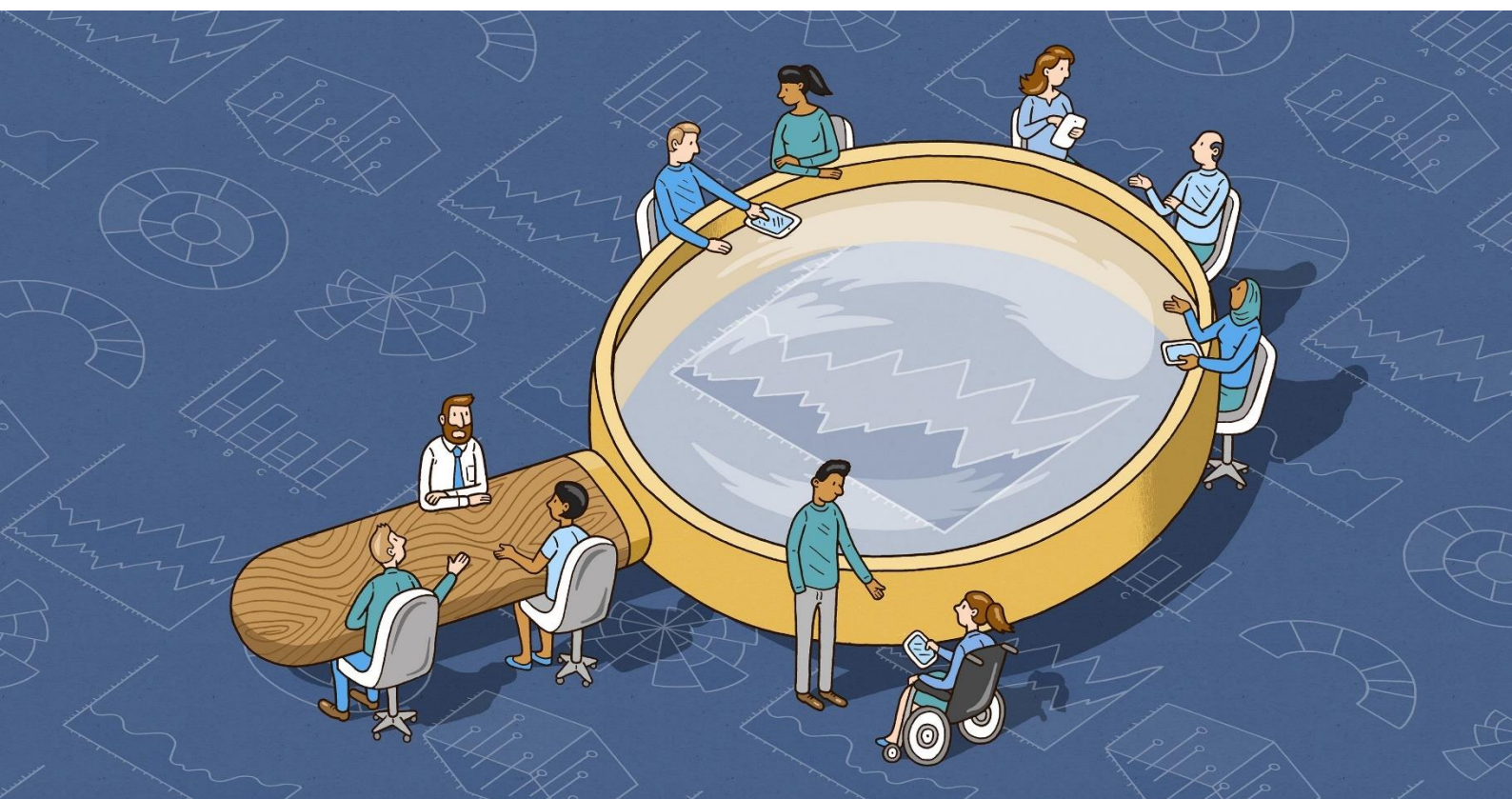# Research in Brazil towards International Collaboration

Research output, impact and levels of collaboration of Brazilian Institutions that are part of the PrInt Project

ELSEVIER

A report for Capes using SciVal, 2019

Research Intelligence

Executive summary

In addition to the results of International Collaboration of all Brazilian institutions and the comparison of Brazil with 5 research-intensive countries, this report provides specific information on the Brazilian Institutions that were selected to participate in the Capes PrInt Project.

