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Abstract

In today's globalising environment, visibility has become a pivotal asset for higher education institutions to obtain material and human resources and enhance their prestige. Hence, their interest in having their achievements in certain fields are duly acknowledged. In this paper, we propose a pool of tools and indicators to identify the most visible Spanish universities into the international scope, and their thematic strengths. Different sources of information were used: web of science, essential science indicators, and international rankings. Scientometric indicators of visibility were obtained: number of citation by institution and field, highly cited papers, hot cited papers, position of Spanish universities in international rankings. Considering the different thematic classification of sources, an aggregation in 4 areas was maked and relationships between universities and their specialisations were drawn. 44 Spanish universities have some indicator of international visibility; the most frequent are highly cited papers. 27 universities are in the rankings of specialties, most of them present in

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the QS ranking by subject. Greater specialization is given in Experimental Sciences and universities with more visibility are Autonomus University of Madrid, University of Valencia and Autonomus University of Barcelona. This study shows that the analysis of visibility based solely on the impact of publications or in position, in general ranking of universities can be very limited. It is necessary to reach the level of sub-discipline and thus detect institutional strengths in each specific field.

Resumen

En el actual contexto de globalización, la visibilidad internacional se ha convertido en un activo fundamental para las instituciones de educación superior, ya sea para obtener recursos materiales y humanos como para mejorar su prestigio. De ahí el creciente interés, por parte de las universidades, en que sus logros en ciertos campos científicos sean debidamente reconocidos. Utilizando una metodología cienciométrica, en este trabajo, se proponen una serie de herramientas e indicadores para identificar las universidades españolas más visibles internacionalmente y detectar sus fortalezas temáticas. Se han utilizado como fuentes de información la base de datos de publicaciones Web of Science, los Essential Science Indicators de Thomson Reuters y los principales rankings internacionales de universidades. Se obtuvieron indicadores bibliométricos de visibilidad: número de citas por institución y área temática, número de documentos altamente citados (Highly cited papers y Hot cited papers) y posición de las universidades españolas en los rankings internacionales. Para unificar las diferentes clasificaciones temáticas en que cada fuente ofrece la información, se ha realizado una agregación en 4 grandes áreas. Los principales resultados muestran que 44 universidades españolas presentan algún indicador de visibilidad internacional, siendo los más frecuentes los documentos altamente citados. 27 universidades aparecen en los rankings de especialidades y es el ránking QS por temas el que mejor muestra las áreas de especialización. Ciencias Experimentales es el área de mayor especialización y las universidades con más visibilidad en ella son la Universidad Autónoma de Madrid, la Universidad de Valencia y la Universidad Autónoma de Barcelona. Este estudio muestra que el análisis de visibilidad basado únicamente en el impacto de las publicaciones puede ser muy limitado y que el estudio de la presencia en rankings generales no resulta muy preciso. Es necesario profundizar a nivel de sub-disciplina y así detectar las fortalezas institucionales en cada área específica.

Introduction

Today's universities face a dual challenge: on the one hand they need to strengthen their bonds with other institutions to optimise resources and mutually complement capacities, and on the other, they must raise their international visibility to attract resources and establish their standing in the world arena. Changing times require these institutions to build new models to conduct and interpret scientific activity able to capitalise on the results and all the resources available within their international sphere of influence (De Filippo et al., 2015). Against this backdrop of change, university visibility acquires growing importance. International visibility helps universities to attract students, professors and reputed researchers and to become a prominent partner with which foreign institutions decide to collaborate to apply for joint projects in international competitions. International visibility helps universities to attract students, professors and reputed researchers and to become a prominent partner with which foreign institutions decide to collaborate to apply for joint projects in international competitions. Visibility, in a nutshell, translates into recognition and resources (Docampo, 2008). Until very recently, multidisciplinary institutions' (such as universities, groups or institutes) scientific activity (visibility included) was ordinarily assessed with bibliometric indicators of the number of papers published in journals listed in international databases such as *Web of Science* or *Scopus* (Moed, 2010). The number of papers involving international collaboration and other indicators such as the percentage published in first quartile (Q1) journals have also been used to measure visibility. As a rule, however, researchers have tended to apply impact-related indicators, usually the number of citations, although indicators such as highly cited or hot papers are becoming increasingly popular. The reason is that the number of highly cited papers is regarded as a good measure of an institution's reputation (Zhu et al., 2004) and its scientific contribution on an international scale (Tijssen et al., 2002).

International university rankings have also proven to be a useful tool for measuring visibility. Such rankings have had a substantial impact on the academic world because their methodology, while not uncriticised (van Raan, 2005; Harvey, 2008), is generally based on readily understandable indicators common to all institutions, facilitating the comparison of highly heterogeneous organisations.

Within the wide range of international university rankings, the so-called League Tables are those that have acquired greater prestige and those that have had a greater influence on the research policies of the higher education centers: Academic Ranking of World Universities (ARWU), QS World University Rankings (QS) and Times Higher Education World Universities Rankings (THE). This is because they were the first to appear, they use synthetic indicators that are easy to understand by all agents involved and they evaluate a large group of universities around the world based on indicators that not only take into account the research but also include other university missions (Rauhvargers 2011; 2013). After their appearance in 2003-2004, these global university classifications shook academic institutions and since then the ARWU, THE and QS Rankings have generated important positive consequences: they increase the competitiveness among institutions, promote the measurement of the academic performance of universities rather than reputation-based assessment, allow the design of scientific policies aimed at improving the ranking position, etc. (Sanz-Casado 2015).

Considering international rankings of universities, three of the best-known university league tables are ARWU, QS and THE. Even when only these three are used to determine an institution's visibility, account must be taken of the sub-rankings by fields and subjects that have been established to surmount one of the major limitations of general rankings: the inability to detect cross-disciplinary differences in performance (van Raan, 2005; Robinson et al. 2014a).

The first ranking to include information by discipline was the Shanghai listing, first with five major fields in 2007 and subsequently (in 2009) with specific subjects. Since then, many others have followed suit, including the THE, the QS and the National Taiwan University rankings. The CWTS Leiden ranking is, at this writing, the last to adopt the practice, including five major fields in its 2013 edition (Robinson-García and Calero-Medina, 2014b). Such discipline-oriented rankings furnish much more specific information on each institution's specialisation and help identify institutions absent from the overall ranking but which are well positioned and consequently highly visible in a given field.

Drawing from these two sources of information (publications and rankings), this paper aims to identify the Spanish universities with greatest international visibility and their specific areas of specialisation.

That information is used to determine the Spanish university system's main scientific poles of attraction within the international community.

Sources and methodology

Considering the importance that scientometric indicators has achieved in recent decades as a methodology for the study and evaluation of the research activity of institutions (Moed 2005), this study uses quantitative indicators to analyze the visibility of universities. Since it is a question of analyzing international visibility, sources of recognized prestige in this field have been chosen and are among the most recognized and used in the field of evaluation of the scientific activity of higher education institutions

This study was conducted by stages, as follows.

Identification of most cited universities: Essential Science Indicators from Thomson Reuters (2015 edition) which provide information on the number of publications in Web of Science and citations received by each institution in the last decade (2005-2015) were used. The 500 most cited institutions in the world have been detected and Spanish universities have been identified. Citations received and citations per document (relative impact) in the different thematic areas (22 areas InCITES)[2] were collected. Relative impact for each university was compared with the average of relative impact of Spain, to identify institutions and specialties most relevant.

