Lex Humana, Petrópolis, v. 12, n. 1, p. 17-37, 2020, ISSN 2175-0947
© Universidade Católica de Petrópolis, Petrópolis, Rio de Janeiro, Brasil

SCIENTIFIC PRODUCTION BETWEEN BRAZIL AND PORTUGAL: A COMPARATIVE STUDY OF THE PERIODS 1980-90 AND 2005-2015

PRODUÇÃO CIENTÍFICA ENRE BRASIL E PORTUGAL: UM ESTUDO COMPARATIVO DOS PERÍODOS 1980-90 E 2005-2015*

ELENARA CHAVES EDLER DE ALMEIDA**
COORDENAÇÃO DE APERFEIÇOAMENTO DE PESSOAL DE NÍVEL SUPERIOR, BRASIL

PEDRO MIGUEL ALVES RIBEIRO CORREIA***
UNIVERSIDADE DE LISBOA, PORTUGAL

Abstract: The article analyses co-authorship between Brazilian and Portuguese authors in the periods 1980-90 and 2005-15. According to the Web of Science, between 1980 and 1990, Portugal published 221,229 documents (articles, proceeding papers and reviews) and Brazil published 656,866 documents. However, taking into account the Category Normalized Citation Impact, which is the impact of standardised citations for the category, Brazil reached 0.76 (below world average) and Portugal 1.08 (above the world average). The article analyses the number of documents, knowledge areas, journals in which they were published, and Portuguese and Brazilian institutions involved while considering the investments that each country made in science and technology. When the two periods were compared, the number of published documents increased, and the areas of knowledge expanded considerably. The number of unique journals in which documents were published also increased as well as institutions that published in co-authorship. The "hard" sciences excelled in co-authored publications. The financing of science and technology and research and development in the two countries has increased considerably since the 1990s, declining in Portugal after 2008 due to the international financial crisis and declining in Brazil from 2015. However, international cooperation and co-authorship is fundamental to the advancement of scientific knowledge and the quality and visibility of scientific production.

Keywords: Science and technology qualitative data. Scientific production. Brazilian science. Portuguese science. Growth of scientific production.

* Artigo recebido em 01/07/2020 e aprovado para publicação pelo Conselho Editorial em 15/07/2020.
** Doutora em Educação em Ciências: Química da Vida e Saúde pela Universidade Federal do Rio Grande do Sul, Brasil. E-mail: elenara.almeida@campus.ul.pt . Currículo lattes: http://lattes.cnpq.br/4787886293165301. ORCID: 0000-0003-3759-6656. Órgão financiador: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES, Brasil.

*** Doutor em Ciências Sociais (Especialidade em Administração Pública) pelo Instituto Superior de Ciências Sociais e Políticas da Universidade Técnica de Lisboa, Portugal. Vice-Presidente e Investigador Integrado do Centro de Administração e Políticas Públicas do Instituto Superior de Ciências Sociais e Políticas da Universidade de Lisboa. Curriculum: https://www.cienciavitae.pt/4914-5E4E-AF20. E-mail: pcorreia@iscsp.ulisboa.pt

Introduction and Literature Review

The internationalisation of scientific production is one of the main indicators of the importance of scientific contribution a country makes. Scientific cooperation between Brazilian and Portuguese academic institutions has become a tradition. In 2016, to celebrate the 30th anniversary of the signing of the Agreement on Scientific and Technological Cooperation between the Portuguese and Brazilian governments, a joint declaration was signed between the Ministry of Science, Technology, Innovation and Communications of Brazil and the Ministry of Science, Technology and Higher Education of the Portuguese Republic, with the aim of strengthening cooperation in the fields of scientific research and technology. The declaration proposed:

- Working together in the areas of space, oceanic observation, energy, and data science and its impact on the study of climate change;
- Reinforcing of collaboration cooperation in the area of nuclear physics, astroparticles, and cosmology;
- Strengthening the areas of scientific computing, quantum sciences, technologies, and nanosciences;
- Cooperating in research and development and advanced training with emphasis on energy networks and low-carbon urban mobility; and
- Promoting scientific and technological culture. (Ministry of Science, Technology and Higher Education, 2016)

English language is essential for scientific publication. Most of the indexed journals are published in English, from which it can be deduced that publication by English-speaking countries has an initial advantage. Thus, scientific publication between Brazil and Portugal, when written in Portuguese, may provide a disadvantage. Gordin (2015) described that the English language has been the predominant science language since the end of the First World War. He wrote, "English is the language of science today. No matter which languages you know, if you want your work seen, studied, and cited, you need to publish in English" (p. 6). Mur-Dueñas (2012, p. 403) stated, "English has become the predominant language for the dissemination of new academic knowledge". According to Oliveira (2019, p. 96) "when publishing papers or even communicating scientific discoveries, researchers from around the world routinely use English". Some recent studies indicate that English is the most effective language for disseminating research results. Papers published in English are more frequently read by the international audiences and will consequently achieve more citations than other languages (Tahamtan et al., 2016).

Fiorin (2007) noted that the merit of scientific production is indicated by its internationalisation. Technological advancement and communication networks have reduced distances of all kinds in the academic and scientific context. For many scholars, the international scientific collaboration resulting from co-authorship receives a greater number of citations (which increases their visibility), their publication has more positive effects on the final quality of the work, and it increases the scientific performance of research groups. In addition to greater visibility, international scientific cooperation contributes to the transfer of knowledge when research groups

from countries with a high citation index become attractive for the establishment of scientific cooperation agreements. Tahamtan et al. (2016) stated that,

> There is a significant relationship between the international and national cooperation of authors, number of countries and number of organizations in producing papers and the frequency of citations. "Collaboration" can be defined as the co-occurrence of two or more addresses on a publication. Highly cited papers are shown to be the result of teamwork of researchers from different countries. Papers published by the cooperation of authors from several organizations gather significantly more citations than papers authored by authors from one organization. It is maintained that papers with international collaboration have a greater impact than papers with national collaborations because of their greater quality and prestige. Number of institutions and countries in a paper as well as the number of the foreign organizations are significantly correlated with the frequency of citations (p. 1208).

Pless et al. (2010), who conducted a review on the need for research on chronic diseases in children, concluded that the collaboration of scientific centers in research would facilitate funding for research projects, as well as reinforce implementing more research. A study from European Commission on Research and Innovation (2013) shows a list of potential indicators that may be applied in the context of monitoring member state's activities in international cooperation involving intra-European Union and third country activities. These have been categorized against the following broad policy goals, although significant overlap between the categories is inevitable: a) Achieving research excellence; b) Attracting, retaining, and developing human resources for science and technology, c) Competitiveness and innovation; d) Science diplomacy; e) science and technology capacity building; and f) Tackling grand challenges.

