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## International visibility of Brazilian public universities<sup>1</sup>

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### 1. Introduction

Although the development of scientific and technological infrastructure and the formation and expansion of Brazilian academic community are very recent events in Brazil, in the last years the country was one that gained the most prominence on the international scene (Leta, Glanzel, & Thijs, 2006). In part, this fact is due to a series of public policies of the federal government which the main objectives were: promote the expansion of higher education, the internationalization of Research and Development (R&D) and increase the quality of Science and Technology (S&T). These policies increased the promotion of evaluation agencies that guarantee resources in any area of knowledge, and provide infrastructure, equipment and scholarships for undergraduate and postdoctoral researchers. One of the most obvious results is that the ten institutions with the highest number of publications are from the public university system, which represents more than half of all Brazilian scientific documents. In this context of change, the visibility of Brazilian universities has become increasingly important.

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. Definitely, international visibility attracts recognition and resources (Docampo, 2008).

Until a few years ago bibliometric analysis was one of the most relevant tools used to identify the scientific activity of universities. Based on scientific publications in journals indexed in international databases such as Web of Science (WoS) or Scopus, they can detect strengths and weaknesses in each field of knowledge (Bordons, Sancho, Morillo, & Gómez, 2010). Since the emergence of international university rankings, these have also proved to be an effective tool for analyzing visibility and have had a remarkable impact on the academic world. Although it is not exempt from harsh criticism and controversy (Billaut, Bouyssou, & Vincke, 2009; Martínez Rizo, 2011; Rauhvargers, 2013), its methodology usually includes a series of easily understandable indicators common to all institutions. This allows comparisons between very heterogeneous universities.

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Taking into account these two sources of information – scientific publications and universities rankings – the main objective of this study is to detect which Brazilian universities have the greatest international visibility and in which specific areas they specialize. This information will allow to determine the main focuses attraction scientific of the Brazilian University System.

## 2. Sources and Methodology

Quantitative indicators were used in order to analyze the international visibility of Brazilian universities. The study was conducted by stages, as follows:

- **Identification of the most cited Brazilian universities worldwide:** The Essential Science Indicators (ESI) of Clarivate Analytics (edition 2017) were consulted. It includes performance metrics on scientific production and citations received in the last ten years of coverage (2007-2017) of the WoS. Indicators are classified in 22 scientific areas. After identifying the 1000 most cited institutions in the world, and among them the main Brazilian universities, the number of citations received in 22 different areas of knowledge was calculated. Then, relative impact for each university was compared with the average of relative impact of Brazil, to identify institutions and areas most relevant.
- **Selection of highly cited Brazilian documents:** These publications were obtained from the Journal Citation Reports. Considering that citation rates vary according to the area and older documents are cited more than recent ones, the first step is counting the number of articles cited in several citation levels and building the distributions for each thematic category and year. These distributions are used to create the limits of the determined selection, with the same fragment of articles (CLARIVATE ANALYTICS, 2017). So they were detected in the publications that occupy 1% higher in each of the 22 areas per citation for the year in WoS.
- **Detection of Brazilian public universities in the world's main universities rankings:** To complete the information obtained from publications, it was consulted the 2017 edition of the following academics rankings: Academic Ranking of World Universities (ARWU), Quacquarelli Symonds World University Rankings (QS) and Times Higher Education (THE). From their respective official websites, information about the position reached by Brazilian universities was obtained in the general ranking (*Subject*) and in the thematic specialties (*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 4 fields. 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, just like in the study of De Filippo, Dominique Pandiella, & Sanz Casado (2017) we decided unified the rankings classification in Engineering; Life Science & Medicine; Experimental Science; Social Science & Humanities.
- **Representation of more visible universities and thematic area of specialization:** With the collected information, a representation between universities and thematic specialization was obtained. This allows identify areas of greater visibility and the