Selection of most cited papers: Using Essential Science Indicators (Thomson Reuters, 2015) highly cited papers (publications most cited in 10 years)[3] were selected. Spanish universities signing the 200 most cited papers were identified. Data were collected by thematic field (22 areas InCITES) and the position for each university in world rank by citation was calculated.

The Hot cited papers (publications with high citation in the last 2 years) were also obtained. Publications with more than 100 citations have been considered and then, the documents signed by Spanish universities in each subject (22 areas InCITES) were identified.

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[2] Thematic classification used by the Essential Science Indicator is detailed in: http://incites.isiknowledge.com/common/help/h_field_category.html

[3] Red more about Highly cited papers from Thomson Reuters in: http://esi.webofknowledge.com/help/h_da-thic.htm

Detection of universities in international rankings: To complete the information obtained from publications, it was consulted the 2015 edition of the following rankings: ARWU, QS y THE. First, information about the positions reached by all universities in each country in different subject areas was obtained. Then Country-field/area correspondence analyses were conducted with XLstat software to establish Spain's international standing versus the other countries with universities in the rankings. With the obtained information from the rankings we elaborate indicators positioning Spanish universities both in the general rankings as thematic specialties (subject and field).

Aggregation in broad subject areas

Whereas information on publications is classified into 22 areas, it has been aggregated into 4 broad areas to make it more comparable with the classification of international rankings of universities. We have used the GIPP classification of Thomson Reuters in 6 fields[4]: Table I).

The most frequently aggregation system used by University rankings is in 5 broad areas, but they use different classification systems to each other. Therefore, to have a similar classification to GIPP areas, it has unified rankings classification in 4: Engineering; Life Science & Medicine; Experimental Science; Humanities & Social Science. Table II shows the final correspondence between areas.

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[4] The process followed by Thomson Reuter to obtain the Highly cited papers could be consulted at: http://esi.webofknowledge.com/help/h_dathic.htm

[5] Arts & Humanities; Clinical, Preclinical & Health; Engineering & Technology; Life Science; Physical Sciences; Social Sciences. Then they have joined the categories Social Science and Humanities with Arts & Life Science with Clinical, Preclinical & Health

TABLE I. Aggregation of thematic categories (WoS Categories and GIPP)

Area GIPP	WoS category
Engineering	Acoustics; Automation & Control Systems; Computer Science; Construction & Building Technology; Energy & Fuels; Engineering; Ergonomics; Imaging Science & Photographic Technology; Instruments & Instrumentation; Materials Science; Mechanics; Metallurgy & Metallurgical Engineering; Microscopy; Mining & Mineral Proce ssing; Nuclear Science & Technology; Operations Research & Management Science; Remote Sensing; Robotics; Telecommunications; Transportation
Life Science & Medicine	Agriculture; Agronomy; Anatomy & Morphology; Andrology; Behavioral Sciences; Biochemistry; Biodiversity Conservation; Biology; Biophysics; Biotechnology; Cell Biology; Ecology; Entomology; Environment; Fisheries; Forestry; Genetics; Horticulture; Immunology; Limnology; Marine & Freshwater Biology; Microbiology; Neuroscience; Ornithology; Paleontology; Parasitology; Physiology; Veterinary Science; Zoology. Allergy; Anesthesiology; Cardiac & Cardiovascular Systems; Clinical Neurology; Critical Care Medicine; Dentistry; Dermatology; Emergency Medicine; Endocrinology & Metabolism; Gastroenterology & Hepatology; Geriatrics & Gerontology; Health Care Sciences & Services; Hematology; Infectious Diseases, Integrative & Complementary Medicine; Medicine, General & Internal; Nursing; Nutrition & Dietetics; Nursing; Obstetrics & Gynecology; Oncology; Ophthalm ology; Oncology; Orthopedics; Otorhinolaryngology; Pathology; Pediatrics; Peripheral Vascular Disease; Pharmacology & Pharmacy; Primary Health Care; Psychiatry; Public, Environmental & Occupational Health; Radiology; Rehabilitation; Respiratory System; Rhe umatology; Sport Sciences; Substance Abuse; Urology & Nephrology; Transplantation; Tropical Medicine; Urology & Nephrology
Experimental Science	Astronomy/Astrophysics; Chemistry; Crystallography; Electrochemistry; Geochemistry & Geophysics; Geography, Phy sical; Geology; Geosciences; Mathematics; Meteorology & Atmospheric Science; Mineralogy; Multidisciplinary Sciences; Nanoscience & Nanotechnology; Oceanography; Optics; Physics; Polymer Science; Spectroscopy; Statistics & Probability; Thermodynamics; Water Resources
Social Sciences & Humanities	Anthropology; Archaeology; Business; Communication; Criminology & Penology; Demography; Economics; Education; Environmental Studies; Ethics; Ethnic Studies; Geography; Gerontology; Health Policy & Services; History of Social Sciences, Hospitality, Leisure, Sport & Tourism; International Relations; Law; Management; Planning & Development; Political Science; Psychology; Public Administration; Social Issues; Social Work; Sociology; Urban Studies; Women`s Studies. History & Philosophy of Science; Humanities; Language; Linguistics; Literature, Medieval Studies; Music; Philosophy; Poetry; Religion; Theater

TABLE II. Final thematics aggregation in 4 broad areas

Normalized Área	Area from sources	Rank
Social Science & Humanities	SOC	ARWU
	Social Sciences and Management	QS
	Social Sciences	THE
	Arts and Humanities	QS
	Arts & Humanities	THE
	Arts & Humanities	INCITE
	Social Science	INCITE
Life Science & Medicine	LIFE	ARWU
	Life sciences	THE
	MED	ARWU
	Life Sciences and Medicine	QS
	Clinical, Pre-clinical & Health	THE
	Clinical, Pre-Clinical & Health	INCITE
	Life Science	INCITE
Engineering & Technology	ENG	ARWU
	Engineering and Technology	QS
	Engineering and technology	THE
	Engineering & Technology	INCITE
Experimental Science	SCI	ARWU
	Natural Scieces	QS
	Phisical Science	THE
	Physical Sciences	INCITES

Relationship between universities and thematic area of specialization: With the collected information, a relationship between universities and thematic specialization was obtained. This allows identify areas of greater visibility in the Spanish Higher Education System and the most relevant universities in each area. For visualization, RAW program was used[6]. Figure I shows the process performed.

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(6) RAW is an open Access tool accessible in: http://raw.densitydesign.org

FIGURE I. Methodological steps developed
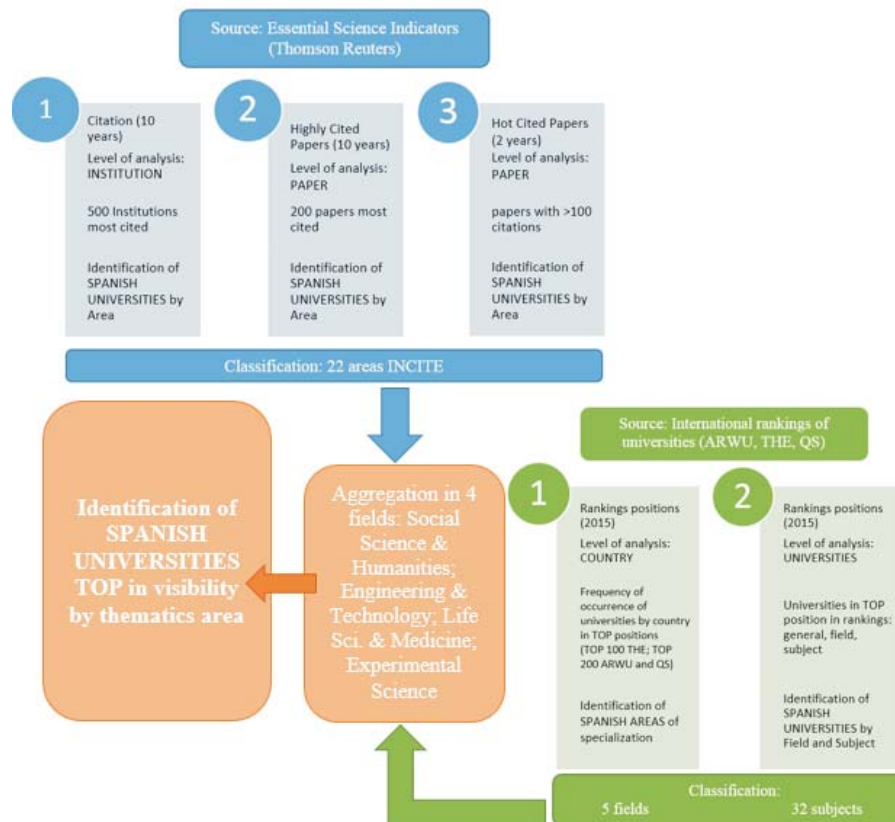
Results