Brazilian and Portuguese Context

Brazilian and Portuguese collaborative scholarship has increased. Between 1980 and 1990, 34 articles, proceedings and reviews were published. This increased significantly during the decade from 2005 to 2015, during which 7,764 articles, proceedings papers and reviews were published. Brazilian scientific publications are the most indexed in the Journal Citation Report (JCR) within the Ibero-American world. According to Fausto (2016) Brazil is the Ibero-American country that has the most journals indexed in the JCR. The number of Brazilian publications indexed in the WoS shows a continuous growth in relation to the other countries. In 1995, the Brazilian journals indexed in WoS represented 0.83% of the total, which went up to 1% in 1997 and to 1.33% in 2000, making Brazil ninth in the ranking of the 20 countries with the highest growth in the number of articles published in journals indexed in the WoS. Portugal, on the other hand, had a great increase in the number of scientific publications, from 2000 when it had 136.2 publications per 100 thousand inhabitants, passing to 206.0 publications by the same number of inhabitants, in 2015.The promotion of public policies within the Portuguese scientific world, as of 2005, included important internationalisation initiatives of both researchers and institutions.

Purpose of the Study

The purpose of the study was to verify whether the existing agreements between the two countries and the volume of resources invested in Science and Technology by these countries influenced the performance of these countries' scientific production and whether it has benefited Portugal and Brazil equally. To achieve this purpose, the scientific production of Portuguese authors in co-authorship with Brazilian authors was analyzed in terms of number of documents, knowledge areas, journals that they were published, and institutions involved. Scientific production between Portuguese and Brazilian authors was based on the analysis of two periods: 1980-1990 and 2005-2015. The countries that most publish in co-authorship with authors from Portugal and the position of Brazil in this ranking will be identified. Given this panorama, our main questions are: **Did the co-authorship of Brazilian and Portuguese scientists bring benefits to science**? This question leads to others that we also need to be answers. **Were there any benefits?** Let's check if they happened through the CNCI, this will be the indicator. **In what areas did they happen?** The answer is found in tables 3 and 4. Table 3 brings the results ranked by times cited and table 4 ranked by numbers of documents. **Where were these articles published? Which institutions participated? What was the behavior of the investments of the countries in the scientific area?**

Methods

Data Collection

Data on scientific production were extracted from the InCites database of the Institute of Scientific Information of Clarivate Analytics. InCites is a personalised, citation-based online assessment tool that allows one to perform scientific productivity analysis and compare results with countries around the world. Building on the Web of Science (WoS) records, InCites brings analytical tools and metrics to quantify and qualify search results. For this analysis, we consider articles, reviews and proceeding papers only as scientific production (publications) published in journals.

InCites uses data from the following editions of Web of Science Core Collection for its publication counts and indicators. These editions represent more than 12,000 journals, 12,000 annual conferences and 53,000 scholarly books. Currently source publications from 1980 onwards are used within InCites, and all document types are included. These citation indices capture the most influential, global content in all published areas of the sciences, social sciences, and humanities.

- Science Citation Index Expanded (SCIE)
- Social Science Citation Index (SSCI)
- Arts & Humanities Citation Index (AHCI)
- Conference Proceedings Citation Index – Science (CPCI-S)
- Conference Proceedings Citation Index – Social Science & Humanities (CPCI – SSH)
- Book Citation Index – Science (BKCI-S)
- Book Citation Index – Social Sciences & Humanities (BKCI-SSH)
- Emerging Sources Citation Index (ESCI)

Data on scientific production from Portugal was collected from 1980 to 2015 in order to identify the countries that have the most articles published in partnership with Portuguese authors. Then, an analysis of the Portuguese scientific production in partnership with the Brazilian counterparts was examined (i.e., publications that have at least one Portuguese and one Brazilian author) for the periods 1980 until 1990 and 2005 until 2015. The following metrics were extracted: Number of documents, category normalized citation impact (CNCI). and number of times cited.

Number of documents quantifies documents published by the authors of the countries in question listed in Web of Science (WoS). CNCI is calculated by dividing the actual count of citing items by the expected citation rate for documents with the same document type, year of publication, and subject area. When a document is assigned to more than one subject area, an average of the ratios of the actual to expected citations is used. The CNCI of a set of documents, for example, the collected works of an individual, institution or country, is the average of the CNCI values for all the documents in the set. For a single paper that is only assigned to one subject area, this can be represented as:

$$\text{CNCI} = \frac{c}{e_{ftd}}$$

For a single paper that is assigned to multiple subjects, the CNCI can be represented as the harmonic average. For a group of papers, the CNCI value is the average of the values for each of the papers, represented as:

$$CNCI_i = \frac{\Sigma_i \, CNCI_{\,each\ paper}}{\rho_i}$$

Where: e = the expected citation rate or baseline for a given field or subject area (*f*), year (*t*), and document type (*d*); c = number of citations that a given article received by other authors; p = number of papers; n = the number of subjects a paper is assigned to; and *i* = the entity being evaluated (institution, country, person, etc).

CNCI is a valuable and unbiased indicator of impact irrespective of age, subject focus, or document type. Therefore, it allows comparisons between entities of different sizes and different subject mixes. A CNCI value of 1.0 represents performance at par with world average; values above 1.0 are considered above average, and values below 1.0 are considered below average. For example, a CNCI value of 2.0 is considered twice world average. CNCI is an ideal indicator for benchmarking at all organizational levels (author, institution, region etc). One can also use CNCI to identify impactful sub-sets of documents and assess any research activity. For example, as a funding organization, one may use the CNCI as a quantitative performance indicator to monitor the performance of funded projects or to assess the track record of a research teams applying for a new funding.

Analysis

Counting of the number of publications from each country was undertaken carefully, taking into account the problems that arise when such records are sought (Gauffriau et al., 2007; Larsen & Von Ins, 2010). These problems are related to the occurrence of double counting of scientific literature that can happen when production in different countries, institutions and/or fields of knowledge occurs. This is due to the origin of each publication, when it comes from the cooperation between researchers connected to two or more countries, institutions or different areas. The InCites platform takes into account that the same article can be classified in more than

one area of knowledge or it can be written by more than one author from different countries. However, when adding the total number of articles, it will be counted only once.

Results

Scientific Production

Which countries collaborate with Portugal during the period 1980 – 2015?

Considering the period 1980 to 2015 the countries that most collaborate with Portugal in scientific production are listed bellow.

Table 1. *Countries with international collaboration with Portugal: 1980-2015*

Country	Rank	Documents*	Category Normalized Citation Impact - CNCI	Times Cited
SPAIN	1	20,500	1.71	432,271
USA	2	19,659	2.07	588,205
ENGLAND	3	16,950	2.04	487,594
FRANCE	4	14,830	2.13	435,020
GERMANY	5	13,402	2.16	377,493
ITALY	6	10,842	2.35	318,663
BRAZIL	7	9,159	1.57	149,511
NETHERLANDS	8	7,707	2.34	241,888
SWITZERLAND	9	5,509	2.98	198,746
BELGIUM	10	5,507	2.58	181,917

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

Table 1 shows that Brazil is the 7th country that publishes most articles with Portugal, although its CNCI is in 29th place (see Appendix 1). This means that the citation average of articles published by Portuguese and Brazilians together is in the 29th rank position (57% higher than the world average), while in number of publications they rank the 7th. We note that in the case of co-authored publications, Brazil and the United States are the only countries outside Europe appearing in the top ten rank order in the list of results. Brazil is the only Latin American country appearing in this rank. A detailed listing of all countries can be found in Appendix A.

