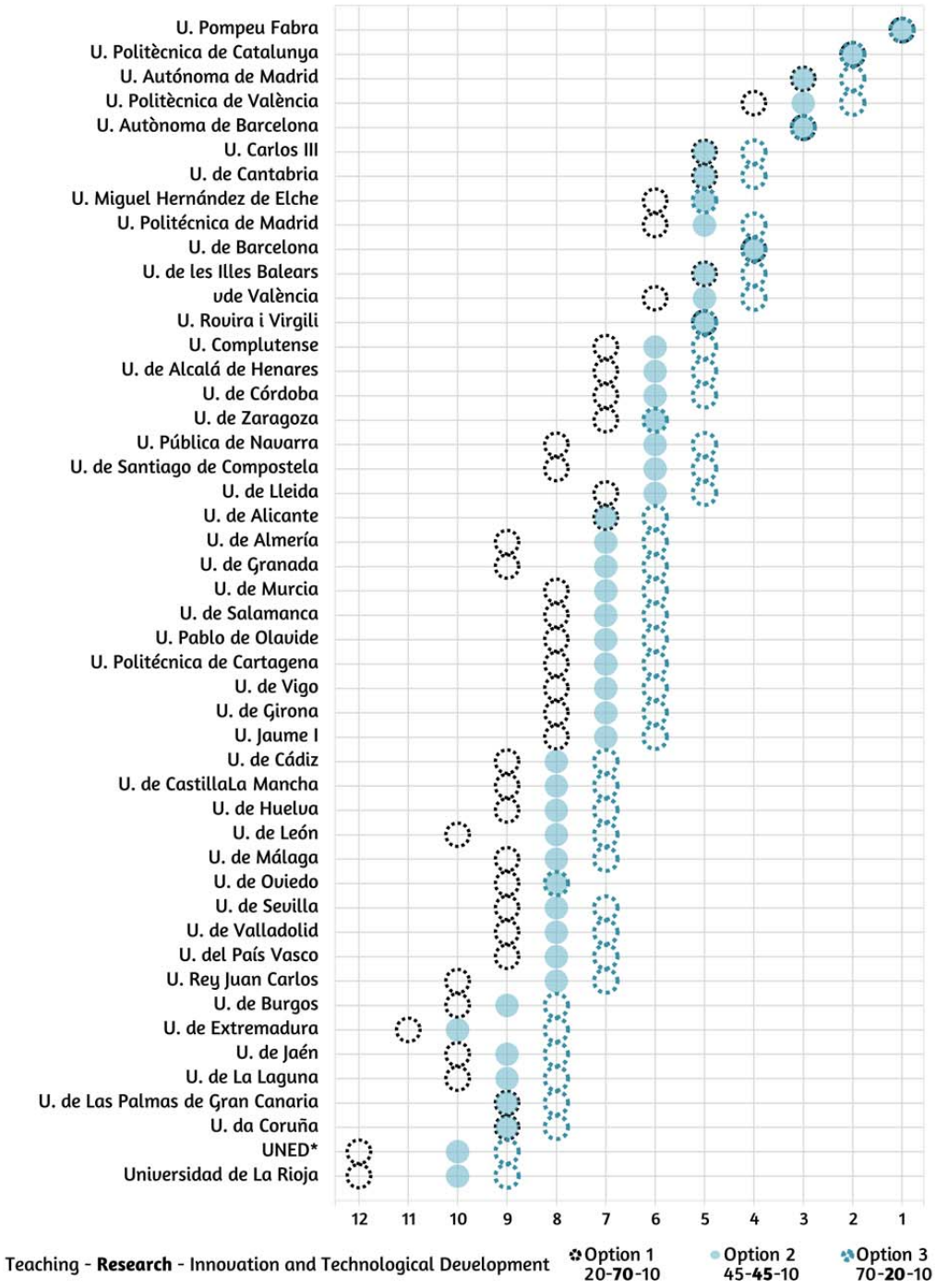
The evolution of the universities, when the weight of research increases, frequently presents movements from right to left (regressions) characterized by:

- Two top universities remain at the head of the ranking: Universitat Pompeu Fabra and Politécnica de Cataluña.
- Among the rest of universities that lead the classification, the variations in their positions are few, there being in many cases only a change in one level.
- On the contrary, at the bottom part of the figure, where less productive universities are found, two position regressions are frequent when the weight of research activity increases.
- The exceptions to these rules are the universities that recede more when the weight of research increases. In the middle of the figure, the Universidad Pública de Navarra, the Universidade de Santiago de Compostela, the Universidad de Granada and the Universidad of Almería move back up to three positions. At the bottom of the figure, the Universidades de León, Rey Juan Carlos, Extremadura, UNED and La Rioja go down three positions.

Thus, the rankings are sensitive to changes in the weights given to teaching and to research, especially if we compare weightings as different as those corresponding to our options 1 and 3. When these weights change less, variations are minor and, definitely, alterations never occur for this reason in the classifications. A university does not pass from the top places to the bottom ones however substantial the changes in the weights, but it is true that some can improve their positions in the ranking by some places if greater importance is accorded to teaching.

[18] Furthermore, significantly increasing the weight of the activities relating to technological development and innovation would not be justified, given their limited importance in the budgets of the Spanish universities. Certainly, in the Polytechnic universities the weight of these activities is greater, but disaggregated information is not available to value more precisely the results of each in this aspect of their specialization.

Figure 8. Evolution of the ISSUE-P Ranking according to variations in the weight of research



* The National Distance Education University.

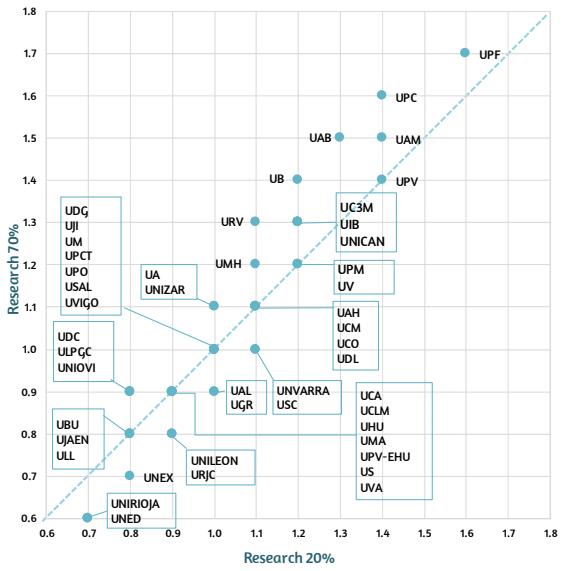
Note: Universities are ordered by their position in the global productivity ranking with the following weights: 56/34/10.