Identification of most cited universities:

According to Essential Science Indicators, in the last 10 years (2005-2015), six Spanish universities were listed among the 500 'most cited' institutions: University of Barcelona (UB), Autonomous University of Barcelona (UAB), University of Valencia (UV), Autonomous University of Madrid (UAM),

Complutense University of Madrid (UCM) and University of Granada (UGR).

A review of the impact values in the 22 ESI fields revealed where each university excelled. University of Barcelona was the highest positioned Spanish institution in seven, with particularly high values with respect to the national mean in Computer Science. The Autonomous University of Madrid was prominent in five areas, with a high impact in Chemistry, while the University of Valencia was well placed in four, in particular Materials Science.

Thematic aggregation in 4 broad areas, shows a high relative impact (citation by document) of the University of Barcelona in Life Science with an average much higher than Spain. In Experimental Science, the impact of the University of Valencia is the most relevant, while in Engineering is especially high the number of citations per document at the University of Barcelona. Social Sciences is the field in which all universities have a relative impact above average than Spain (Table III).

TABLE III. Citation by document of the Spanish universities at TOP 500 institution of the world (2005-2015)

Área	UB	UAB	UV	UAM	UCM	UGR	ESPAÑA
LIFE	17,85	14,02	13,32	15,34	11,07	10,55	**14,90**
EXP	12,06	15,43	17,83	16,42	6,77	13,44	**14,39**
ENG	12,06	9,81	11,27	9,05	9,33	7,19	**8,53**
SOC	6,63	5,97	4,15	4,04	4,26	4,43	**3,43**
Total	**16,61**	**13,65**	**14,37**	**15,05**	**10,98**	**10,86**	**12,41**

Source: formulated by the authors based on Essential Science Indicators (2015)

Most cited paper selection

Highly cited papers in Web of Science

Information on the Web of Science's highly cited papers over the last 10 years can be gleaned from Essential Science Indicators. The University

of Vigo published the highest ranking Spanish paper, which appeared (in the field Molecular Biology and Genetics; LIFE Area) on the list of the world's 200 most cited articles with a total of 3 901 citations. Spanish universities with papers on that list are enumerated in Table IV, along with the field of research, the worldwide position by number of citations and the number of citations received by the highest ranking paper in the field. The University of Granada ranked highly for four articles in Physics (EXPERIMENTAL Area), which was, moreover, the field of research with the highest concentration of highly cited Spanish papers.

TABLE IV. Top Spanish universities' highly cited papers in all fields of research (TOP 200 institution in the world)

Rank in Spain	University	N citations recibed	Area	Area InCite	Rank in the Word	Max citation in the area
1	UVIGO	3901	LIFE	Molecular Biology & Genetic	55	18635
2	UPV	3573	EXP	Physics	74	15048
2	UGR	3573	EXP	Physics	74	15048
3	UB	3383	ENG	Computer Science	6	9344
4	UPV	3375	EXP	Physics	87	15048
4	UGR	3375	EXP	Physics	87	15048
5	UV	3257	EXP	Physics	94	15048
5	UGR	3257	EXP	Physics	94	15048
6	UV	3247	EXP	Physics	96	15048
6	UGR	3247	EXP	Physics	96	15048
7	UGR	3114	EXP	Physics	106	15048
7	UV	3114	EXP	Physics	106	15048
7	UAB	3114	EXP	Physics	106	15048
8	UNIZAR	2520	EXP	Physics	156	15048
9	UAM	2404	EXP	Chemistry	177	39341
9	UMU	2404	EXP	Chemistry	177	39341

Source: formulated by the authors based on Essential Science Indicators (2015)

An in-depth analysis of the fields revealed specialisation strengths. Computer Science, Environmental Science, Multidisciplinary Science and Physics were the fields with the largest number of Spanish universities accredited with the authorship of highly cited articles. By institutions, the

University of Barcelona stood out with a paper in Computer Science that was the sixth most cited worldwide. Papers with Polytechnic University of Valencia and Granada University authorship in Physics ranked ninth worldwide. Figure II shows the area of specialization of each university indicating its position through the size and color of the circles (dark colors and large circles = best positions).

FIGURE II. Highly cited papers from the Spanish universities best positioned in each area (articles of the TOP 200 institutions of the world by citation.
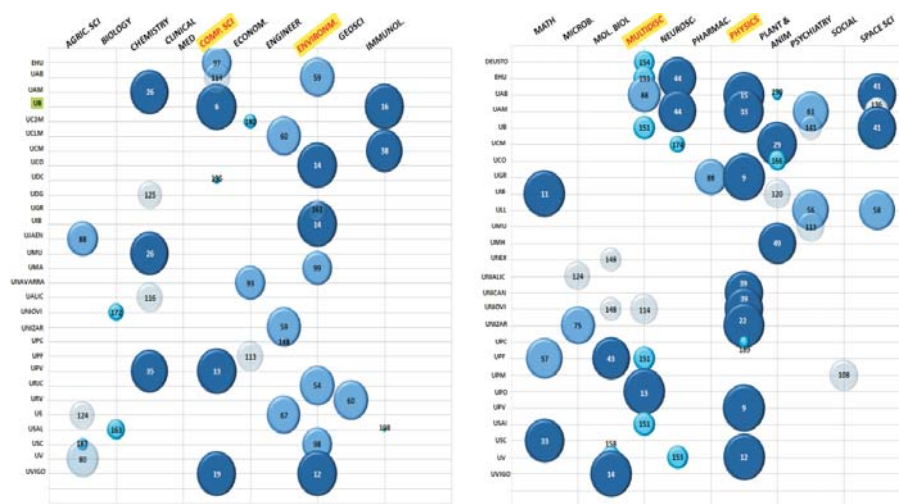
Source: formulated by the authors based on Essential Science Indicators (2015)

Hot cited papers in web of science

Hot cited papers are articles receiving a large number of citations in the last 2 years since its publication. Table V lists the hot cited paper (with more than 100 citations) from Spanish universities. Considering the 31 hot cited papers detected, Life Science is the abroad area with higher number of papers. Clinical Medicine and Physics were the fields with the largest number of hot cited papers authored by Spanish universities,

although the articles in question were often written in collaboration between universities. One article from Autonomous University of Madrid ranked first worldwide in Plant & Animal Science and another authored by Barcelona University (Clinical Medicine), ranked fifth.