Were there any benefits?

Table 2. *Scientific production of Brazil and Portugal during the period between 1980 to 2015*

Country	Rank world	Documents*	Category Normalized Citation Impact - CNCI	Times Cited
USA	1	10,954,144	1.41	390,347,959
BRAZIL	17	656,866	0.76	6,254,838
PORTUGAL	36	221,299	1.07	2,710,406

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

As shown in Table 2, regardless of co-authorship, the WoS indexed between 1980 and 2015 656,866 documents originating in Brazil and 221,299 in Portugal, thus 2.09 times more documents with Brazilian affiliation. However, if we observe the CNCI, Brazil has 0.76 (below the world average) while Portugal has 1.08 (above average).

How does Brazilian-Portuguese co-authored compare by discipline between 1980-90 and 2005-15?

In what areas did they (benefits) happen?

In order to demonstrate the co-authorship benefits, by subject area, of Portuguese and Brazilians authors, we present tables 3 and 4. Table 3 provides information ranked by number of times cited by research area of co-authored publications, and Table 4 provides the information ranked by the absolute numbers of publications. Brazilian-Portuguese co-authored publications, ranked by times cited, represent the following disciplines during the period of 2005-2015: Physics, Particles and Fields, 33,594 citations*;* Astronomy and Astrophysics, 25,372 citations*;* Physics, Nuclear, 20,482 citations*;* Physics, Multidisciplinary, 9,321 citations*;* Materials Science, Multidisciplinary, 5,254 citations*;* Chemistry, Physical, 5,057 citations*;* Cell Biology, 5,031 citations*;* Oncology, 4,831 citations*;* Critical Care Medicine, 4,640 citations; and Engineering, Chemical, 3,723 citations. During 1980-90, only the first six categories had citations in this period and only 2 areas were among the top 10 positions: Physics, Nuclear, 105 citations versus 20,482 citations in 2005-2015; and Physics, Particles and Fields, 96 citations versus 33,594 citations in 2005-2015. More detailed information for all categories can be found in Appendix B.

Table 3. *Scientific production by research area - Publications by Portuguese authors with co-authorship of Brazilian authors by times cited- 1980/90 and 2005/15*

AREA OF KNOWLEDGE	2005 – 2015 PERIOD					1980-1990 PERIOD				
	Rank Times Cited	Rank documents	Documents	CNCI	Times Cited	Rank Times Cited	Rank documents	Documents	CNCI	Times Cited
PHYSICS, PARTICLES & FIELDS	1	1	940	3.21	33,594	2	2	4	1.52	96
ASTRONOMY & ASTROPHYSICS	2	2	589	3.72	25,372	14	4	3	0.40	32
PHYSICS, NUCLEAR	3	5	340	5.32	20,482	1	1	6	1.16	105
PHYSICS, MULTIDISCIPLINARY	4	8	240	3.32	9,321	20	9	1	0.26	7
MATERIALS SCIENCE, MULTIDISCIPLINARY	5	4	388	1.09	5,254	29	9	1	0.05	1
CHEMISTRY, PHYSICAL	6	6	285	0.92	5,057	19	9	1	0.32	8
CELL BIOLOGY	7	62	63	2.76	5,031	-	-	-	-	-
ONCOLOGY	8	25	133	2.28	4,831	-	-	-	-	-
CRITICAL CARE MEDICINE	9	116	28	10.75	4,640	-	-	-	-	-
ENGINEERING, CHEMICAL	10	9	231	1.19	3,723	-	-	-	-	-

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

Table 4. *Scientific production by research area - Publications by Portuguese authors with co-authorship of Brazilian authors by documents - 1980/90 and 2005/15*

RESEARCH AREA	2005 - 2015 PERIOD			1980-1990 PERIOD		
	Rank documents	Documents*	CNCI	Rank documents	Documents*	CNCI
PHYSICS, PARTICLES & FIELDS	1	940	3.21	2	4	1.52
ASTRONOMY & ASTROPHYSICS	2	589	3.72	4	3	0.40
ENGINEERING, ELECTRICAL & ELECTRONIC	3	499	1.25	-	-	-
MATERIALS SCIENCE, MULTIDISCIPLINARY	4	388	1.09	9	1	0.05
PHYSICS, NUCLEAR	5	340	5.32	1	6	1.16
CHEMISTRY, PHYSICAL	6	285	0.92	9	1	0.32
ENVIRONMENTAL SCIENCES	7	260	0.92	-	-	-
PHYSICS, MULTIDISCIPLINARY	8	240	3.32	9	1	0.26
ENGINEERING, CHEMICAL	9	231	1.19	-	-	-
BIOCHEMISTRY & MOLECULAR BIOLOGY	10	212	1.13	9	1	0.97

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

Table 4 shows the top 10 disciplines for co-authored scholarship (a detailed listing of all fifty research areas and their ranking can be found in Appendix C). The top 10 scholarship areas are: Physics, Particles & Fields (940 documents), Astronomy & Astrophysics (589 documents), Engineering, Electrical & Electronic (499 documents), Materials Science, Multidisciplinary (388 documents), Physics, Nuclear (340 documents), Chemistry, Physical (285 documents), Environmental Sciences (260 documents), Physics, Multidisciplinary (240 documents), Engineering, Chemical (231 documents), and Biochemistry & Molecular, Biology (212 documents). Comparing the performance of these areas in the 1980-1990 period, we noticed that seven of them presented some type of published document and three stood out among the first 5 positions: Physics, Nuclear with 6 documents, Physics, Particles & Fields with 4 documents and Astronomy & Astrophysics with 3 documents published. Significant increases in the 2005-2015 period over the previous period are evident.

When analysing the joint production of the 2 countries, by quantity of documents, (appendix table 3), the following stand out among the first 20 areas in the 2005-15 period and are absent in the 1980-90 period: Engineering, Electrical & Electronics; Environmental Science; Engineering, Chemical; Computer Science, Theory & Methods; Biotechnology & Applied Microbiology; Sport Sciences; Computer Science, Information Systems; Public Environmental & Occupation Health; Genetics & Heredity and Food Science & Technology.

If we consider the number of the "Web of Science Documents", we select the ten areas that present the greatest evolution. The growth of cooperation between Brazil and Portugal in the 2005-15 period is evident. The most evolved area, taking into account co-authorship was Physics, Particles & Fields, followed by Astronomy & Astrophysics; Material Sciences; Physics, Nuclear; Chemistry, Physical. Only areas considered as part of the hard sciences.

Which journals publish Brazilian-Portuguese co-authored scientific production between 1980-90 and 2005-15?

Where were these articles published?