Source: BBVA Foundation-Ivie.

If we consider the values of the index by which the ISSUE-P ranking is obtained, we observe that their stability when changing the weights of teaching and research is very notable. We observe this in figure 9, representing the synthetic indicator from which the ISSUE-P Ranking is derived for research weights of 20% and 70%. As we can appreciate in the figure, the biggest variation would occur in 4 Catalan universities: Universitat Politècnica de Catalunya, Autònoma de Barcelona, de Barcelona and Rovira i Virgili. In these universities, the index would increase by two decimals if the weight of research changed from 20% to 70%.

Figure 9. ISSUE-P for two different weights in Research

Weights of Teaching/Research/Innovation: 70/20/10 vs. 20/70/10



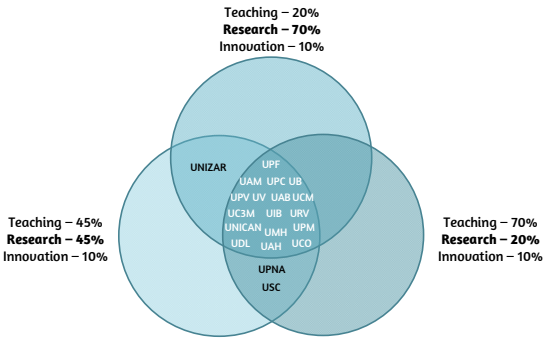
See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie.

To offer another sample of the stability of the groups of universities, the Venn diagram in figure 10 presents the results of the productivity ranking for the three weights described above. Concentrating on the first tertile of universities, the stability mentioned is evident, as there is a group of 17 universities —of the 20 that appear in the first 16 positions in some scenarios— that are located at the intersection, that is, that belong to the first tertile independently of the weight accorded to teaching or to research.

Figure 10. The role of research in ISSUE-P

Top 20 universities according to different weights given to Research



See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie.

They are: Universitat Pompeu Fabra, Universitat Politècnica de Catalunya, Universidad Autónoma de Madrid, Universitat Politècnica de València, Universitat Autònoma de Barcelona, Universitat de Barcelona, Universidad Carlos III, Universitat de les Illes Balears, Universidad de Cantabria, Universidad Politécnica de Madrid, Universitat de València, Universitat Rovira i Virgili, Universidad Miguel Hernández de Elche, Universidad de Alcalá de Henares, Universidad Complutense, Universidad de Córdoba and Universitat de Lleida. As detailed earlier, the Universidad de Zaragoza enters into this group as the weight of research increases and the Universidad Pública de Navarra and the Universidade de Santiago de Compostela leave it.

5.7. RANKINGS OF TEACHING, RESEARCH, AND INNOVATION AND TECHNOLOGICAL DEVELOPMENT

The methodology used constructs indicators of results of the three activities of the universities, then aggregates them to draw up the two overall rankings presented. These results for each university in each of the three dimensions can be analyzed and arranged in order to obtain a *teaching ranking*, a *research ranking* and an *innovation and technological development ranking*. Each of them can be calculated in the two variants, volume of results and productivity.

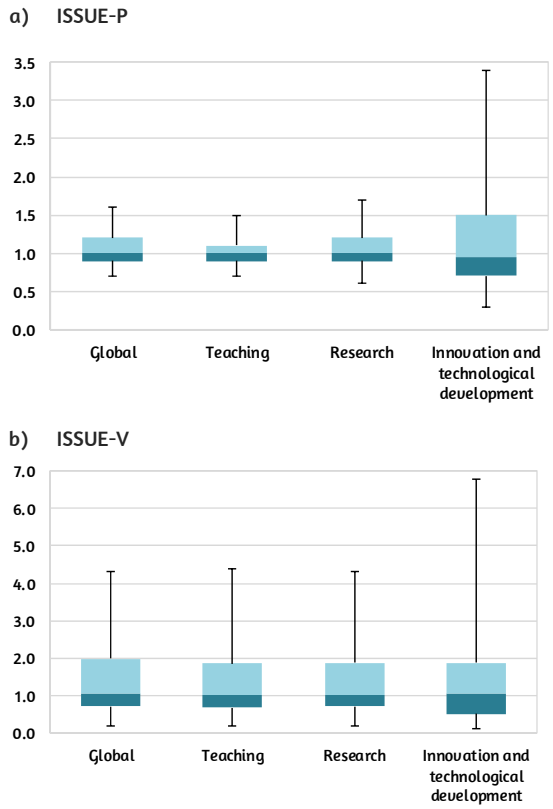
Figure 11 shows by means of *box plots* the distribution corresponding to the indices of each of the dimensions and of the overall index of a university in the case of productivity (panel a) and volume of results (panel b). The extremes of the black lines represent the maximum and minimum values reached by the indices in each dimension and define the range of variation of the index; the top of the central box indicates the 75% percentile, while the 25% percentile is marked by the bottom of the box, so that between them is situated 50% of the distribution (interquartile range). The border between the two parts of the box defines the median value. From the comparative analysis of the two panels two fundamental aspects stand out:

- First, the comparison of panels *a* and *b* permits us to observe again that the differences between the universities are much greater if analyzed on the basis of their volume of results than in terms of their productivity. This feature is observed in any of the dimensions considered. In the activities of innovation and technological development it is greater than in teaching and research.

- Second, the differences in terms of productivity —in general smaller than in volume— present an increasing scale when going from teaching to research and from the latter to innovation and technological development. Thus for example, the range of the teaching index is 0.8 points, that of research 1.1 and that of innovation and technological development 3.1. The relative differences of the interquartile ranges are even greater in the case of this last dimension.

Table 9 shows the coefficients of correlation between the different rankings and productivity indices for each pair of activities. The strongest correlation occurs between the universities' teaching and research activity, while the latter presents the weakest relationship with innovation and technological development activity. These results suggest that complementarity exists among the different activities, but is limited, especially with reference to research and innovation.

Figure 11. ISSUE Rankings. Distribution of the indices obtained in each dimension



Source: BBVA Foundation-Ivie.