TABLE V. Top Spanish universities' hot cited papers in all fields of research (papers with >100 citations)

Rank en España	Universidad	N de citas recibidas	Area	Area InCite	Rank en el mundo	Maxima citación en el área
1	UB	502	LIFE	Clinical medicine	5	3089
2	UB	445	LIFE	Clinical medicine	7	3089
2	UV	445	LIFE	Clinical medicine	7	3089
2	UNAVARRA	445	LIFE	Clinical medicine	7	3089
2	URV	445	LIFE	Clinical medicine	7	3089
2	UMA	445	LIFE	Clinical medicine	7	3089
2	ULPGC	445	LIFE	Clinical medicine	7	3089
3	UV	332	LIFE	Clinical medicine	11	3089
6	UV	277	LIFE	Clinical medicine	21	3089
7	UB	244	LIFE	Clinical medicine	28	3089
10	UAB	209	LIFE	Clinical medicine	36	3089
11	UNIOVI	209	LIFE	Molecular Biology	6	524
15	UAM	160	LIFE	Plant & Animal Sciences	1	160
16	UAB	158	LIFE	Clinical medicine	54	3089
18	UAB	148	LIFE	Clinical medicine	63	3089
19	UAB	147	LIFE	Clinical medicine	64	3089
21	UNIOVI	142	LIFE	Clinical medicine	68	3089
22	UB	142	LIFE	Neuroscience	6	333
22	UAB	142	LIFE	Neuroscience	6	333
23	UNIZAR	141	EXP	Physics	15	303
25	UNIALI	131	EXP	Chemistry	35	641
26	UAB	127	EXP	Physics	19	303
26	UAM	127	EXP	Physics	19	303
26	UV	127	EXP	Physics	19	303
26	UGR	127	EXP	Physics	19	303
29	UDG	103	LIFE	Environment / Ecology	7	202
31	UB	100	LIFE	Clinical medicine	120	3089

Source: formulated by the authors based on Essential Science Indicators (2015)

When the data are broken down by sub-areas, it is observed in more detail what the best positions reached for Spanish universities. Figure III shows the documents from Spanish universities with more than 100 citations in each area. The best position reaches by the paper considering the InCITE area is presented and their position is represented by the size and color of the circles.

FIGURE III. Hot cited papers from Spanish university by InCITES area (papers with >100 citations)
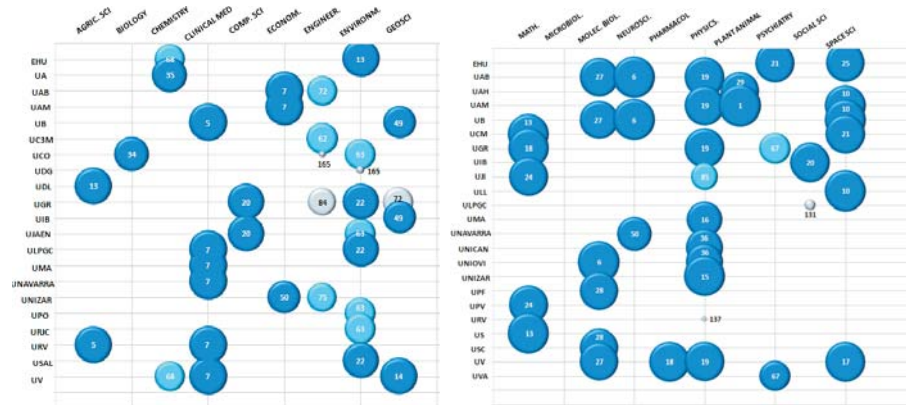
Source: formulated by the authors based on Essential Science Indicators (2015)

Detection of universities in international rankings:

Ranking ARWU

Thirteen Spanish universities were listed among the top 500 in the 2015 edition of the Shanghai ranking. The University of Barcelona ranked highest, between places 151 and 200. Although Spain placed a fairly small number of institutions in the general ranking, when analysed by field and subject, up to 18 were identified.

In the country classification by field, Spain was 14th by number of universities among the top 200, with four in Science (SCI), four in Social Sciences (SOC), three each in Engineering (ENG) and Life Sciences (LIFE) and two in Medicine (MED).

This information can be used to analyse university systems' specialisation. Figure 5 shows the correspondence analysis for countries and fields based on the presence of their universities in field rankings. Social Sciences (top) and the Natural Sciences and Mathematics (bottom) are distributed along the vertical axis and the Life and Agricultural Sciences and Medicine (left) and Engineering/Technology (right) along the horizontal axis. Spain is located at the centre of the map, for it has universities in all the field rankings. Judging from the position occupied, the Spanish university system is specialised in much the same way as Sweden's, Australia's and Belgium's, with a balanced distribution among the various fields.

FIGURE IV. Distribution by field of national systems hosting the world's top 200 universities (ARWU, 2015)
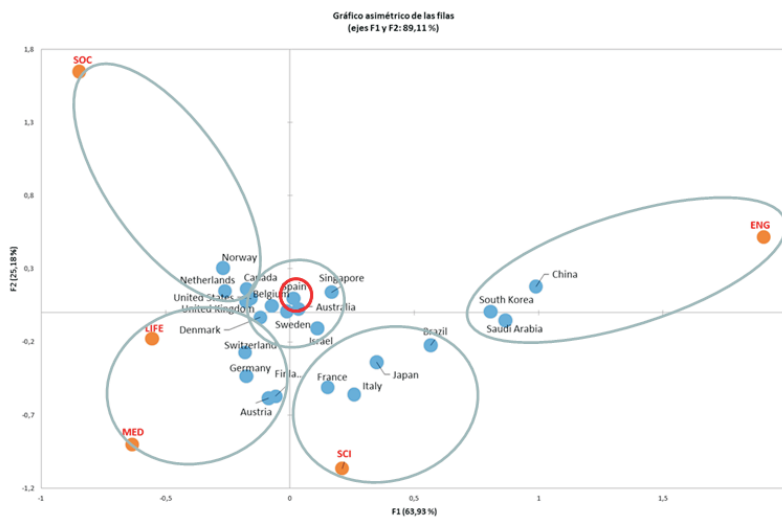
The field and subject analysis of the Spanish university system detected a larger number of institutions, affording the country a better position than in the general ranking. It also identified each university's specialisation. In the field ranking (covering the top 200 universities), the University of Barcelona ranked highest, in the 51st-75th place range in Medicine, followed by the Autonomous University of Madrid, in 76th-100th

place in Science. In the subject ranking, the University of Granada ranked 42nd in Computer Science, with the Autonomous University of Madrid, the University of Santiago de Compostela and Pompeu Fabra University respectively taking from 51st to 75th place in Physics and Mathematics, Mathematics and Economics. Mathematics and Computer Science were the subjects with the densest cluster of universities (Table VI).