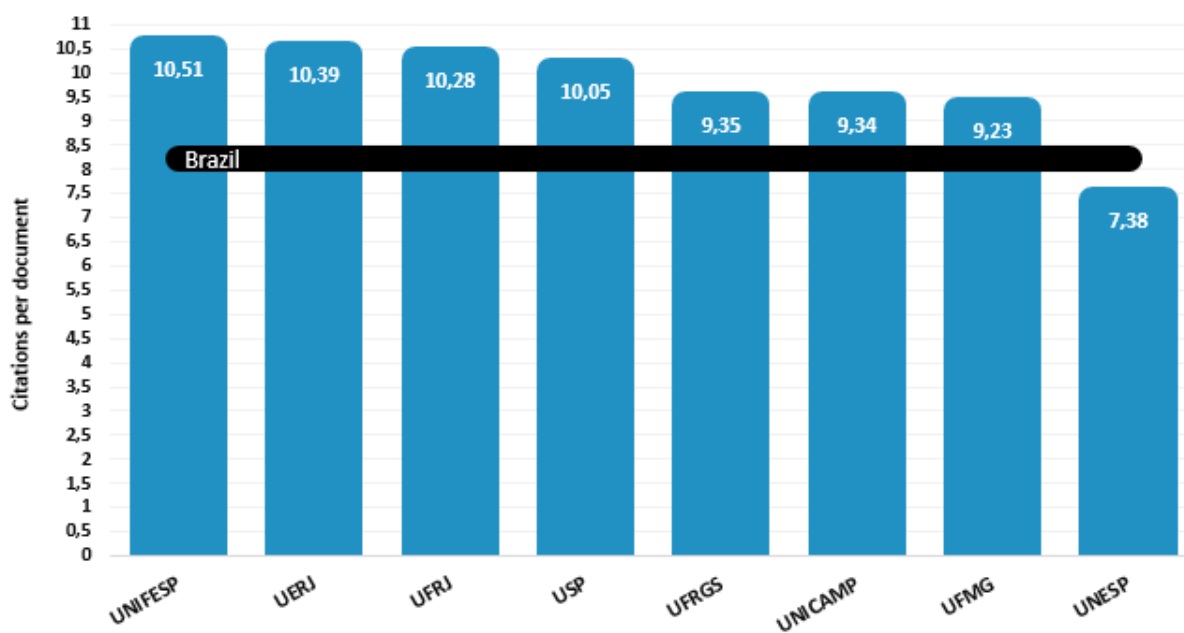
most relevant universities in each area. For results visualization, Infogram e RAW Graphs programs was used.

### 3. Results

#### 3.1 Citations received by article in WoS

A total of 398.386 Brazilian scientific publications was indexed in the WoS databases during the last ten years analyzed. The country is ranks 13th by number of documents published in the world, 17th by citations received (3.273.335) and 123rd by citations/documents, with an average of 8.22 citations per document in all areas. Among the first 1000 institutions most cited worldwide, there are eight Brazilian public universities (Figure 1). Probably due to greater availability of human and financial resources and installed infrastructure, they are all located in the South and Southeast regions of the country. The Federal University of São Paulo (UNIFESP) is the leader, with an average of 10.51 citations per document. The São Paulo State University (UNESP) is the only institution that, among those analyzed, has an average of citations per article published lower than the Brazil (7.38).

Figure 1: Number of citations received per document in the production of the Brazilian universities with the greatest impact (2007-2017).



Considering the citation values in each of the 22 areas classified in the ESI, it is possible to detect that, in terms of impact by thematic fields, Brazil stands out in Space Science (15.13 citations per document). At institutional level, considering the most outstanding Brazilian universities, UFRJ is at the first position in 4 scientific areas. Especially high values were detected in *Molecular Biology and Genetics* (19.98) compared to Brazil (12.23 citations per document). In *Immunology* prevails the impact of the UFMG (17.23 citations per document), since in *Physics* the number of citations per document is especially high in UNESP (16.43). On the other side, *Engineering* is the scientific field in which all Brazilian universities analyzed have a higher impact than the average of the country (Table 1).

Table 1: Number of citations received per document by areas in the Brazilian universities publications (1000 most cited institutions) (2007-2017).