Table 9. Correlation coefficients of the ISSUE-P rankings by dimension

	Index	Ranking
Teaching - Research	0.80	0.72
Teaching - Innovation and Technological Development	0.62	0.55
Research - Innovation and Technological Development	0.59	0.53

Note: The ranking values are calculated by means of a Spearman correlation coefficient and the index values by means of a Pearson correlation coefficient.

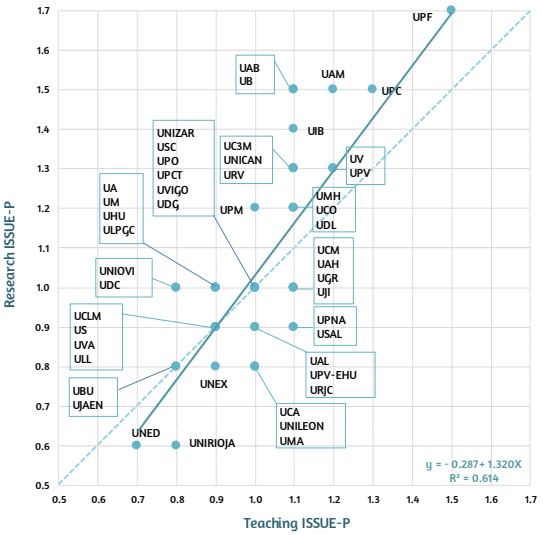
Source: BBVA Foundation-Ivie.

To assess in greater detail up to what point rankings and synthetic values change on passing from research to teaching, figure 12 presents both in a format similar to those used to compare the general rankings. In this way it is possible to test better whether or not the hypothesis that the results for research are good predictors of the results for teaching is supported.

Figure 12 shows a positive correlation between the results in both activities and confirms that there are no excellent universities in one dimension but there are ones with very poor results in the other. In fact, there is an appreciable correlation between the rankings of 0.72 (measured by the Spearman coefficient of correlation of rankings, bounded between -1 and 1) and of 0.80 between the indices (measured by the Pearson coefficient of correlation, bounded between -1 and 1). However, at the same time there is a certain dispersion of the results around the main diagonal. Consequently, the research results do not predict accurately those for teaching: the fit between the synthetic indicators for teaching and for research presents a coefficient of determination of 0.61.

Finally, after describing the results of the rankings of teaching, research and innovation and technological development, tables 10 and 11 present in detail the results of the eight rankings drawn up for all the Spanish public universities.

Figure 12. ISSUE-P-D Ranking vs. ISSUE-P-I Ranking Index



See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie

Table 10. ISSUE-P Ranking for Teaching, Research, and Innovation and Technological Development

University	Global		Teaching		Research		Innovation and Technological Development	
	Rank.	Index	Rank.	Index	Rank.	Index	Rank.	Index
Universitat Pompeu Fabra	1	1.6	1	1.5	1	1.7	4	2.4
Universitat Politècnica de Catalunya	2	1.5	2	1.3	2	1.5	2	3.1
Universidad Autónoma de Madrid	3	1.4	3	1.2	2	1.5	5	2.3
Universitat Politècnica de València	3	1.4	3	1.2	4	1.3	1	3.4
Universitat Autònoma de Barcelona	4	1.3	4	1.1	2	1.5	8	1.8
Universidad Carlos III	5	1.2	4	1.1	4	1.3	10	1.5
Universidad de Cantabria	5	1.2	4	1.1	4	1.3	9	1.6
U. Miguel Hernández de Elche	5	1.2	4	1.1	5	1.2	9	1.6
Universidad Politécnica de Madrid	5	1.2	5	1	5	1.2	3	2.6
Universitat de Barcelona	5	1.2	4	1.1	2	1.5	16	0.8
Universitat de les Illes Balears	5	1.2	4	1.1	3	1.4	12	1.2
Universitat de València	5	1.2	3	1.2	4	1.3	17	0.7
Universitat Rovira i Virgili	5	1.2	4	1.1	4	1.3	12	1.2
Universidad Complutense	6	1.1	4	1.1	6	1	13	1.1
Universidad de Alcalá de Henares	6	1.1	4	1.1	6	1	12	1.2
Universidad de Córdoba	6	1.1	4	1.1	5	1.2	15	0.9
Universidad de Zaragoza	6	1.1	5	1	6	1	10	1.5
Universidad Pública de Navarra	6	1.1	4	1.1	7	0.9	6	2.2
U. de Santiago de Compostela	6	1.1	5	1	6	1	7	1.9
Universitat de Lleida	6	1.1	4	1.1	5	1.2	17	0.7
Universidad de Alicante	7	1	6	0.9	6	1	8	1.8
Universidad de Almería	7	1	5	1	7	0.9	13	1.1
Universidad de Granada	7	1	4	1.1	6	1	17	0.7
Universidad de Murcia	7	1	6	0.9	6	1	15	0.9
Universidad de Salamanca	7	1	4	1.1	7	0.9	14	1
Universidad Pablo de Olavide	7	1	5	1	6	1	14	1
U. Politécnica de Cartagena	7	1	5	1	6	1	11	1.3
Universidade de Vigo	7	1	5	1	6	1	16	0.8
Universitat de Girona	7	1	5	1	6	1	18	0.6
Universitat Jaume I	7	1	4	1.1	6	1	18	0.6
Universidad de Cádiz	8	0.9	5	1	8	0.8	11	1.3
Universidad de Castilla-La Mancha	8	0.9	6	0.9	7	0.9	15	0.9
Universidad de Huelva	8	0.9	6	0.9	6	1	14	1
Universidad de León	8	0.9	5	1	8	0.8	18	0.6
Universidad de Málaga	8	0.9	5	1	8	0.8	15	0.9
Universidad de Oviedo	8	0.9	7	0.8	6	1	17	0.7
Universidad de Sevilla	8	0.9	6	0.9	7	0.9	12	1.2
Universidad de Valladolid	8	0.9	6	0.9	7	0.9	17	0.7
Universidad del País Vasco	8	0.9	5	1	7	0.9	16	0.8
Universidad Rey Juan Carlos	8	0.9	5	1	7	0.9	19	0.5
Universidad de Burgos	9	0.8	7	0.8	8	0.8	18	0.6
Universidad de Extremadura	9	0.8	6	0.9	8	0.8	21	0.3
Universidad de Jaén	9	0.8	7	0.8	8	0.8	16	0.8
Universidad de La Laguna	9	0.8	6	0.9	7	0.9	20	0.4
U. de Las Palmas de Gran Canaria	9	0.8	6	0.9	6	1	20	0.4
Universidade da Coruña	9	0.8	7	0.8	6	1	20	0.4
UNED*	10	0.7	8	0.7	9	0.6	19	0.5
Universidad de La Rioja	10	0.7	7	0.8	9	0.6	19	0.5

* The National Distance Education University.