TABLE VI. Spanish universities' positions in ARWU (2015) field and subject rankings

| Institución	General (500) Rank Mundial	Field (200 univ)					Subject (200)				
		MED	**SOC**	**SCI**	**LIFE**	**ENG**	**MATH**	**CHEM**	**COMP**	**ECON**	**PHYS**
UB	151-200	51-75	151-200	151-200	151-200	X	X	101-150	X	X	151-200
UAB	201-300	151-200	X	X	151-200	X	101-150	151-200	151-200	151-200	X
UAM	201-300	X	X	76-100	151-200	X	51-75	151-200	X	X	51-75
UCM	201-300	X	X	X	X	X	101-150	151-200	X	X	X
UPF	201-300	X	101-150	X	X	X	X	X	151-200	51-75	X
UV	301-400	X	X	151-200	X	X	X	101-150	X	X	76-100
UPV	301-400	X	X	X	X	151-200	76-100	76-100	101-150	X	X
UGR	301-400	X	X	X	X	101-150	101-150	X	42	X	X
UPC	401-500	X	X	X	X	101-150	X	X	101-150	X	X
USC	401-500	X	X	151-200	X	X	76-100	X	X	X	X
EHU	401-500	X	X	X	X	X	101-150	X	X	X	X
UNIZAR	401-500	X	X	X	X	X	X	76-100		X	X
US	401-500	X	X	X	X	X	101-150	X	X	X	X
UC3M	X	X	X	X	X	X	X	X	151-200	101-150	X
UJAEN	X	X	X	X	X	X	X	X	51-75	X	X
UPM	X	X	X	X	X	151-200	X	X	101-150	X	X
UAL	X	X	X	X	X	X	X	151-200	X	X	X
URiV	X	X	X	X	X	X	X	151-200	101-150	X	X

Source: formulated by the authors from ARWU (2015) data

Ranking QS

Twelve Spanish universities were listed in the 2015 edition of the QS top 500. The highest-ranking institution was the University of Barcelona,

which took 166th place, although the country's universities were substantially better positioned in the faculty area rankings. The largest number (7) were in Social Sciences, followed by Natural Science and Arts & Humanities (5 each). According to the profiles in Figure V based on that distribution, Spanish universities specialised in much the same areas as their counterparts in Singapore, Australia and United Kingdom.

FIGURE V. Distribution by faculty area of national systems hosting the world's top 200 universities (QS, 2015)
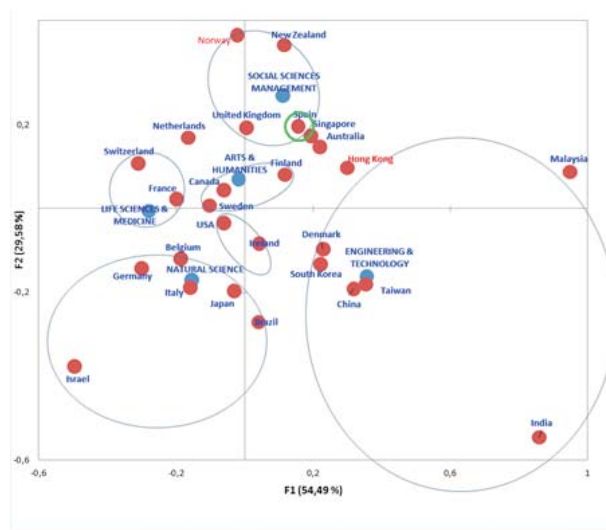
At the institutional level, while no Spanish university was among the top 150 in the QS general ranking, the Polytechnic University of Catalonia took 92nd place in Engineering & Technology. Three institutions were among the 150 highest ranking universities in Arts & Humanities: University of Barcelona, Complutense University of Madrid and Autonomous University of Madrid. Just one Spanish university (UB) was among the top 150 in Life Science & Medicine, while three (UB, UAB, UC3M) were so placed in Natural Science and four (UB, UAB, UPF and UC3M) in Social Sciences. In the ranking by subject, the situation improved considerably, with Pompeu Fabra University in 23rd place in Economics & Econometrics (Social Science), Ramón Llull University in

29th (Business & Management, also Social Science) and Carlos III University in 38th, likewise in Economics & Econometrics.

Table VII shows the position of universities in the general ranking and the best positions reached by each university in the rankings by field and subject. Since the classification by subject includes 32 disciplinary categories, only the top aggregation is mentioned, while the detail of the specific subject in which each university positions shown in Annex.

TABLE VII. Spanish universities' positions in QS (2015) rankings by faculty area and subject (pooled by faculty area)

Institución	General (500) Rank Mundial	Fields (400 univ)					Subject (200)				
		ARTS & HUM	ENG & TECH	Life SCI & MED	NATUR SCI	SOC SCI	ARTS & HUM	ENG & TECH	Life SCI & MED	NATUR SCI	SOCIAL SCI
UB	166	98	104	87	62	129	48	101-150	51-100	51-100	51-100
UAB	190	164	227	164	128	140	51-100	151-200	23	51-100	51-100
UAM	186	149	234	228	103	183	101-150	151-200	150	51-100	51-100
UCM	226	103	240	236	175	174	51-100	151-200	40	101-150	51-100
UNAV	265	280	X	321	X	155	51-100	X	101-150	X	51-100
UPF	295	235	X	X	X	119	101-150	X	251-300	X	23
UPC	299	385	82	X	272	X	X	22	X	101-150	51-100
UC3M	314	389	244	X	X	141	51-100	151-200	X	251-300	38
UPM	461-470	X	130	X	X	X	X	51-100	51-100	251-300	X
UPV	410-420	X	160	X	198	X	X	101-150	51-100	201-250	101-150
UGR	461-470	220	X	355	349	397	101-150	201-250	151-200	201-250	151-200
UNIZAR	491-500	X	387	X	349	X	201-250	251-300	151-200	251-300	X
USAL	481-490	216	X	X	X	X	101-150	X	151-200	X	151-200
UV	X	385	X	351	239	360	151-200	X	151-200	X	X
URLL	X	X	X	X	X	198	X	X	X	X	29
US	X	305	374	X	X	X	151-200	201-250	X	301-400	151-200
IE	X	X	X	X	X	X	X	X	X	X	51-100

Source: formulated by the authors from ARWU (2015) data

Ranking THE

The Times Higher Education ranking listed 800 universities in its general edition for 2015-2016. The list included 25 Spanish institutions, the highest ranking being the Autonomous University of Barcelona, positioned 146th. Nine Spanish universities were among the top 500.

The 2014-2015 edition (at this writing, the 2015-2016 ranking by subject had not been released) covered six subjects, which listed the top 100 institutions in each. Overall, Spain ranked 22nd worldwide with a very small presence in each subject: two universities in Arts & Humanities, one in Clinical Medicine and one in Social Science

The correspondence analysis conducted with the above information placed Spain in the Arts & Humanities and Social Sciences quadrant. Universities in New Zealand, Netherlands and Hong Kong had similar profiles (Figure VI).

FIGURE VI. Distribution of national university systems by subject (THE, 2015)
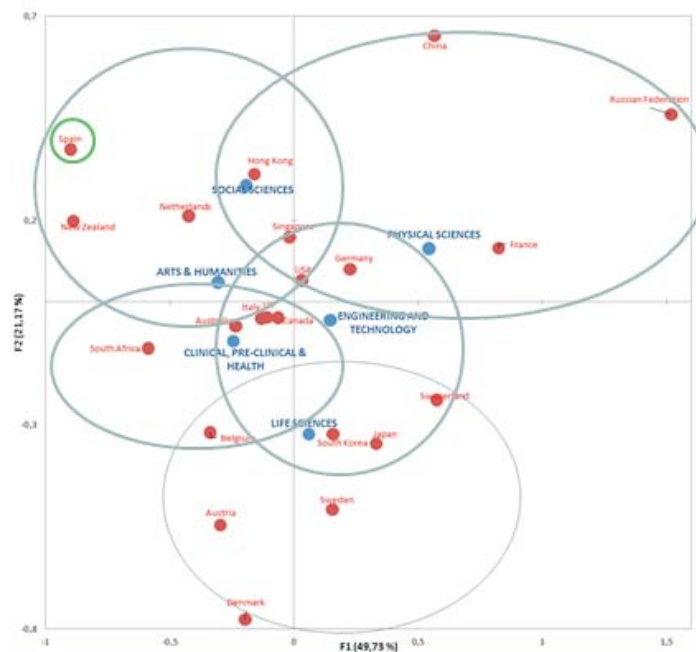
A total of only four Spanish universities were among the top 100 by subject, in Arts & Humanities, Social Sciences and Clinical & Preclinical Health. Pompeu Fabra University was positioned the highest (67 in Social Science). Table VIII shows the position of each university in the general ranking and the best position reached in each field.