Areas Essential Science Indicators	Brazil	UNIFESP	UERJ	UFRJ	USP	UFRGS	UNICAMP	UFMG	UNESP
Agricultural Sciences	4,79	6,24	-	7,51	7,03	5,60	8,81	4,03	3,80
Biology & Biochemistry	10,14	10,27	-	12,12	10,94	11,98	10,92	13,06	8,09
Chemistry	9,55	-	-	9,15	10,91	11,68	10,87	10,82	9,34
Clinical Medicine	9,64	11,01	8,50	10,26	10,44	10,78	8,44	10,16	7,03
Computer Science	4,77	-	-	-	5,81	-	5,17	-	-
Economics & Business	3,92	-	-	-	6,43	-	7,44	-	-
Engineering	6,15	-	-	6,33	11,49	6,90	12,90	6,24	6,88
Environment/Ecology	10,09	-	-	10,36	-	9,19	-	8,92	9,32
Geosciences	9,67	-	-	-	12,13	8,23	-	-	-
Immunology	12,58	15,30	-	14,65	12,55	-	-	17,23	-
Materials Science	7,68	-	-	8,18	8,45	7,66	9,27	9,89	8,95
Mathematics	3,81	-	-	-	4,24	-	-	-	-
Microbiology	9,76	12,30	-	12,60	9,89	-	-	9,01	-
Molecular Biology & Genetics	12,23	-	-	19,98	16,03	15,03	-	-	-
Multidisciplinary	9,16	-	-	-	-	-	-	-	-
Neuroscience & Behavior	12,13	10,84	-	14,08	12,88	14,48	10,61	11,75	-
Pharmacology & Toxicology	8,96	10,77	-	9,09	10,33	9,50	9,32	8,94	10,17
Physics	10,86	-	16,36	17,20	13,99	-	13,95	-	16,43
Plant & Animal Science	5,28	6,30	-	6,55	6,59	5,03	6,90	5,31	5,00
Psychiatry/Psychology	9,22	9,64	-	8,87	12,35	13,67	-	-	-
Social Sciences, general	4,54	6,14	4,91	4,40	5,90	4,82	4,78	5,09	2,98
Space science	15,13	-	-	-	-	-	-	-	-
All fields	8,22	10,51	10,39	10,28	10,05	9,35	9,34	9,23	7,38
World ranking position	17°	648°	961°	459°	108°	541°	461°	608°	509°
N° documents	398.386	17.394	10.438	26.116	89.051	23.454	28.603	20.861	32.526
N° citations	3.273.335	182.872	108.436	268.366	895.169	219.257	267.092	192.474	240.004

- Data not available

### 3.2 Highly cited Brazilian documents

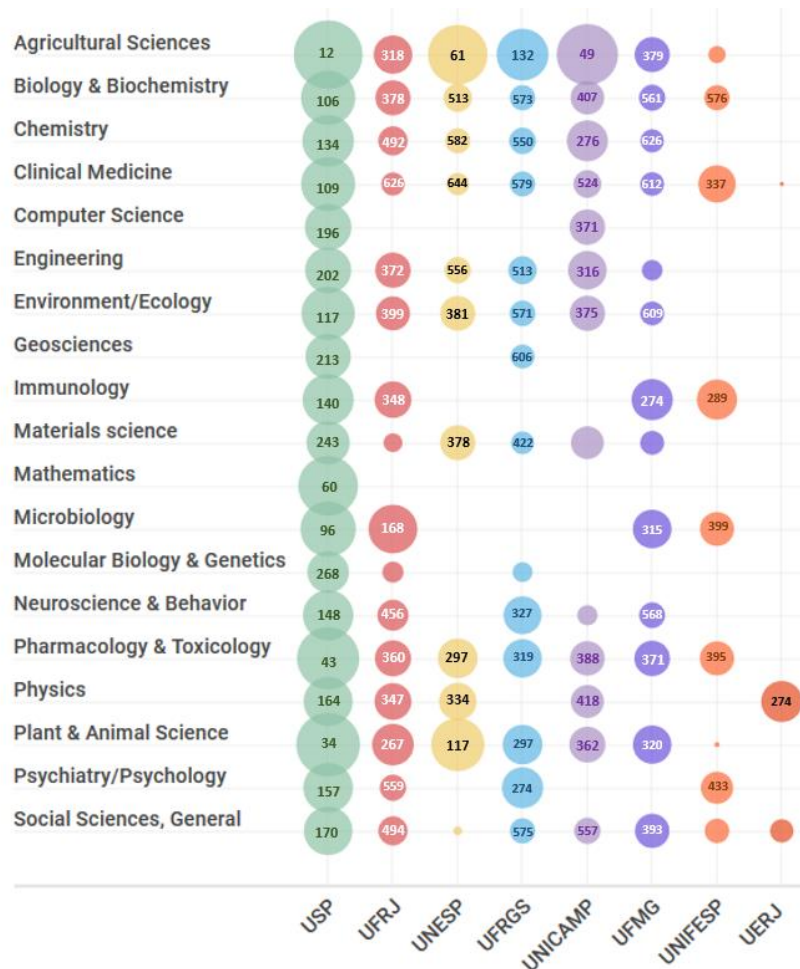
Considering the number of citations received in highly cited documents disaggregated by areas of the ESI, *Clinical Medicine*, *Physics* and *Chemistry* are the ones with the greatest impact in Brazil (Table 2). At the institutional level, the first cited Brazilian university is USP. During the last ten years it received 238,463 citations in *Clinical Medicine*, which represents 19.30% of the total citations of the country in this area.

Table 2: Number of citations of each Brazilian university according to areas of the Essential Science Indicators (2007-2017).