Table 5. *Scientific production by journal titles - Publications by Portuguese authors with co-authorship of Brazilian authors - 1980/90 and 2005/15*

JOURNALS	2005 - 2015 PERIOD			1980 - 1990 PERIOD		
	Rank	Documents*	Times Cited	Rank	Documents*	Times Cited
JOURNAL OF HIGH ENERGY PHYSICS	1	235	3,789	-	-	-
PHYSICS LETTERS B	2	225	17,194	1	2	18
PHYSICAL REVIEW D	3	198	3,883	5	1	14
EUROPEAN PHYSICAL JOURNAL C	4	195	5,722	-	-	-
PHYSICAL REVIEW LETTERS	5	129	7,370	-	-	-
PLOS ONE	6	98	960	-	-	-
ASTRONOMY & ASTROPHYSICS	7	59	1,500	-	-	-
JOURNAL OF INSTRUMENTATION	8	57	1,569	-	-	-
PHYSICAL REVIEW C	9	55	1,839	1	2	22
JOURNAL OF HUMAN KINETICS	10	35	55	-	-	-

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

Taking to account the journals that has being published these researches, we have 55 titles among the 49 best positions of the journals, in the 2005-2015 period, which published the most co-authored documents (A detailed listing of all journals can be found in appendix D). Among the rank of top ten positions, the following stand out, Journal of High Energy Physics, with 235 articles and 3,789 citations; Physics Letters B with 225 articles and 17,194 citations; Physical Review D with 198 articles and 3,883 citations; European Physical Journal C with 195 articles and 5,722 citations; Physical Review Letters with 129 articles and 7,370 citations; Plos One with 98 articles and 960 citations; Astronomy & Astrophysics with 59 articles and 1,500 citations; Journal of Instrumentation with 57 articles and 1,569 citations; Physical Review C with 55 articles and 1,839 citations and Journal of Human Kinetics with 35 articles and 55 citations. All these journals are published in the English language and are published in Italy, the Netherlands, the United States, Germany, France and England countries.

We can also see that in the 1980-1990 period there were six journals that published articles in co-authorship, and they continued publishing in the 2005-2015 period among the fifty-five titles that have published over 13 papers. And among the 49 first positions, the six journals are: Physics Letters B; Physical Review D; Physical Review C; Talanta; Memories of the Oswaldo Cruz Institute; Nuclear Instruments & Methods in Physics Research Section a-Accelerators Spectrometers Detectors and Associated Equipment that have published articles of Portuguese and Brazilian co-authorship. These journals also publish in the English language and are published in the Netherlands, the United States, England, Brazil and the Netherlands countries.

Which institutions are responsible to Brazilian-Portuguese co-authored scientific production between 1980-90 and 2005-15?

Which institutions participated?

Table 6. *Scientific production by Portuguese institutions - Publications by Portuguese authors with co-authorship of Brazilian authors - 1980/90 and 2005/15*

INSTITUTIONS OF PORTUGAL	2005 - 2015 PERIOD			1980 - 1990 PERIOD		
	Rank	Documents *	CNCI	Rank	Documents *	CNCI
Universidade de Lisboa	1	2,121	1.88	1	13	0.62
University of Porto	2	1,675	1.64	3	7	0.68
University of Minho	3	1,328	1.87	-	-	-
University of Coimbra	4	1,298	2.06	3	7	0.67
Technical University of Lisbon	5	1,025	1.60	2	12	0.66
University of Aveiro	6	876	1.14	-	-	-
Nova University of Lisbon	7	750	2.34	5	2	0.53
University of Trás-os-Montes & Alto Douro	8	211	0.70	-	-	
niversity of the Algarve	9	120	1.03	-	-	-
Polytechnic Institute of Porto	10	103	1.43	-	-	-

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

Considering the Portuguese institutions (table 6) in which the authors published most in co-authorship with Brazilian authors were: University of Lisbon, with 2,121 documents; University of Porto with 1,675 documents; University of Minho with 1,328 documents; University of Coimbra, with 1,298 documents; Technical University of Lisbon with 1,025 documents; University of Aveiro with 876 documents; Nova University of Lisbon with 750 documents. A minimum of 75 documents per year and a maximum of 212 documents per year during the 2005-15 period among these 7 institutions. In the 1980-90 period, only five of these institutions had publications in co-authorship with Brazilian authors and the minimum total quantity of the whole period was 2 documents and the maximum was 13 documents, demonstrating the quantitative evolution of the production.

In relation to the number of Portuguese institutions that published documents in co-authorship with Brazil, we observed that in the 2005-2015 period there were a total of 66 Portuguese institutions, although only the 53 best ranked institutions among the 50 that publish the most documents (A detailed listing of all institutions can be found in appendix E). It is also possible to observe that only 6 institutions published articles in the 1980-1990 period. This demonstrates a tenfold increase in the number of Portuguese institutions when comparing the two periods.

Table 7. *Scientific production by Brazilian institutions -_Publications by Portuguese authors with co-authorship of Brazilian authors - 1980/90 and 2005/15*

BRAZILIAN INSTITUTIONS	2005 - 2015 PERIOD				1980 – 1990 PERIOD			
	Rank	Documents *	CNCI	Times Cited	Rank	Documents *	CNCI	Times Cited
University of Sao Paulo	1	1,773	2.40	41,958	1	8	0.47	79
Federal University of Rio de Janeiro	2	1,049	2.42	30,600	5	2	2.46	65
Sao Paulo State University	3	817	2.69	23,299	-	-	-	-
Rio de Janeiro State University	4	745	3.05	26,925	-	-	-	-
University of Campinas	5	597	2.46	12,967	2	4	0.68	54
Brazilian Center for Research in Physics	6	583	3.65	24,761	10	1	0.76	17
Federal University of ABC (UFABC)	7	501	3.88	21,098	-	-	-	-

	2005 - 2015 PERIOD				1980 – 1990 PERIOD			
BRAZILIAN INSTITUTIONS	Rank	Documents *	CNCI	Times Cited	Rank	Documents *	CNCI	Times Cited
Federal University of Juiz de Fora	8	448	3.25	14,052	-	-	-	-
Federal University of Sao Joao del-Rei	9	428	3.36	14,289	-	-	-	-
Federal University of Santa Catarina (UFSC)	10	387	3.38	7,189	10	1	1.06	34

Source: InCites, Clarivate Analytics. Extracted in 07/12/2017. *Documents=articles, proceeding papers and review articles.

Doing the same analysis from Brazilian institutions (table 7) we find that the top ten ranked are: University of São Paulo, Federal University of Rio de Janeiro, State University of São Paulo, State University of Rio de Janeiro, State University of Campinas, Brazilian Center for Research in Physics, Federal University of ABC, Federal University of Juiz de Fora, Federal University of São João Del Rei and Federal University of Santa Catarina. They are all public institutions. One of them, the ABC Federal University that appears in 7th place in the ranking, is an extremely young institution. It was established by Law in 2005. We also found in this ranking the presence of a research institute, the Brazilian Center for Research in Physics, of the Ministry of Science, Technology, Innovation and Communication of Brazil. This is a difference when we observe that in Portugal they are all universities, institutions that are dedicated to teaching, research and extension.

In the 1980-90 period, the Brazilian institutions that published in co-authorship with Portuguese authors, and that are among the ten best ranked, besides those already mentioned above, were: Federal University of Minas Gerais (12th in the 2005-15 ranking and 5th between 1980-1990), Federal University of Pernambuco (13th in the 2005-2015 ranking and 3rd between 1980-1990), University of Pará (16th in the 2005-2015 ranking, and 10th between 1980-1990), Oswaldo Cruz Foundation (22nd in the 2005-2015 ranking and 3rd between 1980-1990), State University of Maringá (28th in the 2005-2015 ranking and 10th between 1980-1990), Department of Aerospace Science and Technology-CTA (39th in the 2005-2015 ranking and 5th between 1980-1990), National Nuclear Energy Commission (41st in the ranking, 2005-2015 and 5th between 1980-1990) and Institute of Energy and Nuclear Research - IPEN - (48th in the 2005-2015 ranking and 5th between 1980-1990). All public institutions, 4 being research institutes and the rest being Universities. A detailed listing of all institutions can be found in appendix F.