Note: Universities are ordered from the highest to the lowest global index value. Universities with the same index value are ordered alphabetically.

Source: BBVA Foundation-Ivie.

Table 11. ISSUE-V Ranking for Teaching, Research, and Innovation and Technological Development

University	Global		Teaching		Research		Innovation and Technological Development	
	Rank.	Index	Rank.	Index	Rank.	Index	Rank.	Index
Universidad Complutense	1	4.3	1	4.4	2	4.1	4	4.3
Universitat de Barcelona	2	3.3	2	3.1	1	4.3	10	2.3
Universidad Politécnica de Madrid	3	2.8	5	2.5	5	2.8	2	6.1
Universitat de València	3	2.8	3	2.9	3	3.1	13	1.7
Universitat Politècnica de València	3	2.8	6	2.4	6	2.6	1	6.8
Universidad de Granada	4	2.7	3	2.9	6	2.6	12	1.8
Universidad del País Vasco	5	2.6	4	2.8	7	2.4	11	2.1
Universidad de Sevilla	6	2.5	5	2.5	8	2.3	7	3.4
Universitat Autònoma de Barcelona	6	2.5	7	2.2	4	2.9	6	3.5
Universitat Politècnica de Catalunya	6	2.5	8	2.1	6	2.6	3	5.3
UNED*	7	2.2	6	2.4	9	2.1	14	1.6
Universidad Autónoma de Madrid	7	2.2	9	2	7	2.4	5	3.7
Universidad de Zaragoza	8	1.9	10	1.8	10	1.8	9	2.7
U. de Santiago de Compostela	8	1.9	10	1.8	11	1.7	8	3.2
Universidad de Málaga	9	1.5	11	1.6	12	1.4	16	1.4
Universidad de Salamanca	9	1.5	11	1.6	12	1.4	15	1.5
Universidad de Alicante	10	1.3	13	1.2	13	1.3	10	2.3
Universidad de Murcia	10	1.3	12	1.3	12	1.4	17	1.3
Universidad Carlos III	11	1.2	15	1	13	1.3	16	1.4
Universidad de Castilla-La Mancha	11	1.2	13	1.2	14	1.2	18	1.2
Universidad de Oviedo	11	1.2	14	1.1	12	1.4	21	0.9
Universidad de Valladolid	11	1.2	13	1.2	14	1.2	21	0.9
Universidad de Alcalá de Henares	12	1.1	14	1.1	16	1	19	1.1
Universitat Pompeu Fabra	12	1.1	15	1	15	1.1	14	1.6
Universidade de Vigo	13	1	15	1	16	1	22	0.8
Universidad de Córdoba	14	0.9	16	0.9	16	1	22	0.8
Universidad de La Laguna	14	0.9	15	1	16	1	25	0.4
Universidad de Cádiz	15	0.8	16	0.9	19	0.7	19	1.1
Universidad de Cantabria	15	0.8	18	0.7	17	0.9	19	1.1
Universidad de Extremadura	15	0.8	15	1	18	0.8	26	0.3
U. de Las Palmas de Gran Canaria	15	0.8	17	0.8	17	0.9	25	0.4
Universidad Rey Juan Carlos	15	0.8	16	0.9	18	0.8	24	0.5
Universitat de les Illes Balears	15	0.8	18	0.7	17	0.9	22	0.8
Universitat Rovira i Virgili	15	0.8	18	0.7	17	0.9	22	0.8
U. Miguel Hernández de Elche	16	0.7	19	0.6	19	0.7	20	1
Universidade da Coruña	16	0.7	18	0.7	17	0.9	25	0.4
Universitat Jaume I	16	0.7	17	0.8	19	0.7	24	0.5
Universidad de Almería	17	0.6	19	0.6	21	0.5	23	0.6
Universidad de Jaén	17	0.6	19	0.6	20	0.6	24	0.5
Universitat de Girona	17	0.6	19	0.6	20	0.6	25	0.4
Universidad de Huelva	18	0.5	21	0.4	21	0.5	24	0.5
Universidad de León	18	0.5	19	0.6	21	0.5	25	0.4
Universidad Pablo de Olavide	18	0.5	20	0.5	21	0.5	24	0.5
Universidad Pública de Navarra	18	0.5	20	0.5	22	0.4	20	1
Universitat de Lleida	18	0.5	20	0.5	20	0.6	26	0.3
Universidad Politécnica de Cartagena	19	0.4	22	0.3	23	0.3	24	0.5
Universidad de Burgos	20	0.3	22	0.3	23	0.3	27	0.2
Universidad de La Rioja	21	0.2	23	0.2	24	0.2	28	0.1

* The National Distance Education University.

Note: Universities are ordered from the highest to the lowest global index value. Universities with the same index value are ordered alphabetically.

Source: BBVA Foundation-Ivie.

5.8. 2013 AND 2014 ISSUE RANKINGS

The results obtained by the U-Ranking Project in 2014 are highly correlated with those presented in the first edition in the year 2013, as will be shown below. Nevertheless, there are some interesting differences that deserve to be mentioned in this section.

As table 12 shows, the coefficients of correlation between the indices and the rankings corresponding to the two editions are high. All the correlations, both those referring to the positions in the ranking (Spearman) and to the values of the synthetic indicator (Pearson), are significant to 1% and present coefficients higher than 0.8. These correlations approach 1 in the case of the synthetic indicators of the ISSUE-P rankings, indicating that hardly any changes can be appreciated in the levels of productivity. This result is not surprising —only one year has passed— but it is important because, as well as the passage of time, in the second edition significant informative improvements and also two new variables have been introduced.

Table 12. Correlation coefficients of the 2013 and 2014 ISSUE rankings

	ISSUE-P		ISSUE-V	
	Ranking	Index	Ranking	Index
Global	0.97	0.99	0.99	0.98
Teaching	0.96	1.00	0.99	0.97
Research	0.88	0.99	0.99	0.93
Innovation and Technological Development	0.93	0.98	0.92	0.96

Note: The ranking values are calculated by means of a Spearman correlation coefficient and the index values by means of a Pearson correlation coefficient..