Essential Science Indicators Areas	Number of citations by Brazilian public universities									Maximum area citations
	BRASIL	USP	UFRJ	UNESP	UFRGS	UNICAMP	UFMG	UNIFESP	UERJ	
Agricultural Sciences	201.902	38.974	5.162	18.925	11.172	21.146	4.345	1.998	-	170.928
Biology & Biochemistry	192.100	60.468	21.311	14.477	12.458	19.650	12.835	12.436	-	752.224
Chemistry	311.728	75.223	26.026	20.837	22.331	43.050	19.233	-	-	1.357.651
Clinical Medicine	<b>737.661</b>	<b>238.463</b>	38.955	37.508	<b>43.778</b>	<b>50.910</b>	<b>40.070</b>	<b>91.032</b>	15.822	2.254.471
Computer Science	26.343	5.248	-	-	-	3.182	-	-	-	83.322
Economics & Business	11.387	-	-	-	-	-	-	-	-	119.265
Engineering	118.666	19.141	11.118	6.925	7.848	12.647	5.442	-	-	201.868
Environment/Ecology	150.695	33.309	10.979	11.543	7.407	11.649	6.651	-	-	383.600
Geosciences	77.497	22.594	-	-	6.136	-	-	-	-	419.325
Immunology	106.700	28.732	11.834	-	-	-	14.885	13.893	-	412.718
Materials Science	97.038	19.349	5.592	12.106	6.669	10.748	6.979	-	-	599.006
Mathematics	34.202	9.003	-	-	-	-	-	-	-	71.572
Microbiology	80.355	18.473	12.725	-	-	-	6.984	5.423	-	182.067
Molecular biology & Genetics	123.013	46.171	13.528	-	12.702	-	-	-	-	1.144.452
Multidisciplinary	4.249	-	-	-	-	-	-	-	-	30.336
Neuroscience & Behavior	148.451	46.303	13.545	-	20.218	7.047	10.068	-	-	791.087
Pharmacology & Toxicology	113.805	30.291	8.095	9.547	9.112	7.506	7.807	7.430	-	151.686
Physics	276.834	82.003	<b>43.991</b>	<b>45.195</b>	-	35.920	-	-	<b>53.742</b>	1.029.180
Plant & Animal Science	262.860	60.456	15.915	31.798	14.385	11.632	13.696	2.748	-	292.465
Psychiatry/Psychology	51.931	20.536	4.463	-	11.716	-	-	6.365	-	346.505
Social sciences, General	85.491	19.444	5.589	2.058	4.660	4.921	7589	4.422	4.201	320.556
Space science	60.427	-	-	-	-	-	-	-	-	494.403

Descending the position analysis of Brazilian universities in each of the 22 areas of ESI, it is possible to verify where the strengths are located in thematic specialization. In Figure 2 the better position is represented by the larger size of the presented circles. Ranked 12th in the world, USP is first in *Agricultural Sciences* and second in *Plant & Animal Science* in 34th place in the world.

Figure 2: Position of Brazilian universities in the world ranking of highly cited documents according to the areas of the Essential Science Indicators (2007-2017).



### 3.3 Presence of Brazilian universities in the rankings

Within the wide range of international university rankings, the 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) (De Filippo, Dominique Pandiella & Sanz Casado, 2017). Considering the presence of the Brazilian universities in this three main university rankings, we detected that most of them are public and located in important cities. Furthermore have an important economic development, a state investment above the national average and a rigorous student selection system. These characteristics make them potential world-class universities (Alperin, 2013). Each of them is detailed below.

#### 3.3.1 Ranking ARWU

The data obtained in the 2017 edition of the ARWU show that in the general classification there are 5 Brazilian institutions among the top 500 (USP, UNESP, UFMG, UFRGS and UNICAMP) and 7 between positions 501-800 (UFPR, UFV, UFSC, UNIFESP, UFPE, UFSCAR and UNB). USP stands out among the group 151-200. Although the position of

UNICAMP in the general ranking is relatively low (401-500), their condition improves when ARWU sub-rankings are analyzed by field and subject: 151-200 in *Engineering/Technology and Computer Sciences*, specifically in *Mathematics*.

### 3.3.2 Ranking QS

In the 2017 edition of the QS ranking, 22 Brazilian universities are among the 800 best institutions in the world. The USP is the best university in Brazil and the 120th best placed in the ranking of the main institutions in the world. Then there are UNICAMP (191<sup>a</sup> position) and UFRJ (321<sup>a</sup> position). UFRGS is present in the group 461-470. Analyzing the ranking by subject, the positions of Brazilian universities improve considerably. The largest number of institutions located in *Life Sciences & Medicine* (10), followed by *Engineering and Technology* (6).