TABLE VIII. Spanish university positions in the Times Higher Education (THE) ranking (2014-2015)

Institución	General (2015)	Field (2015-2016)		
	Ránking mundial	ATS & HUM	SOCIAL SCI	CLINICAL, PRECLIN & HEALTH
UAB	146	X	X	X
UPF	164	X	67	X
UB	174	X	X	76
UAM	301-350	90	X	X
UNAV	301-350	X	X	X
UV	401-500	X	X	X
UCM	401-500	87	X	X
UPC	401-500	X	X	X
URV	401-500	x	x	x

Source: formulated by the authors from ARWU (2015) data

Overview of visibility from different sources

Further to the indicators drawn from the sources analysed, 44 Spanish universities had at least one visibility indicator, mostly in connection with papers cited, while 26 institutions were present in rankings by field or subject. The institutions with greatest visibility (based on publication indicators and rankings both) were the Autonomous University of Barcelona, the University of Barcelona, the Autonomous University of Madrid and Complutense University (Table IX).

TABLE IX. Frequency of appearance of Spanish universities among the top 200 (most cited papers and in rankings)

Universidad	Essential Science Indicators		Ranking ARWU		Ranking QS		Ranking THE	Total
	HIGHGLY CITED PAPERS	HOT CITED PAPERS	FIELD	SUBJECT	FIELD	SUBJECT	SUBJECT	
UAB	10	6	3	4	5	22	1	51
UB	8	5	4	2	5	25	1	50
UAM	9	2	2	3	5	18	0	39
UCM	4	0	0	2	5	21	1	33
UV	7	4	1	3	4	8	0	27
UPF	10	0	1	2	2	7	1	23
UGR	7	1	1	2	4	6	0	21
UPV	6	0	2	0	2	8	0	18
UPC	2	0	1	2	3	7	0	15
UNIZAR	4	1	0	2	2	5	0	14
UC3M	1	0	0	2	3	6	0	12
US	3	0	0	1	2	6	0	12
USAL	4	0	0	0	1	7	0	12
USC	4	0	1	2	0	4	0	11
UNAV	2	1	0	0	3	4	0	10
UNIOVI	7	2	0	1	0	0	0	10
UPM	1	0	0	1	1	5	0	8
UIB	5	0	0	2	0	0	0	7
UVIGO	6	0	0	0	0	0	0	6
EHU	3	0	0	1	0	0	0	4
UA	3	0	0	1	0	0	0	4
UAL	3	1	0	0	0	0	0	4
UM	2	1	0	0	0	1	0	4
URV	2	1	0	1	0	0	0	4
UJI	0	3	0	0	0	0	0	3
ULL	3	0	0	0	0	0	0	3
UCO	2	0	0	0	0	0	0	2
UHU	0	0	0	2	0	0	0	2
UJAEN	1	0	0	1	0	0	0	2
UNAVARRA	0	2	0	0	0	0	0	2
UNICAN	2	0	0	0	0	0	0	2
UPO	1	1	0	0	0	0	0	2
URJC	2	0	0	0	0	0	0	2
DEUSTO	1	0	0	0	0	0	0	1
UCLM	1	0	0	0	0	0	0	1
UDC	1	0	0	0	0	0	0	1
UDG	0	1	0	0	0	0	0	1
UDL	0	1	0	0	0	0	0	1
ULPGC	0	1	0	0	0	0	0	1
UMA	1	0	0	0	0	0	0	1
UMH	1	0	0	0	0	0	0	1
UNEX	1	0	0	0	0	0	0	1
URL	0	0	0	0	1	0	0	1
UVA	0	0	0	1	0	0	0	1

Note: In the glossary the extended names of all universities is presented

Considering the type of source and area, it can be seen that the highly cited papers are mainly of Experimental Science, while in the Hot cited papers and in the rankings, Life & Medicine is the most important area (Figure VII).

FIGURE VII. Spanish visibility by source and area

After identifying the indicators of visibility for each university and their subject area, it is possible to detect the relationship between universities and areas. Experimental Science is the field where the best Spanish universities are positioned, with the Autonomous University of Madrid, Valencia and Autonomous University of Barcelona on the first positions. In Life Science & Medicine the University of Barcelona has the higher visibility, while in Social Science highlights the Autonomous University of Barcelona and in Engineering the universities of Vigo, Granada and the polytechnics. Figure VIII shows universities with greater visibility (frequency> 1) identifying the area. The thickness of the line is proportional to the total frequency of visibility to each institution.

FIGURE VIII. Universities with high international visibility by subject area
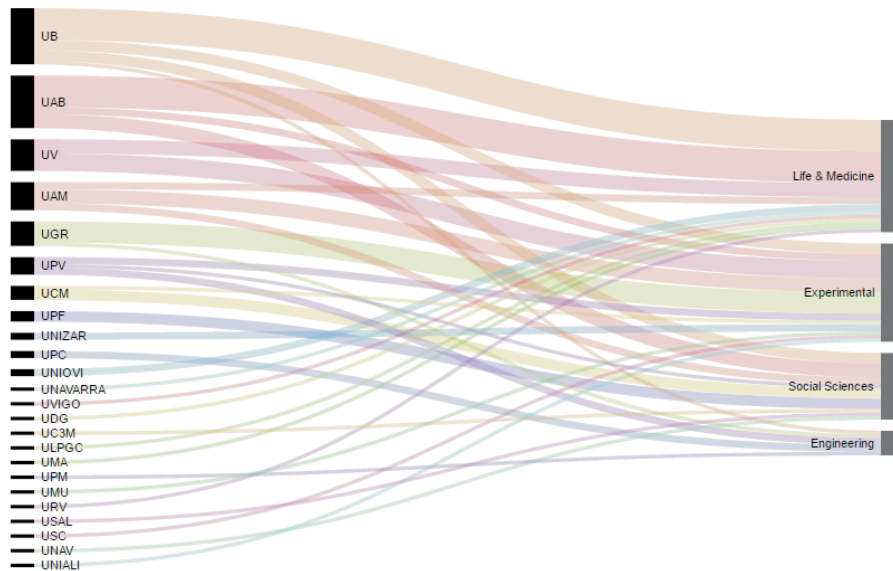
Discussion of results

The conclusions drawn from the data obtained in this study may prove to be very useful for university system stakeholders, such as academic department heads, policymakers, professors, researchers and students. The findings showed that as universities are very heterogeneous, general rankings do not suitably reflect their strengths. A number of factors determine certain universities' high positions in general rankings, thereby masking speciality-driven research and teaching. It is therefore essential to identify universities with similar disciplinary approaches to compare and interpret such comparisons. Furthermore, global comparisons can harm certain types of institutions and influence their positioning as was mentioned by Bornmann et al. (2013a).

To avoid such pitfalls, this study drew from a series of bibliometrics indicators and the rankings by field provided by the major international university classifications to identify high quality universities with excellent

scientific results in certain areas of activity. This type of information is much more useful for stakeholders, as it allows them to focus on each university's most prominent characteristics.