Source: BBVA Foundation-Ivie.

The close fit between the indicators of both editions of the ISSUE Project can also be appreciated in the following figures, which show on the horizontal axis the synthetic indicator of each university in 2014 and on the vertical axis the results for 2013, both for ISSUE-P (figure 13) and for ISSUE-V (figure 14). In both cases we observe that a greater number of observations are situated below the diagonal, indicating that in 2014 quite a number of universities have improved the value of the indicator over that calculated for the preceding year.

Figure 13. ISSUE-P of the Spanish public universities. 2013 and 2014

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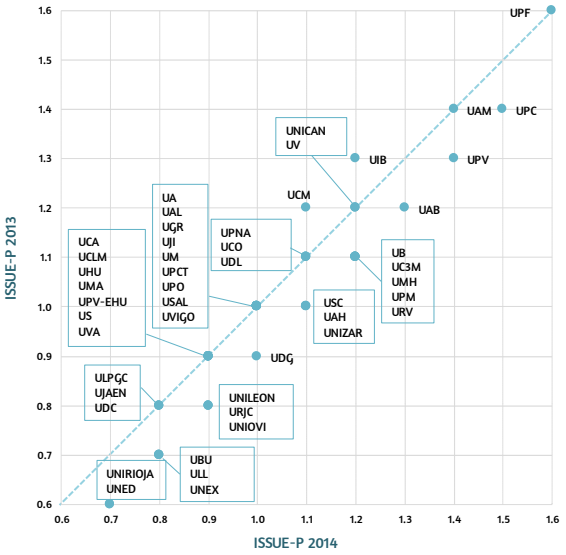
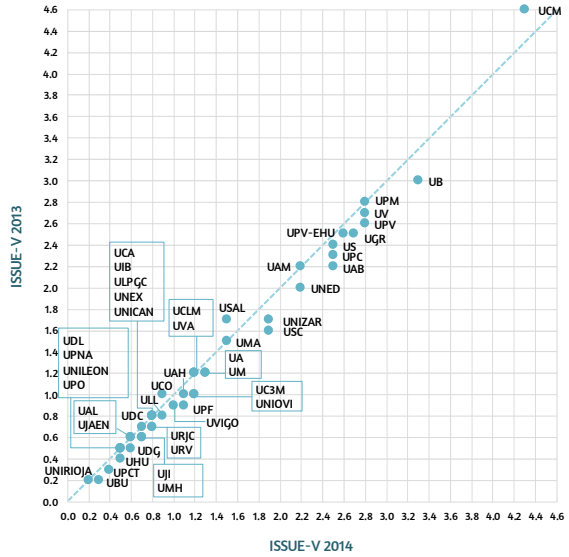


See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie.

Figure 14. ISSUE-V of the Spanish public universities. 2013 and 2014

Index



See appendix 2 for a list of the University abbreviations used.

Source: BBVA Foundation-Ivie.

Table 13. ISSUE-P and ISSUE-V Rankings. 2013 and 2014 results

University	ISSUE-P Ranking		ISSUE-P Index		University	ISSUE-V Ranking		ISSUE-V Index	
	2014	2013 adapted	2014	2013		2014	2013 adapted	2014	2013
Universitat Pompeu Fabra	1	1	1.6	1.6	Universidad Complutense	1	1	4.3	4.6
U. Politècnica de Catalunya	2	2	1.5	1.4	Universitat de Barcelona	2	2	3.3	3.0
Universidad Autónoma de Madrid	3	2	1.4	1.4	Universidad Politécnica de Madrid	3	3	2.8	2.8
Universitat Politècnica de València	3	3	1.4	1.3	Universitat de València	3	4	2.8	2.7
U. Autònoma de Barcelona	4	4	1.3	1.2	Universitat Politècnica de València	3	5	2.8	2.6
Universidad Carlos III	5	5	1.2	1.1	Universidad de Granada	4	6	2.7	2.5
Universidad de Cantabria	5	4	1.2	1.2	Universidad del País Vasco	5	6	2.6	2.5
U. Miguel Hernández de Elche	5	5	1.2	1.1	Universidad de Sevilla	6	7	2.5	2.4
Universidad Politécnica de Madrid	5	5	1.2	1.1	U. Autònoma de Barcelona	6	9	2.5	2.2
Universitat de Barcelona	5	5	1.2	1.1	U. Politècnica de Catalunya	6	8	2.5	2.3
Universitat de les Illes Balears	5	3	1.2	1.3	UNED*	7	10	2.2	2.0
Universitat de València	5	4	1.2	1.2	Universidad Autónoma de Madrid	7	9	2.2	2.2
Universitat Rovira i Virgili	5	5	1.2	1.1	Universidad de Zaragoza	8	11	1.9	1.7
Universidad Complutense	6	4	1.1	1.2	U. de Santiago de Compostela	8	12	1.9	1.6
Universidad de Alcalá de Henares	6	6	1.1	1.0	Universidad de Málaga	9	13	1.5	1.5
Universidad de Córdoba	6	5	1.1	1.1	Universidad de Salamanca	9	11	1.5	1.7
Universidad de Zaragoza	6	6	1.1	1.0	Universidad de Alicante	10	14	1.3	1.2
Universidad Pública de Navarra	6	5	1.1	1.1	Universidad de Murcia	10	14	1.3	1.2
U. de Santiago de Compostela	6	6	1.1	1.0	Universidad Carlos III	11	15	1.2	1.0
Universitat de Lleida	6	5	1.1	1.1	U. de Castilla-La Mancha	11	14	1.2	1.2
Universidad de Alicante	7	6	1.0	1.0	Universidad de Oviedo	11	15	1.2	1.0
Universidad de Almería	7	6	1.0	1.0	Universidad de Valladolid	11	14	1.2	1.2
Universidad de Granada	7	6	1.0	1.0	Universidad de Alcalá de Henares	12	15	1.1	1.0
Universidad de Murcia	7	6	1.0	1.0	Universitat Pompeu Fabra	12	16	1.1	0.9
Universidad de Salamanca	7	6	1.0	1.0	Universidade de Vigo	13	16	1.0	0.9
Universidad Pablo de Olavide	7	6	1.0	1.0	Universidad de Córdoba	14	15	0.9	1.0
U. Politécnica de Cartagena	7	6	1.0	1.0	Universidad de La Laguna	14	17	0.9	0.8
Universidade de Vigo	7	6	1.0	1.0	Universidad de Cádiz	15	17	0.8	0.8
Universitat de Girona	7	7	1.0	0.9	Universidad de Cantabria	15	17	0.8	0.8
Universitat Jaume I	7	6	1.0	1.0	Universidad de Extremadura	15	17	0.8	0.8
Universidad de Cádiz	8	7	0.9	0.9	U. de Las Palmas de Gran Canaria	15	17	0.8	0.8
U. de Castilla-La Mancha	8	7	0.9	0.9	Universidad Rey Juan Carlos	15	18	0.8	0.7
Universidad de Huelva	8	7	0.9	0.9	Universitat de les Illes Balears	15	17	0.8	0.8
Universidad de León	8	8	0.9	0.8	Universitat Rovira i Virgili	15	18	0.8	0.7
Universidad de Málaga	8	7	0.9	0.9	U. Miguel Hernández de Elche	16	19	0.7	0.6
Universidad de Oviedo	8	8	0.9	0.8	Universidade da Coruña	16	18	0.7	0.7
Universidad de Sevilla	8	7	0.9	0.9	Universitat Jaume I	16	19	0.7	0.6
Universidad de Valladolid	8	7	0.9	0.9	Universidad de Almería	17	19	0.6	0.6
Universidad del País Vasco	8	7	0.9	0.9	Universidad de Jaén	17	19	0.6	0.6
Universidad Rey Juan Carlos	8	8	0.9	0.8	Universitat de Girona	17	20	0.6	0.5
Universidad de Burgos	9	9	0.8	0.7	Universidad de Huelva	18	21	0.5	0.4
Universidad de Extremadura	9	9	0.8	0.7	Universidad de León	18	20	0.5	0.5
Universidad de Jaén	9	8	0.8	0.8	Universidad Pablo de Olavide	18	20	0.5	0.5
Universidad de La Laguna	9	9	0.8	0.7	Universidad Pública de Navarra	18	20	0.5	0.5
U. de Las Palmas de Gran Canaria	9	8	0.8	0.8	Universitat de Lleida	18	20	0.5	0.5
Universidade da Coruña	9	8	0.8	0.8	U. Politécnica de Cartagena	19	22	0.4	0.3
UNED*	10	10	0.7	0.6	Universidad de Burgos	20	23	0.3	0.2
Universidad de La Rioja	10	10	0.7	0.6	Universidad de La Rioja	21	23	0.2	0.2