When Portugal publishes with Brazil its CNCI is 57% higher than the world average (Table 1). However, Portugal gets more visibility with co-authorship with Switzerland, Austria, Canada, Australia, Finland, Norway, Japan, Turkey and Israel where the normalized impact index is approximately twice the world average.

Financing

What was the behavior of the investments of the countries in the scientific area?

Innovation is a factor that determines the technological and socioeconomic development of a country, so countries that have public policies focused on technological innovation are usually richer countries with more advanced industries and less social inequality, even though there is no direct relationship, according to Oliveira et al (2015). The process of technological innovation is actively influenced by spending on R&D. According to the OECD manual (2005), quoted by Oliveira et al. (2015, p. 269), ¨research and development comprises creative work carried out on a

systematic basis with the purpose of increasing the stock of existing knowledge, including scientific and technological knowledge, as well as the use of this knowledge for new applications¨.

According to the document of the Ministry of Science, Technology and Higher Education, entitled Stimulus to scientific employment: implementation and concretization plan September 2016, the financial support for research is carried out in Portugal from:

- Funds from the State Budget for public, university and polytechnic higher education institutions,
- Specific support, of a competitive nature, to be awarded by the Fundação para a Ciência e a Tecnologia, IP, (FCT), to stimulate scientific employment and science and technology activity, including direct support for the contracting, by institutions, of PhD researchers (in particular through annual calls for tender);
- Specific support, of a competitive nature, to be awarded through Portugal 2020 for the development of mobilising and I&D projects (innovation and development), as well as for innovation contracts for the establishment and promotion of collaborative laboratories;
- Support funds for the development of inland territories, low population density regions and Autonomous Regions, oriented towards higher education institutions;

As of 1999 there was a significant increase in funding for research, from EUR 7.5 million in 1995 to EUR 25.5 million in 1999, representing 0.75% of GDP

In the 2006-10 period, Portugal had the largest investment in S&T and I&D, spending 1.6% of its GDP, surpassing Italy, Spain and Ireland in terms of I&D investments, but still far from other European Union countries. Policies in this period aimed at promoting scientific culture, training of human resources and support to scientific institutions, giving priority to collective projects and the internationalisation of scientific production. Companies in 2005 devoted more resources to I&D than higher education institutions, this coincided with a tax review of business I&D called SIFIDE. These actions also brought an increase in the hiring of researchers by the private sector. Heitor (2015) writes: "In 2008, business expenditure on I&D as a percentage of GDP was equal to the expenditure of the entire "institutional sector", comprising the higher education sector, the private non-profit sector and the public sector (representing about 0.78% of gross domestic product). Moreover, in the energy, automotive, communications and information technology sectors.

Special attention was given to the sectors of: Aerospace and Defence; Water; Foods; Biomass and Bioeconomics; Social Sciences and Technologies; Climate; Economics and Digital Society; Energy; Nuclear; Health; and Convergent and Enabling Technologies.

In this period, the number of researchers in Portugal reached the OECD average number of researchers per thousand active workers in 2008 (7.2 per thousand active workers) and the total public budget in I&D grew by 11% per year between 2004 and 2009 (Hector, 2015). As of 2011, due to the international economic crisis, the percentage of investment has decreased. According to Heitor (2015, p. 20): "Portugal registered the second highest percentage in terms of the total number of researchers (measured in FTE, Full Time Equivalent) per thousand active workers (about 34%), well above the European average (which only grew by 5.4% from 2003 to 2006),

Spain (13%) and Ireland (7%). The total number of researchers in the business sector increased by around 111% between 2005 and 2007, and by 164% between 2005 and 2008, from 4014 to 10,589 FTE. As regards the percentage of women in scientific activities, the latest available data show that Portugal continues to register a considerably high rate of female researchers, in particular to perform activities in academic research, with the percentage of total researchers growing from 41% in 1997 to 45% in 2010. However, the proportion of researchers as a percentage of the total number of active workers is still somewhat reduced in Portugal (less than 10 in 2005) when compared to countries such as Finland or Sweden which have respectively 32 and 28 researchers per thousand active workers."

On average, Portugal invested 44 thousand dollars per researcher, in 2005. The OECD average in the period is $ 101,000 per researcher.

In Brazil the document National Strategy for Science, Technology and Innovation 2012 - 2015(ENCTI) announced the continuity of the Action Plan on Science, Technology and Innovation 2007-2010 (PACTI), which established guidelines to consolidate the so-called National System of Science, Technology and Innovation, combining efforts at the federal, state, municipal, public and private levels to improve S&T laws and guidelines, as well as integration of different S&T support mechanisms in Brazil.

The pillars of the ENCTI were: Promotion of Innovation; New standard of funding for scientific and technological development; Strengthening research and scientific and technological infrastructure; and Training and qualification of human resources.

And they translated into the following Priority Programmes: ICT - Information and communication technologies; Pharmaceuticals and Industrial Health Complex; Oil and Gas; Defence Industrial Complex; Aerospace; Nuclear; Frontiers of innovation; Biotechnology; Nanotechnology and new materials; Fostering the green economy; Energy; Biodiversity; Climate changes; Oceans and coastal areas; S,T&I for Social Development; Popularisation of S,T&I and improvement of science education; Productive inclusion and social technology; Assistive technologies; Technologies for Sustainable Cities and also included complementary Programmes.

In 2016 Law 13.341, of 09/29/16, determined the transformation of the Ministry of Communications and the Ministry of Science, Technology and Innovation into the Ministry of Science, Technology, Innovation and Communications (MCTIC). Its competence, established by Decree 8.877, dated 10/18/16, covers:

- National telecommunications policy;
- National broadcasting policy;
- Postal services, telecommunications and broadcasting;
- National policies for scientific and technological research and incentives for innovation;
- Planning, coordination, supervision and control of science, technology and innovation activities;
- Software development and automation policy;
- National biosafety policy;
- Space policy;

- Nuclear policy;
- Export control of sensitive goods and services;
- Articulation with the Governments of the States, Federal District and Municipalities, with civil society and with federal government bodies to establish guidelines for national science, technology and innovation policies.

The Ministry expects to invest in the quadrennium 2012-2015 resources of about 74.6 billion reais coming from various sources. 29.2 billion from the Ministry itself. Other ministries 21.6 billion; of state-owned BNDS, Petrobrás and Eletrobrás it was expected to reach 13.6 billion and 10.2 billion state resources from research support foundations (FAPs).

In these expenditures, called "Applied Resources - Consolidated Indicators" federal, state, and business expenditures are considered. And, by science and technology what is meant is experimental research and development (R&D) and related scientific and technical activities (ACTC).