It has worked specifically with reliable and prestigious sources. However, it is clear that they are not without limitations. In the case of publications databases, the thematic and linguistic bias and the underrepresentation of the production of certain countries as well as the documentary type collected by these sources must be taken into account when drawing conclusions (Gómez-Caridad and Bordons-Gangas, 1996). Regarding university rankings, although the three selected are the ones that have achieved greater renown and are internationally recognized, they are also criticized for the poor clarity with which they are often calculated or weighted the indicators used and the difficulty of doing **comparable** results obtained from very different institutions (Pusser and Marginson, 2013). In order to overcome these criticisms, we have worked with multiple indicators avoiding weightings (which may be subjective and not transparent) and thus present a battery of data that provide a broad and varied view on the visibility of research activity in the analyzed universities.

The data gathered showed that 44 Spanish universities (more than 50% of the Spanish Higher Education System) have visibility indicators. Most relevant are Autonomous University of Barcelona, University of Barcelona, Autonomous University of Madrid, Complutense University of Madrid and University of Valencia. These universities are the most productive in Spain considering number of Web of Science papers (IUNE, 2016). This shows that are great institutions of higher education which stand out for their capacity and critical mass, although smaller universities can excel in certain specialties, and this is what is observed in most other universities analyzed.

In addition, public universities are those with visibility indicators since only two institutions (University of Navarra and DEUSTO) are private. In this sense, institutional type (public / private), in the Spanish case, is closely linked to activity of universities, public still much more research-intensive (Casani et al: 2014).

Considering the type of indicator obtained, the highly cited papers are most frequent since almost all universities have at least one highly cited document, while the appearance in the overall rankings is the most restrictive criteria. This is because in the case of highly cited papers what

is measured is the visibility (quality, excellence) through a document, while to be positioned in a general ranking is necessary for the university as a whole meets criteria prestige, quality, excellence, etc. Despite the different levels of analysis of each indicator, these are complementary to identify institutions and areas that are more active.

Each type of result in turn is more related to a particular subject area being abundant the highly cited papers in Experimental Sciences. This is logical considering that this area includes publications of Big Science areas such as physics, with high international collaboration, citation and impact. By contrast, the Spanish universities in the rankings show a more active trend in Life Science & Medicine

Analyzing each source of income we can see that between the institution with the 200 most cited papers, the most prominent were the University of Barcelona in computer science, the University of the Balearic Isles in mathematics, the University of Vigo in environmental science, the Technical University of Valencia in computer science, Pablo Olavide University in multi-disciplinary science and the University of Cordoba in environmental science.

Six Spanish universities (UAB, UB, UAM, UPF, UCM and UPC) were listed on all three major general rankings, ARWU, QS and THE. A total of 24 universities were listed on the rankings by field or subject, however. Many of these were ranked much higher in their field of specialisation than on the general listing. The following institutions ranked at higher than 75th place on the ARWU rankings: the University of Granada in Computer Science, the Autonomous University of Madrid in Physics and Mathematics, the University of Santiago de Compostela in Mathematics, the Technical University of Valencia in Chemistry, Pompeu Fabra University in Economics and the University of Barcelona in Medicine. The universities in better than 50th place on the QS ranking included the Polytechnic University of Catalonia in Engineering & Technology, Pompeu Fabra University, Carlos III University of Madrid and Ramón Llull University in Social Sciences, and Complutense and Autonomous Universities of Madrid in Life Science & Medicine. The highest rank (67th place) on the THE listing was obtained by Pompeu Fabra University in Social Sciences. This study of ranking by specialisation showed that Spain was better positioned on the QS and ARWU rankings.

These findings indicate that visibility studies based solely on the impact of publications may prove to be very limited, inasmuch as a single

sporadic publication may have a very high impact but not necessarily be representative of the ongoing quality of a reputed research group or university department.

Nor are studies that use the presence in general rankings very precise. Authors such as Cheng and Liu (2006) classified organisations on the grounds of specific disciplines and in a more recent study, Bornmann et al. (2013b) developed a web application that maps institutions of excellence by field. Such initiatives attest to the need to circumvent general worldwide classifications and focus on the development of field-geared tools (Robinson-García and Calero-Medina 2014b).

In Spain, using specialisation-based information may prove to be beneficial, for very few Spanish universities are listed on all rankings and the use of pooled fields hampers the identification of each institution's strengths. As field rankings, on the contrary, afford a more precise view of the country's specialisation as a whole and of each university's focus, they are better suited to analysing institutions' specific performance. National initiatives such as the development of domestic rankings and the creation of science watches are of particular interest and growing relevance, insofar as they furnish varied and comparable information on the Spanish higher education system at large (Sanz-Casado et al. 2013; Casani et al. 2014).

Conclusions

Following the work presented, some general conclusions are mentioned:

- Universities are heterogeneous institutions and overall rankings do not reflect them strengths.
- It is necessary to use a wide battery of indicators to account for the diversity and specialization of higher education institutions.
- The institutional typology (public / private) is linked to the orientation of the activity of the universities, being the public ones more intensive in research and therefore, more visible internationally.
- Only 6 Spanish universities appear in the three main international rankings, however the number increases when studying thematic rankings.

- The use of indicators to identify the thematic specialization of each university is central to identifying the strengths of each institution.
- Advancing the definition of strategies for analysis and evaluation of university research activity is a central issue given the impact it has on the management of higher education institutions and on the influence they will have on the orientation and profile of higher education institutions.

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Annex

Annex I. Position of Spanish universities in the QS ranking by subject

Arts & Humanities 2015		
Area	**Institución**	**Rank mundial**
Art & design	UCM	51-100
English language & Literature	UAM	151-200
	UCM	151-200
	UAH	151-200
	UGR	151-200
	USAL	151-200
	UB	151-200
	UNIZAR	201-250
	UAB	201-250
	UALI	251-300
	USC	251-300
History	UCM	51-100
	UAM	101-150
	UB	151-200
Linguistics	UB	51-100
	UAM	101-150
	UCM	101-150
	UPF	101-150
	UGR	151-200
Modern languages	UC3M	51-100
	UAB	51-100
	UB	51-100
	UAM	101-150
	UGR	101-150
	USAL	101-150
	UAH	151-200
	US	151-200
	UNIZAR	201-250
	USC	201-250
	UPF	201-250
	UALI	251-300
Philosophy	UB	48
	UCM	51-100
	UNAV	51-100
	UAM	101-150
	UV	151-200

Engineering & Technology 2015

Area	Institución	Rank mundial
Architecture	UPC	22
	UPM	51-100
Chemical Enginering	UPV	101-150
	UB	101-150
	UAM	151-200
	UCM	151-200
	UAB	151-200
Civil & estructural Eng.	UPC	35
	UPM	51-100
	UPV	101-150
Computer Sci	UPC	51-100
	UB	101-150
	UPM	151-200
	UC3M	151-200
	UCM	151-200
	UGR	201-250
	UPV	251-300
Electric & Electronic Eng.	UPC	51-100
	UPM	101-150
	UC3M	151-200
	UPV	151-200
	UAM	201-250
	US	201-250
	UAB	201-250
	UB	201-250
	UNIZAR	251-300
Mecanical, Aeronautical & Manufacturing Eng.	UPM	101-150
	UPC	151-200
	UPV	201-300
	UB	201-300