* The National Distance Education University.
Note: The order of the 2013 Ranking has been adapted to make the comparison with the results obtained in 2014. The adapted 2013 Ranking has been ordered according to the value of the synthetic index rounded to one decimal place.
Source: BBVA Foundation-Ivie.

Finally, to facilitate comparison between the rankings presented in 2014 and those of 2013, table 13 reflects the position obtained in both years by all the universities after adapting the rankings for 2013 according to the criteria used in this second edition. The adaptation consists of calculating the results by means of the synthetic indicator rounded to one decimal and placing those universities that present the same index in the same position in the ranking.

The results thus obtained confirm a notable stability of the ISSUE-V ranking: with very few exceptions, the positions barely differ by one or two places. The group of universities that occupied the top places in 2013 continue to be located at the top in the 2014 edition. The same occurs with the other two tertiles.

From the point of view of productivity the differences are also small in the group of 13 universities located in 2013 in the 1st to the 6th places. These universities also occupied the top places of the classification in the ranking of 2013 but now more universities are located on the step beginning at place number 6. The same occurs at other steps, which makes comparisons more difficult and produces an impression of greater changes than have in fact taken place when the values of the indices and the correlations presented are considered.

6. Conclusions

The aim of the ISSUE Rankings (Synthetic Indicators of the Spanish University System) is to generate classifications of the Spanish universities on the basis of broad data sets that consider the principal dimensions of their activities. The ISSUE methodology is rigorous and is aligned with the recommendations of the recent international studies on this subject.

Aggregating the information on the results of the universities in different areas presents difficulties. Not considering them and contemplating the different indicators separately is not a practical solution, since most people interested in comparing the universities do not want to face large and complex volumes of information. Students, faculty members, researchers, university managers or politicians, and communications media appreciate having synthetic indicators available. The rankings —provided they are constructed with suitable criteria and metrics— are useful in this sense, because they condense the results and reduce the effort that the users of the information must make.

Some international initiatives in this terrain are already very well known —such as the Shanghai ranking or that of Times Higher Education (THE)— and have increased the visibility of the classifications of universities and the social demand for such rankings. But these rankings place the emphasis on the indicators of research and training of high international prestige, leaving out most of the activity of our university system, focused on the teaching of the Bachelor's degree and not really competing in these leagues. This orientation towards indicators of research is also characteristic of most of the existing national rankings, drawn up with guarantees of quality by specialists but considering indicators of the activities of our universities that are too partial.

The ISSUE Rankings permit us to overcome both limitations in good measure by analyzing the teaching, research and transfer results of all the public universities of Spain. In the near future we will incorporate into the ISSUE Rankings those private universities for which similar information is available to that used to analyze the public universities.

The rankings were constructed from a set of variables that take into account three relevant aspects: (i) the universities' different missions (teaching, research, innovation and technological development); (ii) the existence of differences in the results of a university in the different areas of study; and (iii) the importance of considering the preferences of the users of university services when constructing some rankings.

ISSUE has generated two general rankings of the universities —that of volume of results (ISSUE-V) and that of productivity (ISSUE-P)— as well as six partial rankings: teaching, research and transfer, in terms both of volume and of productivity. The set of rankings offers eight profiles of each of the universities, which can be of interest for assessing them from different perspectives. In some cases the images of a university projected by each ranking are the same, and in others they are different. It corresponds to the users of the information —university or political leaders, researchers, students, analysts, etc.— to consider which of these images are the most relevant for their needs or interests.

The rankings obtained when considering on the one hand the universities' total volume of activity and on the other their productivity are clearly different. This is not surprising, because in Spain great classical institutions —some several centuries old, with all the advantages and disadvantages that this implies— coexist with universities of more recent creation —many of them with less than fifty years of life and some with little more than a decade— and much smaller in size. But the disparity of results permits us to observe that neither size nor

antiquity are unequivocal determinants of advantages or disadvantages: there exist examples of good practice among the big universities with many years of history, and also among those created in the second half of the 20th century and among the youngest.