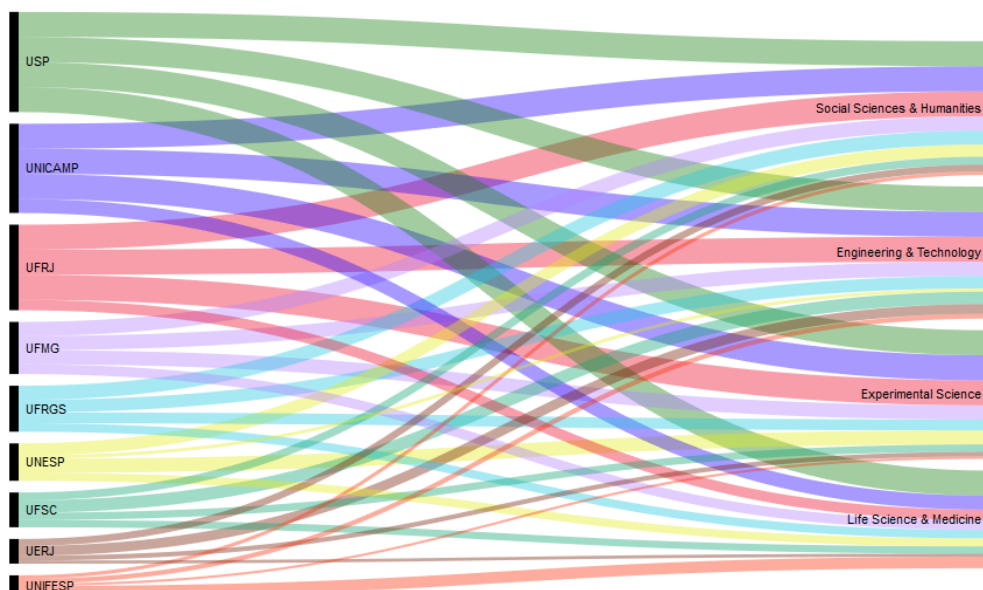
### 3.3.2 Ranking THE

In 2016-2017 Times Higher Education ranks 981 universities in the categories of teaching, research, knowledge transfer and internationalization. Brazil is the country with the best performance in Latin American rankings, with 27 Brazilian institutions classified. The USP occupies the first position (251-300). After the position 200, the ranking does not consider the institutions in a unitary way and start to consider them by groups. Then there are UNICAMP (among the top 500) and Federal University of ABC (among the top 600).

### 3.4 Representation of more visible universities and thematic specialization

After identifying the different scientific indicators of international visibility for each Brazilian university and determine their respective thematic areas, Figure 3 shows the representation between the two variables. The most outstanding areas are appreciated (with universities in better positions) and the main institutions in each one (the thickness of the line is proportional to the frequency).

Figure 3: Brazilian universities with higher international visibility by thematic area (2016-2017).



Nine Brazilian public universities were listed on all three major general rankings. USP is that shows greater visibility in all the thematic fields. UFRJ highlights as the best Brazilian federal university. His activity in *Engineering and Technology* is very relevant. On the other hand, traditionally recognized as an institution specialized in the *Health Sciences*, UNIFESP stands in *Life Science & Medicine*.

#### 4. Discussion

The data obtained allow to present some reflections of interest to different stakeholders of the Brazilian university system. Sources considered of great international prestige by the academic and scientific community were used. The publications and the rankings are currently the pillars for evaluating the quality of university research activity.

Regarding the Brazilian universities it was verified that public are the ones that have visibility indicators. No institution studied is private. So, the institutional typology (public/private), is closely linked to the activity of universities. The public ones are much more intensive in R&D (Leta, 2012).

Furthermore, the disciplinary specialization of that institutions can have a great influence on the position it acquires in a general university ranking (López-Illescas, Moya-Anegón, & Moed, 2011). Those oriented to areas with high visibility, such as experimental sciences or medical sciences, will have a better chance of achieving good positions in international rankings. In this context, it is essential to identify universities with similar disciplinary approaches in order to compare them and interpret this type of comparisons. Global comparisons can harm certain types of universities and influence their positioning (Bornmann Lutz, Moya Anegón Felix, & Mutz Rüdiger, 2013).

For the next stages of the study, we planned to include the results of the Leiden Ranking (in which many more Brazilian universities are located), as well as data about the history, the main lines of research and research groups of these universities, which can help understand the field trends shown in this document.

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