Table 8. *National expenditures on research and development (R&D) in relation to the gross domestic product (GDP) of selected countries, 2000-2015*

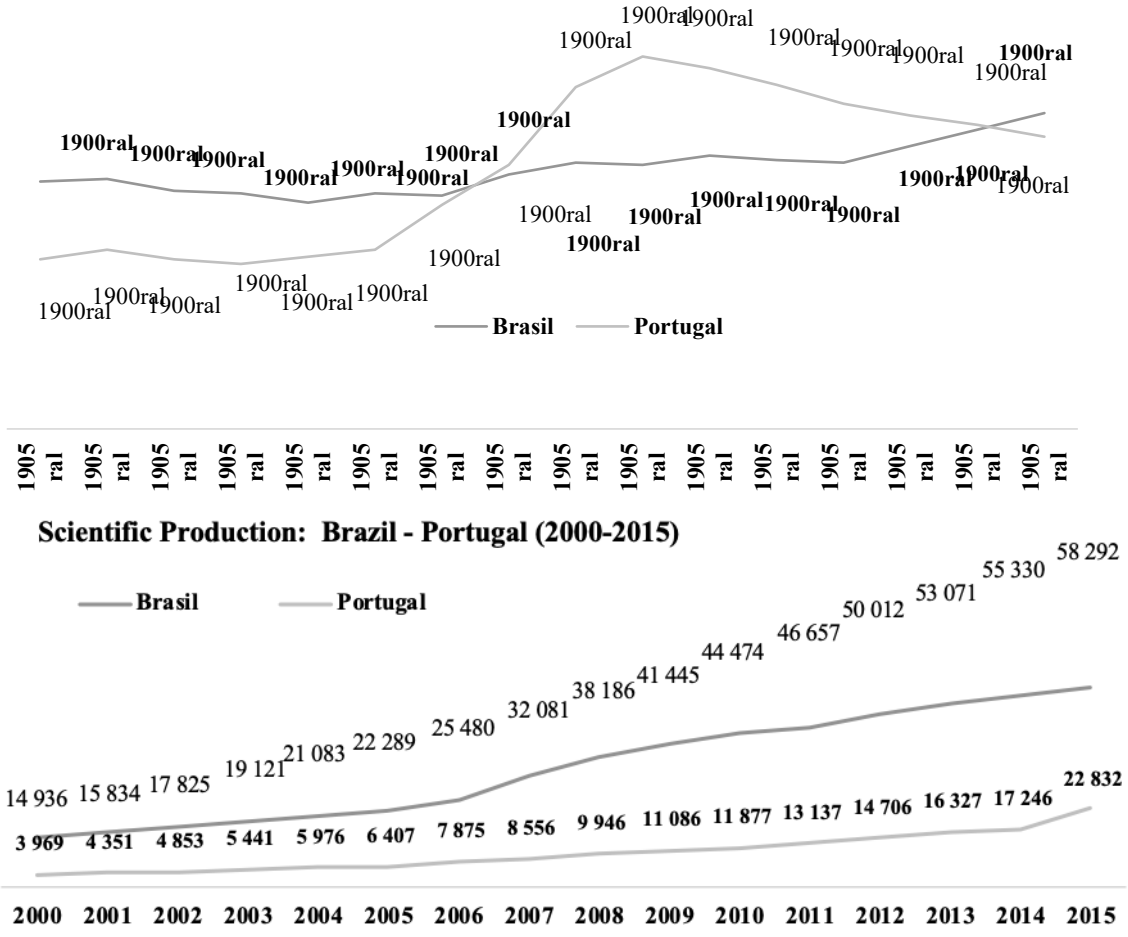
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
South Africa	-	0.72	-	0.76	0.81	0.86	0.90	0.88	0.89	0.84	0.74	0.73	0.73	0.72	0.77	0.80
Germany	2.39	2.39	2.42	2.46	2.42	2.42	2.46	2.45	2.60	2.73	2.71	2.80	2.87	2.82	2.87	2.92
Argentina	0.40	0.39	0.36	0.38	0.40	0.42	0.45	0.46	0.47	0.58	0.56	0.57	0.64	0.62	0.59	0.62
Brazil	**1.05**	**1.06**	**1.01**	**1.00**	**0.96**	**1.00**	**0.99**	**1.08**	**1.13**	**1.12**	**1.16**	**1.14**	**1.13**	**1.20**	**1.27**	**1.34**
Canada	1.86	2.03	1.98	1.97	2.00	1.98	1.95	1.91	1.86	1.92	1.84	1.80	1.79	1.71	1.72	1.65
China	0.89	0.94	1.06	1.12	1.21	1.31	1.37	1.37	1.44	1.66	1.71	1.78	1.91	1.99	2.02	2.06
Singapore	1.82	2.02	2.07	2.03	2.10	2.16	2.13	2.34	2.62	2.16	2.01	2.15	2.00	1.99	2.16	2.07
Korea	2.18	2.34	2.27	2.35	2.53	2.63	2.83	3.00	3.12	3.29	3.47	3.74	4.03	4.15	4.29	4.22
Spain	0.88	0.89	0.96	1.02	1.04	1.10	1.17	1.23	1.32	1.35	1.35	1.33	1.29	1.27	1.24	1.22
United States	2.62	2.64	2.55	2.55	2.49	2.51	2.55	2.63	2.77	2.82	2.74	2.77	2.71	2.72	2.73	2.74
France	2.08	2.13	2.17	2.11	2.09	2.04	2.05	2.02	2.06	2.21	2.18	2.19	2.23	2.24	2.28	2.27
India	0.78	0.81	0.79	0.77	0.77	0.81	0.88	0.87	0.86	0.89	0.87	0.87	0.88	0.74	0.71	0.69
Italy	1.01	1.04	1.08	1.06	1.05	1.05	1.09	1.13	1.16	1.22	1.22	1.21	1.27	1.31	1.34	1.34
Japan	3.00	3.07	3.12	3.14	3.13	3.31	3.41	3.46	3.47	3.36	3.25	3.38	3.34	3.31	3.40	3.28
Mexico	0.33	0.35	0.39	0.39	0.39	0.40	0.37	0.43	0.47	0.52	0.54	0.52	0.49	0.50	0.53	0.52
Portugal	**0.72**	**0.76**	**0.72**	**0.70**	**0.73**	**0.76**	**0.95**	**1.12**	**1.45**	**1.58**	**1.53**	**1.46**	**1.38**	**1.33**	**1.29**	**1.24**
United Kingdom	1.64	1.63	1.64	1.60	1.55	1.57	1.59	1.63	1.64	1.70	1.68	1.68	1.61	1.65	1.67	1.67
Russia	0.99	1.10	1.17	1.21	1.08	1.00	1.01	1.05	0.98	1.17	1.06	1.02	1.05	1.03	1.07	1.13

Source(s): Organisation for Economic Co-operation and Development (OECD), Main Science and Technology Indicators, 2018/1; India: Research and Development Statistics 2017-18 and Brazil: Coordination of Indicators and Information (COIND) - CGGI/DGE/SEXEC - Ministry of Science, Technology, Innovation and Communications (MCTIC) Elaboration: Coordination of Indicators and Information (COIND) - CGGI/DGE/SEXEC - Ministry of Science, Technology, Innovation and Communications (MCTIC). Updated on: 17/10/2018.