By means of the synthetic indicators from which the rankings are derived it is possible to appreciate that the differences in productivity between universities are substantial —the indicator of the most productive ones doubles that of the least— but much smaller than their differences in volume of results, as these are influenced by the productivity and by the size of the universities, which is very different.

It is important to highlight that there is a group of universities —formed by institutions with very varied profiles, but among which those of larger size predominate— that occupy the best positions both from the perspective of volume of results and in terms of productivity. Most of them also form part of the group of Spanish universities that most appear at the top of the best known international rankings, such as those of Shanghai, THE and QS. So, the ISSUE Rankings confirm that the Spanish universities that appear frequently in the international rankings are those that generate a greater volume of results and are more productive. The repeated signals emitted by these institutions allow us to identify, in a manner fairly robust to the use of different criteria, the group of Spanish universities that stand out for their excellence.

The ISSUE-V results agree in large measure with those of the Shanghai ranking —because this index is based fundamentally on indicators of volume of results— although our aggregate ranking gives a more important role to the teaching dimension. Nine of the ten Spanish universities that currently figure in the Top 500 of the Shanghai ranking form part of the sixteen constituting the first tertile of the ISSUE-V Ranking. Eight of the ten belong also to the leading group of the ISSUE-P Ranking.

The fact that the results of the general rankings based above all on indicators of research agree fairly well with others that consider different dimensions (teaching, research, innovation and technological development) indicates that the higher or lower quality of each university in the different areas is usually correlated. But this correlation is far from perfect and it is therefore important not to omit any of the dimensions of university activity. The comparison of the partial rankings of teaching and research generated indicates that, although the correlation between the two is high, we also detect a significant variety of teaching results among universities with similar level of research results. Therefore, a general ranking that considers both dimensions gains in precision over one that is only based on research information. And, above all, a research ranking is imprecise when what we want to compare is the teaching activity of the universities, which is what interests a high proportion of students.

The case in which the attention of the user of the rankings focuses most clearly on teaching is when students want to consult them in order to choose a university to study for their degrees. In this situation it is probable that, in addition, the student will be interested above all in the quality of the university in certain studies, more than in the quality of research, and even in the quality of the teaching in general. In response to the demands for information from this perspective, ISSUE has developed a web tool that generates personalized rankings of Bachelor's degrees. These rankings are obtained taking into account students' preferences as to what they want to study, where they are willing to study it, and the importance they attribute to the teaching or R&D&I aspects. The project intends to extend this analysis in the future to postgraduate degrees, but the information currently available does not allow this.

The role of the web tool developed is to offer students information of quality and rankings very easy to obtain. In this way we facilitate their task of assessing the options that best fit their criteria, when choosing the university in which to study for a degree. If the rankings are constructed rigorously they can help notably to orientate with reasonable criteria decisions that are complex for non-experts, and even for professionals such as careers advisers. Actually, no ranking is without problems but the alternative is to dedicate much effort to gathering and sorting a lot of information. The difficulties and the cost of doing so often lead to making the decision in almost total absence of information. We therefore consider that a well-

founded system of rankings like the one offered —and the complementary information on cut-off marks, cost of registration and characteristics of the surrounding environment— may be of great utility, since by enormously easing the task it will permit many people to make better informed decisions.

One general conclusion from the results of the project is that it confirms a notable diversity among the Spanish public universities with regard to their capacity to generate results and to their productivity. This diversity is also very notable with regard to their teaching and research specialization and their capacity to stand out in specific subject areas or degrees. In reality, the general characteristics of each university constitute an important element in explaining their results in each of their activities, but a notable internal diversity is also appreciated in many cases, examples of excellence existing in specific degrees in institutions that are not, in general terms, outstanding.

The broad dataset on the universities offered by the U-Rankings Project permits us to profile very relevant features of the diversity of the Spanish university system and inside each of the universities. Acknowledgement of this diversity is very relevant to various objectives: to evaluate the universities' results; to selectively orientate their strategies for improvement and university policies; to orientate the potential users of teaching services; and to supply information to firms and institutions interested in knowing the universities' capacity to generate R&D&I results.

Appendix 1: Glossary of Indicators

Appendix 1. Glossary of indicators and statistical sources of 2014 ISSUE Rankings

Dimension	Area	Indicator and definition	Source	Period	Disaggregation
Teaching	Resources	**Faculty member with PhD per 100 students:** Faculty member with PhD equivalent to full-time per each 100 students registered in studies of 1st and 2nd cycle (former Spanish degree structure) and in Bachelor's degrees in centers belonging to the University, Master's degrees and Doctoral degrees (Bologna's degree structure)	CRUE	2008-09 and 2010-11	Branch of knowledge
		Budget / Student: Effective income of the University by number of students registered in studies of 1st and 2nd cycle and Bachelor's degree (in centers belonging to the University), Master's degrees and Doctoral degrees	CRUE	2008 and 2010	University
		Faculty member with PhD / Faculty members: Faculty member with PhD equivalent to full-time over total teaching and research staff equivalent to full-time	CRUE	2008-09 and 2010-11	University
	Output	**Success rate**: Number of credits passed (excluding transfer, validated and recognized credits) over total credits evaluated	CRUE	2008-09 and 2010-11	Bachelor's degree group
		Evaluation rate: Number of credits evaluated over total credits registered	CRUE	2008-09 and 2010-11	Bachelor's degree group
		Drop-out rate: Students registered in academic year t who, two years after registering in the first year of a degree, abandon it without graduating, over the total number of students registered in year t	CRUE	2008-09 and 2010-11	Bachelor's degree group
	Quality	**Attractiveness index**	-	-	-
		Percentage of postgraduate students: Students registered in Master's degrees over the total number of students of 1st and 2nd cycle, Bachelor's degrees and Master's degrees	MECD	2009-10 to 2012-13	Branch of knowledge
		Cut-off mark: Mark of the last *general group*[1] student that gained admission to a degree with limited places	Universities	2013-14	Bachelor's degree
	Internationalization	**Percentage of foreign students:** Non-Spanish students of 1st and 2nd cycle, Bachelor's degrees and Master's degrees over the total number of students of 1st and 2nd cycle, Bachelor's degrees and Master's degrees	MECD	2010-11 to 2012-13	University
		Percentage of students in exchange programs: Spanish Students of 1st and 2nd cycle and Bachelor's degrees who participate in the ERASMUS programme, over the total number of students of 1st and 2nd cycle and Bachelor's degrees	CRUE	2008-09 and 2010-11	Branch of knowledge
		Percentage of students registered in programs imparted in non-official languages	-	-	-