Life Science & Medicine 2015

Area	Institución	Rank mundial
Medicine	**UB**	**51-100**
	UAB	151-200
	UAM	201-250
	UNAV	201-250
	UCM	251-300
	UV	251-300
	UGR	301-400
	USAL	301-400
	USC	301-400
	UPF	301-400
Biological Sciences	**UB**	**101-150**
	UAB	151-200
	UCM	201-250
	UGR	251-300
	UNAV	251-300
	UV	251-300
	UPF	251-300
Psychology	**UAM**	**101-150**
	UCM	101-150
	UAB	101-150
	UB	101-150
	UGR	151-200
	UV	151-200
Pharmacy & Pharmacology	**UB**	**51-100**
	UCM	101-150
	UNAV	101-150
	USAL	151-200
	UAB	151-200
Agriculture & Forestry	**UPM**	**51-100**
	UPV	51-100
	UAB	51-100
	UAM	101-150
	UCM	101-150
	UCO	101-150
	UB	101-150
	UGR	151-200
	UNIZAR	151-200
	UV	151-200
Dentistry	**UCM**	**40**
Veterinary Sciences	**UAB**	**23**
	UCM	50

Natural Science 2015		
Area	**Institución**	**Rank mundial**
Physics & Astronomy	UAM	51-100
	UAB	51-100
	UB	51-100
	UCM	201-250
	UGR	201-250
	UV	251-300
	UPC	251-300
	UNIZAR	301-400
	UPV	301-400
Mathematics	UAB	51-100
	UCM	101-150
	UB	101-150
	UPC	101-150
	UAM	151-200
	UGR	201-250
	UPV	201-250
	UPM	251-300
	UC3M	251-300
	US	301-400
	UNIZAR	301-400
	USC	301-400
Environmetal Sci	UB	51-100
	UAB	101-150
	UCM	151-200
	UAM	201-250
	UPV	201-250
	UPC	201-250
	UGR	251-300
	USC	251-300
Earth & Marine Sci	UB	51-100
	UCM	151-200
	UAB	151-200
Chemistry	UB	51-100
	UAM	101-150
	UCM	101-150
	UAB	101-150
	UNIZAR	251-300
	UV	251-300
	UGR	301-400
	US	301-400
Material Science	UAM	101-150
	UB	101-150
	UCM	151-200
Geography	UAB	51-100
	UB	51-100
	UCM	101-150
	UAM	151-200

Social Science 2015		
Area	**Institución**	**Rank mundial**
Statitic & Operational Res	**UB**	**51-100**
	UPC	51-100
	UC3M	101-150
	UPV	101-150
	UCM	151-200
	UGR	151-200
	US	151-200
	UAB	151-200
Sociology	**UB**	**51-100**
	UCM	101-150
	UAB	101-150
Politics & International Studies	**UCM**	**101-150**
	UAB	151-200
	UB	151-200
	UPF	151-200
Law	**UAM**	**51-100**
	UC3M	51-100
	UCM	51-100
	UNAV	101-150
	UB	101-150
	UPF	151-200
Economics & Econometry	**UPF**	**23**
	UC3M	38
	UAB	51-100
	UB	101-150
	UAM	151-200
	UCM	151-200
Accouting & Finance	**UNAV**	**51-100**
	UAM	101-150
	UC3M	101-150
	UCM	151-200
	UAB	151-200
	UB	151-200
	UPF	151-200
Communication & Media Studies	**UCM**	**51-100**
	UNAV	51-100
	UAB	51-100
	UB	101-150
	USAL	151-200
	USAL	151-200
	UPF	151-200
Education	**UB**	**51-100**
	UCM	101-150
	UAB	101-150
	UAM	151-200
	UGR	151-200
Business and management	**URL**	**29**
	IE	51-100
	UNAV	51-100
	UC3M	151-200
	UCM	151-200

Annex II Names of universities

Abreviatura	Universidad	Tipo
CEU	Universidad San Pablo CEU	Privada
DEUSTO	Universidad de Deusto	Privada
EHU	Universidad del País Vasco	Pública
IE	IE University (Incluye SEK)	Privada
MUNI	Universidad de Mondragón	Privada
NEBRIJA	Universidad Antonio de Nebrija	Privada
UA	Universidad de Alicante	Pública
UAB	Universidad Autónoma de Barcelona	Pública
UAH	Univ Alcalá de Henares	Pública
UAL	Universidad de Almería	Pública
UAM	Universidad Autónoma de Madrid	Pública
UAO	Universitat Abat Oliba CEU	Privada
UAX	Universidad Alfonso X El Sabio	Privada
UB	Universidad de Barcelona	Pública
UBU	Universidad de Burgos	Pública
UC3M	Universidad Carlos III de Madrid	Pública
UCA	Universidad de Cádiz	Pública
UCAM	Universidad Católica San Antonio	Privada
UCAVILA	Universidad Católica Santa Teresa de Jesús de Avila	Privada
UCHCEU	Universidad Cardenal Herrera	Privada
UCJC	Universidad Camilo José Cela	Privada
UCLM	Universidad de Castilla-La Mancha	Pública
UCM	Universidad Complutense de Madrid	Pública
UCO	Universidad de Córdoba	Pública
UCV	Universidad Católica de Valencia San Vicente Mártir	Privada
UDC	Universidad de A Coruña	Pública
UDG	Universidad de Girona	Pública
UDIMA	Universidad a Distancia de Madrid	Privada
UDL	Universidad de Lleida	Pública
UEM	Universidad Europea de Madrid	Privada
UEMC	Universidad Europea Miguel de Cervantes	Privada
UFV	Universidad Francisco de Vitoria	Privada
UGR	Universidad de Granada	Pública
UHU	Universidad de Huelva	Pública
UIB	Universidad de las Illes Balears	Pública
UJAEN	Universidad de Jaén	Pública
UJI	Universidad Jaume I de Castellón	Pública
ULL	Universidad de La Laguna	Pública
ULPGC	Universidad de Las Palmas de Gran Canaria	Pública
UM	Universidad de Murcia	Pública
UMA	Universidad de Málaga	Pública

Abreviatura	Universidad	Tipo
UMCERVANTES	Universidad Miguel de Cervantes	Privada
UMH	Universidad Miguel Hernández de Elche	Pública
UNAV	Universidad de Navarra (Privada)	Privada
UNAVARRA	Universidad Pública de Navarra	Pública
UNED	Universidad Nacional de Educación a Distancia	Pública
UNEX	Universidad de Extremadura	Pública
UNICA	Universidad Internacional de Catalunya	Privada
UNICAN	Universidad de Cantabria	Pública
UNILEON	Universidad de León	Pública
UNIOVI	Universidad de Oviedo	Pública
UNIR	Universidad Internacional de La Rioja	Privada
UNIRIOJA	Universidad de la Rioja	Pública
UNIZAR	Universidad de Zaragoza	Pública
UOC	Universidad Oberta de Catalunya	Privada
UPC	Universidad Politécnica de Catalunya	Pública
UPCO	Universidad Pontificia Comillas	Privada
UPCT	Universidad Politécnica de Cartagena	Pública
UPF	Universidad Pompeu Fabra	Pública
UPM	Universidad Politécnica de Madrid	Pública
UPO	Universidad Pablo de Olavide	Pública
UPSA	Universidad Pontificia de Salamanca	Privada
UPV	Universidad Politécnica de Valencia	Pública
URJC	Universidad Rey Juan Carlos	Pública
URL	Universitat Ramon Llul	Privada
URV	Universidad Rovira i Virgili	Pública
US	Universidad de Sevilla	Pública
USAL	Universidad de Salamanca	Pública
USC	Universidad de Santiago de Compostela	Pública
USJ	Universidad San Jorge	Privada
UV	Universidad de Valencia	Pública
UVA	Universidad de Valladolid	Pública
UVIC	Universidad de Vic	Privada
UVIGO	Universidad de Vigo	Pública
VIU	Universidad Internacional Valenciana	Privada