Table 8 shows R&D expenditures in relation to GDP between 2000 and 2015, where Brazil and Portugal showed an evolution as shown in Graph 1, below. The data for Brazil for 2015

is 1.34, and we noticed a slight increase compared to 2014 with an index of 1.27. In Portugal the rise occurred in 2009 with the index of 1.58 and a decline until 2015 with the index of 1.24.

Graph 1. *National expenditures on research and development (R&D) in relation to the gross domestic product (GDP) of Brazil and Portugal, 2000-2015*



Source(s): Organisation for Economic Co-operation and Development (OECD), Main Science and Technology Indicators, 2018/1; India: Research and Development Statistics 2017-18 and Brazil: Coordination of Indicators and Information (COIND) - CGGI/DGE/SEXEC - Ministry of Science, Technology, Innovation and Communications (MCTIC) Elaboration: Coordination of Indicators and Information (COIND) - CGGI/DGE/SEXEC - Ministry of Science, Technology, Innovation and Communications (MCTIC). Updated on: 17/10/2018 and InCites, Clarivate Analytics. Extracted in 07/12/2017.

In Graph 1 we see that Brazil's GDP remains almost in a straight line, with a small decrease between 2003 and 2004 and then there is a slight increase up until 2014. In 2015, we have an increase of 0.07 in relation to the value of 1.27 in 2014. The GDP of Portugal presents almost a straight line between 2000 and 2005, with a considerable and constant increase up until 2009, declining again up until 2014, where it practically matches the Brazilian GDP. In 2015, the GDP has a slight drop of 0.03. But considering the increase of 0.07 of the Brazilian GDP, in 2015 the two countries have a difference of 0.10 percent. This scenario, with the Brazilian GDP higher than the GDP of Portugal, had not occurred since 2006, when the Brazilian GDP was 1.12 and the Portuguese GDP was 1.08. As investments in R&D are percentages of GDP, we can consider that we live the consequences of this decline in the two countries up until 2014.

Closing Remarks

In this article, we analyse the co-authorship between Brazilian and Portuguese researchers, stating that there was a significant gain in the scientific knowledge of both countries, whether from the angle of published articles, cooperation between institutions, visibility, the periods in which they published the articles in co-authorship.

There is a tradition of scientific cooperation between Brazil and Portugal and it dates back more than 30 years. This collaboration contributes to a higher quality of production in both countries, and especially when the publication takes place in co-authorship it achieves greater visibility considering indicators such as CNCI and Times Cited.

There was an exponential increase in co-authorship between Brazilians and Portuguese authors considering the periods of 1980-90 and 2005-15. The areas that published most in co-authorship are those considered "hard sciences" such as Physics, Particles & Fields; Astronomy & Astrophysics; Material Science, Multidisciplinary; Physics, Nuclear; Chemistry, Physical; Physics, Multidisciplinary; and Biochemistry & Molecular Biology.

When we analyze these areas of knowledge, we notice that not only did the quantity of articles increase, but also the quality of these publications. This is clear if we analyze the citation index of these areas in the two periods in question. This increase can also be observed in the CNCI, the metric that calculates the citation index, as follows: Physics, Particles & Fields: from 1.52 (1980-1990) to 3.21 (2005-2015); Astronomy & Astrophysics from 0.40 (1980 - 1990) to 3.72 (2005 - 2015); Material Science, Multidisciplinary from 0.05 (1980 - 1990) to 1.09 (2005-2015); Physics, Nuclear from 1.16 (1980 - 1990) to 5.32 (2005 - 2015); Chemistry, Physical from 0.32 (1980 - 1990) to 0.92 (2005 - 2015); Physics, Multidisciplinary from 0.26 (1980 - 1990) to 3.36); and Biochemistry & Molecular - 0.97 from (1980 - 1990) to 1.13 (2005 - 2015).

These areas of expertise are consistent with the areas in which the two countries maintain Agreements on Scientific and Technological Cooperation, as expressed in the Joint Declaration

between the Ministry of Science Technology, Innovation and Communications of Brazil and the Ministry of Science, Technology and Higher Education of the Portuguese Republic. This confirms the hypothesis that when signing agreements and joint ventures between the two countries in these areas with the necessary funding support, there was an increase in the quantity and quality of scientific production in both countries.

The development agencies of these two countries, if they plan to give priority to investment in the training of their scientists, they should consider the areas of knowledge that presented the best indicators, such as CNCI and Times Cited, highlighting the following areas: Critical Care Medicine; Allergy; Physics, Nuclear; Electrical & Electronic Psychiatry; Astronomy & Astrophysics; Physics, Multidisciplinary and Physics, Particles & Lields. The complete list of all areas of knowledge and institutions can be found in the appendices C and E.

As usual in the scientific world, the Hard and Exact sciences dominate publications and citations. However, there is an urgent need for special attention to the Human Sciences (the Humanities) in order to encourage their dissemination and impact. They are important for good governance and for the progress of humanity. The areas of Human Sciences (the Humanities) are the foundation of democratic societies and governments.

As with the areas, the number of journals that published articles in co-authorship of the two nationalities increased almost ninety-six fold, from 30 in 1980-90 to 2,884 in 2005-15.

Brazil is the eighth country that publishes most with Portugal, being the only Latin American and also, together with the USA, the only one among the top ten outside the European continent.

However, we still have a long way to go. The main obstacle, at least in Brazil, is the funding that due to political and economic injunctions is decreasing, which has not yet been detected in production, since it can only be verified over the next few years. The increase in the proficiency of English, as articles in English are more cited than those in Portuguese, is an aspect that must be improved.

Another objective to be achieved is the presence of Brazilian and Portuguese scientists in the editorial bodies of indexed journals. To increase international cooperation between the teaching and research institutions of Brazil and Portugal to increase the exchange between researchers and the diversification of areas of knowledge and improve quality.

Give greater support to the inclusion of masters and doctors in companies and research institutions in each country and in exchanges. Create a large network of R&D institutions. This would undoubtedly increase technological capacity and innovation in both countries. As an example, we have the European Research Area (ERA), created in 2000, which aims to increase the competitiveness of European research institutions, bringing them together and encouraging a more inclusive way of working Framework Programmes (FPs), set up as of 1984, the FPs (from 1 to 7, and 8 entitled Horizon 2020-H2020) are funding programmes set up by the European Union / European Commission to support and foster the ERA. These programmes showed significant results in placing the ERA in the period 2000-2013, second in the volume of scientific production behind China, which was first in the ranking, and matches the US, in total publications in 2013. The H2020 (2014-2020) will aim to provide a comprehensive set of actions to intensify research and innovation and focus on three priorities: excellence in science, industrial leadership and societal challenges (European Commission, 2015).

A bibliometric study on the ERA, conducted by Science-Metrix, according to Nassi-Calò's translation (2015), also includes for comparison, in addition to the US, data related to the BRIC (Brazil, Russia, India and China) countries, Japan and South Korea.