Dimension	Area	Indicator and definition	Source	Period	Disaggregation
Research	Resources	**Competitive public resources per faculty member with PhD:** Competitive public resources for undirected research projects, including both projects and complementary actions and ERDF funds, over the total number of faculty members with PhD equivalent to full-time	DGICT CRUE	2007-2012	Branch of knowledge
		Contracts with PhDs, research grants and technical support over total budget: Competitive resources obtained for research staff training, Juan de la Cierva, Ramón y Cajal and support technicians over total effective income	DGICT CRUE	2007-2012	Branch of knowledge
	Output	**Citable documents with ISI reference per faculty member with PhD:** Documents with ISI reference published per 100 faculty members with PhD equivalent to full-time	IUNE (Thomson Reuters) CRUE	2006-2011	Branch of knowledge
		Total *sexenios*[2] over possible *sexenios*: *Sexenios* obtained over the total possible *sexenios* for the universities' tenured research staff.	CNEAI	2009	Branch of knowledge
		Doctoral theses read per 100 faculty members with PhD: Doctoral theses read per 100 faculty members with PhD equivalent to full-time	MECD CRUE	2008-2011	Branch of knowledge
	Quality	**Mean impact factor:** Mean impact factor of the publications with at least one author affiliated to the University	IUNE (Thomson Reuters)	2006-2011	Bachelor's degree group
		Percentage of publications in the first quartile: Publications corresponding to journals in the first quartile of relevance within the Thomson Reuters classification by areas, over the total number of publications belonging to that area	IUNE (Thomson Reuters)	2006-2011	Bachelor's degree group
		Citations per document: Citations received by each document from the date of publication to the date of data gathering	IUNE (Thomson Reuters)	2006-2011	Bachelor's degree group
	Internationalization	**European or international research funds per faculty member with PhD:** Effective income from abroad due to applied research per faculty member with PhD equivalent to full-time	CRUE	2008 and 2010	University
		Percentage of publications with international co-authorship: Publications with at least one co-author affiliated to a foreign institution over the total number of publications	IUNE (Thomson Reuters)	2006-2011	Bachelor's degree group

Dimension	Area	Indicator and definition	Source	Period	Disaggregation
Innovation and Technological Development	Resources	**Income from licenses per 100 faculty members with PhD[3]**: Income generated by the use and exploitation of licenses of the university for each 100 faculty members with PhD	IUNE (OTRIs)	2006-2011	University
		Income from consultancy contracts per 100 faculty members with PhD[3]: Income from R&D and consultancy contracts and from provision of services per 100 faculty members with PhD	IUNE (OTRIs)	2006-2011	University
		Income from continuing professional development (CPD) courses per faculty member with PhD[3]: Fees received from registration both for CPD and for the university's own postgraduate programs (master, specialist and expert) per faculty member with PhD	CRUE IUNE (INE)	2008 and 2010	University
	Output	**Number of patents per 100 faculty members with PhD[3]**: Number of national patents granted to each Spanish university by the Spanish Patents and Trade Marks Office per 100 faculty members with PhD	IUNE (OTRIs)	2006-2011	University
		CPD hours per faculty member with PhD	-	-	-
		Number of contracts per faculty member with PhD	-	-	-
	Quality	**Patents commercialized per faculty member with PhD**		-	-
	Internationalization	**Triadic patents per 100 faculty members with PhD**: Number of simultaneous protections of inventions in different countries obtained through an international patent application, per 100 faculty members with PhD	IUNE (OTRIs)	2006-2011	University
		Income from international contracts per faculty member with PhD	-	-	-

1 General group: students finishing high school or students graduated in Advanced Vocational Training or foreign students.
2 Monetary compensation received for research activity based on the last six years.
3 The faculty members with PhD used for calculating the indicators of *Innovation and Technological Development* are those in the following categories: Professor, University School Professor, Associate Professor, University School Associate Professor, and Assistant Professor, registered each year in the centers belonging to the public universities

Appendix 2: List of University Abbreviations

University	Abbreviation
UNED	UNED
Universidad Autónoma de Madrid	UAM
Universidad Carlos III	UC3M
Universidad Complutense	UCM
Universidad de Alcalá de Henares	UAH
Universidad de Alicante	UA
Universidad de Almería	UAL
Universidad de Burgos	UBU
Universidad de Cádiz	UCA
Universidad de Cantabria	UNICAN
Universidad de Castilla-La Mancha	UCLM
Universidad de Córdoba	UCO
Universidad de Extremadura	UNEX
Universidad de Granada	UGR
Universidad de Huelva	UHU
Universidad de Jaén	UJAEN
Universidad de La Laguna	ULL
Universidad de La Rioja	UNIRIOJA
Universidad de Las Palmas de Gran Canaria	ULPGC
Universidad de León	UNILEON
Universidad de Málaga	UMA
Universidad de Murcia	UM
Universidad de Oviedo	UNIOVI
Universidad de Salamanca	USAL
Universidad de Sevilla	US
Universidad de Valladolid	UVA
Universidad de Zaragoza	UNIZAR
Universidad del País Vasco	UPV-EHU
Universidad Miguel Hernández de Elche	UMH
Universidad Pablo de Olavide	UPO
Universidad Politécnica de Cartagena	UPCT
Universidad Politécnica de Madrid	UPM
Universidad Pública de Navarra	UPNA
Universidad Rey Juan Carlos	URJC
Universidade da Coruña	UDC
Universidade de Santiago de Compostela	USC
Universidade de Vigo	UVIGO
Universitat Autònoma de Barcelona	UAB
Universitat de Barcelona	UB
Universitat de Girona	UDG
Universitat de les Illes Balears	UIB
Universitat de Lleida	UDL
Universitat de València	UV
Universitat Jaume I	UJI
Universitat Politècnica de Catalunya	UPC
Universitat Politècnica de València	UPV
Universitat Pompeu Fabra	UPF
Universitat Rovira i Virgili	URV

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