Another important thing pointed out by the European Commission (2015) in the bibliometric study is that the "international collaboration promoted by the FP7 contributed in fact to increasing integration in the region, evidenced by the number of joint publications during and after the project was in force", however, it emphasises that publications "with multiple authors do not constitute a guarantee of greater impact, but articles resulting from collaboration are more likely to be more cited." Considering the indicators that measure the quality of scientific production, international visibility will contribute not only to scientific progress but also to the development and well-being of historically connected Brazilian and Portuguese societies.

We consider that, in the current political and economic situation that the two countries are facing (considering the context of the European Union where Portugal is an integral part), it is very important to maintain the mobilisation of the academic and scientific community so that at least the same levels of investment are maintained in the field of R&D. In Brazil, Constitutional Amendment 95 already compromises the implementation of the National Education Plan. The budget for education dropped from 6.6 billion in 2017 to 4.52 billion reais in 2018, directly affecting investments in higher education. The decline in investment in both countries will be felt in a short-term horizon and will last for many years.

References

1. BRAZIL. (2012). Ministry of Science, Technology and Innovation. National Strategy for Science, Technology and Innovation 2012 - 2015: Review of Structuring Activities 2011. Brasília. Available at: http://www.ipdeletron.org.br/wwwroot/pdf-publicacoes/21/ENCTI_Balanco_2011.pdf. Access on 21.01.2019.

2. BRAZIL. (2019). Ministry of Science, Technology, Innovation and Communications (MCTIC). Applied Resources - Consolidated Indicators. Available at: http://www.mctic.gov.br/mctic/opencms/indicadores/detalhe/recursos_aplicados/indicadores_consolidados/2.1.1.html. Access on 21.01.2019.

3. BRAZIL. (2016). Law 13.341 of 29/09/2016 and Decree 8.877 of 18/10/2016.

4. European Commission. (2015). Analysis of Bibliometric Indicators for European Policies 2000-2013. ISBN 978-92-79-47690-7. Available at: http://www.science-metrix.com/en/publications/reports#/en/publications/reports/analysis-of-bibliometric-indicators-for-european-policies-2000-2013. Access on: 18.03.2019 DOI: http://dx.doi.org/10.2777/194026.

5. Fausto, S. (2016). JCR 2015 there are news: more indexed Brazilian magazines. *News at SIBI USP*. Available at: http://www.sibi.usp.br/?p=5938. Access on: 18.03.2019

6. Fiorin, J. L. (2007). Internationalization of scientific production: the publication of works of Human and Social Sciences in international journals. *RBPG*, Brasília, v. 4, n. 8, p. 263-281.

7. Gauffriau, M., Larsen, P.O, Maye, I. et al. (2007). Publication, cooperation and productivity measures in scientific research. *Scientometrics* 73: 175. https://doi.org/10.1007/s11192-007-1800-2

8. Gordin, M. D. (2015). Scientific Babel. How Science Was Done Before and After Global English. ISBN: 9780226000299. The University of Chicago Press. Chicago, Ilinois, USA.

9. Heitor, M (2015). Science and knowledge in the modernization of Portugal: the formulation of public policies in overcoming scientific backwardness and in democratizing access to knowledge. In: ALMEDINA. *40 years of science and higher education policies, 2015*. Available at: http://www.manifesto2015.com/docs/capitulo-politicas-C-T-MHeitor-11mai2015.pdf. Access on 19.01.2019.

10. Larsen, P.O. & von Ins, M. (2010). The rate of growth in scientific publication and the decline in coverage provided by Science Citation Index. *Scientometrics* 84: 575. https://doi.org/10.1007/s11192-010-0202-z

11. Mur-dueñas, P. (2012). Critical acts in published and unpublished research article introductions in English: a look into the writing for publication process. In: BAZERMAN, Charles et al. (Org.). International Advances in Writing Research Cultures, Places, Measures. Fort Collins, Colo.: WAC Clearinghouse; Anderson, S. C.: Parlor Press, 2012, p. 403-420. Disponível em: <http://wac.colostate.edu/books/wrab2011/chapter23.pdf >.

12. Nassi-calò, L. (2015). Bibliometric indicators of European scientific production [online]. *SciELO in Perspective*. Available at: http://blog.scielo.org/blog/2015/11/05/indicadores-bibliometricos-da-producao-cientifica-europeia/. Access on: 18.03.2019

13. Oliveira, M. A. C. de et al. (2015). Econometric analysis of research & development (R&D) spending in Brazil. *Journal of Administration and Innovation*, São Paulo, v. 12, n. 3, p. 268-287, Sep. 2015. ISSN 1809-2039. Available at: http://www.revistas.usp.br/rai/article/view/101896. Access on: 28.01. 2019. doi:http://dx.doi.org/10.11606/rai.v12i3.101896.

14. Oliveira, S. S. (2019). The language of science. *FAPESP Journal*. Edition 282. August 2019. Available: http://revistapesquisa.fapesp.br/tag/educação. Access on 18.10.2019.

15. Pless, I.B., stein, R.E.K. & walker, D.K. (2010). Research Consortium on Children with Chronic Conditions (RCCCC): A Vehicle for Interdisciplinary Collaborative Research. *Matern Child Health Journal* 14: 9. https://doi.org/10.1007/s10995-009-0484-z.

16. PORTUGAL. Embassy in Brazil. Acts signed on the occasion of the XII Brazil-Portugal Summit. Available at: http://www.embaixadadeportugal.org.br/noticias/noticia.php?cod_noticia=656. Access on 25.01.2019.

17. PORTUGAL. (2016). Ministry of Science, Technology and Higher Education. Stimulus to scientific employment: implementation and concretization plan. Portugal. Available at: file: file:///Users/elenaraalmeida/Downloads/20161017-mctes-emprego-cientifico.pdf. Access on 18.01.2019.

18. PORDATA. (2015). Scientific publications per 100 thousand inhabitants in Portugal. In: Fundação Francisco Manuel dos Santos. *PORDATA - Contemporary Portugal database.* Available at: http://www.pordata.pt/Portugal/Publica%C3%A7%C3%B5es+cient%C3%ADficas+por+100+mil+habitantes-1196. Access on: 19.02.2019.

19. Tahamtan, I., Safipour, A. & Ahamdzadeh, K. (2016). Factors affecting number of citations: a comprehensive review of the literature. *Scientometric*s 107: 1195. https://doi-org.ez1.periodicos.capes.gov.br/10.1007/s11192-016-1889-2.

Universidade Católica de Petrópolis
Centro de Teologia e Humanidades
Rua Benjamin Constant, 213 – Centro – Petrópolis
Tel: (24) 2244-4000
synesis@ucp.br
http://seer.ucp.br/seer/index.php?journal=synesis

CC BY NC

ALMEIDA, Elenara Chaves Edler de; CORREIA, Pedro Miguel Alves Ribeiro. SCIENTIFIC PRODUCTION BETWEEN BRAZIL AND PORTUGAL: A COMPARATIVE STUDY OF THE PERIODS 1980-90 AND 2005-2015. **Lex Humana**, v. 12, n. 1, p.17-37, jul. 2020. ISSN 2175-0947. Disponível em: http://seer.ucp.br/seer/index.php/LexHumana/article/view/1868