Although internationalization is an important element for different university rankings, the subject has gained greater relevance in recent discussions, with greater visibility for scientific diplomacy. However, this process should be strategic rather than random, or centered on the individual level of the researchers.

The internationalization of higher education and research in Brazil is not a recent process. As an example of Brazilian initiatives, it is noteworthy the federal program created in 2011, Science Without Borders, with a budget of about R$ 13 billion and with a focus on undergraduate student exchange. The latest internationalization program launched by the federal government at the initiative of The Brazilian Federal Agency for Support and Evaluation of Graduate Education - CAPES through its Directorate of International Affairs - DRI in 2017, is the CAPES-PrInt Project, which aims to foster the construction, implementation and consolidation of strategic plans for internationalization of the institutions contemplated in the areas of knowledge they prioritize.

Given the investment and the importance of internationalization actions, as well as the search to make improvements in this process, this report presents a Brazilian scientific scenario of internationalization, more specifically about **the results of International Collaboration of Brazilian institutions**, using SciVal as a solution for analysis, for the period of 2014-2019 (incomplete year).

In addition to the national overview and comparison of Brazil with research intensive countries, such as Canada, Australia, Korea, USA and Germany, this report provides specific information on the **36 Brazilian higher education institutions that were selected to participate in the Capes PrInt Project**.

The present study also highlights which are the top scientific fields of these institutions, and how do Brazilian institutions compare to one another in relation to the levels of collaboration (Institutional, National and International).

The main results show that **the impact of publications of Brazilian institutions in International Collaboration is generally greater than twice the impact of works coming from National Collaboration.** This justifies the importance of initiatives that stimulate the production of works co-authored with other countries.

Key findings

+30%

Institutions participating in the PrInt Project have more than 30% of publications resulting from International Collaboration published in the world's top journals
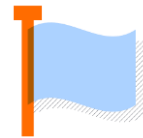
University + Industry

Academic-Corporate Collaboration is a field to be further explored by Brazilian academic institutions.

31.4%

31.4% of Brazilian publications are results of International Collaboration

Brazil + Europe

Europe is the continent that collaborated most with Brazil.

31.9%

31.9% of all the types of collaboration generated by the institutions participating in the PrInt Project together are results of International Collaboration

Research Impact

Institutions participating in the PrInt Project have an impact of citations above the expected world average only when they are collaborating internationally

Contents

Introduction

This report presents a selection of research performance indicators to support Brazilian research managers on their strategies towards International Collaboration.

The idea that International Collaboration contributes to increase scientific impact is the main motivator of the creation of this report. It can be said that International Collaboration is a phenomenon that has gained greater notoriety by the Brazilian scientific community and stimulated by development agencies.

Adopting multidisciplinary as a guideline to International Collaboration, initiatives such as the Capes' PrInt Project bring several benefits to the academic community in Brazil, namely:

- Greater visibility to scientific research conducted in Brazil;

- Encourage international research networks integrated with Brazilian institutions;

- International mobility of researchers and postgraduate students;

- Attractiveness of foreign professors, researchers and graduate students to Brazil.

This report, created by Elsevier Research Intelligence, presents a selection of research performance indicators to support local research managers on their strategies towards International Collaboration.

The objective of this work is to help the Brazilian research community in the analysis of its current behavior and the planning for continued improvement of excellence.

Throughout this report, analyses are based on all Scopus-indexed type of publications. Scopus is the world's largest abstract and citation database of peer-reviewed literature. The scope of the analysis is limited to research-related metrics during the period 2014–2019 (incomplete year) to provide the most current perspective of Brazilian performance. The analyses of bibliometric data in this report are based upon recognized advanced indicators.

In Section 1 - International Collaboration of selected countries, 5 countries were selected to compare levels of International Collaboration with Brazil. They are: Australia, Canada, Germany, United States and South Korea. Section 2 shows Brazilian International Collaboration with all continents and with the top 10 countries that collaborate most with Brazil. Section 3 provides an overview of the general performance as well as levels of collaboration and collaboration impact of the institutions that are part of the PrInt Project. Levels of International, National and Institutional Collaboration were examined.

International Collaboration of selected countries
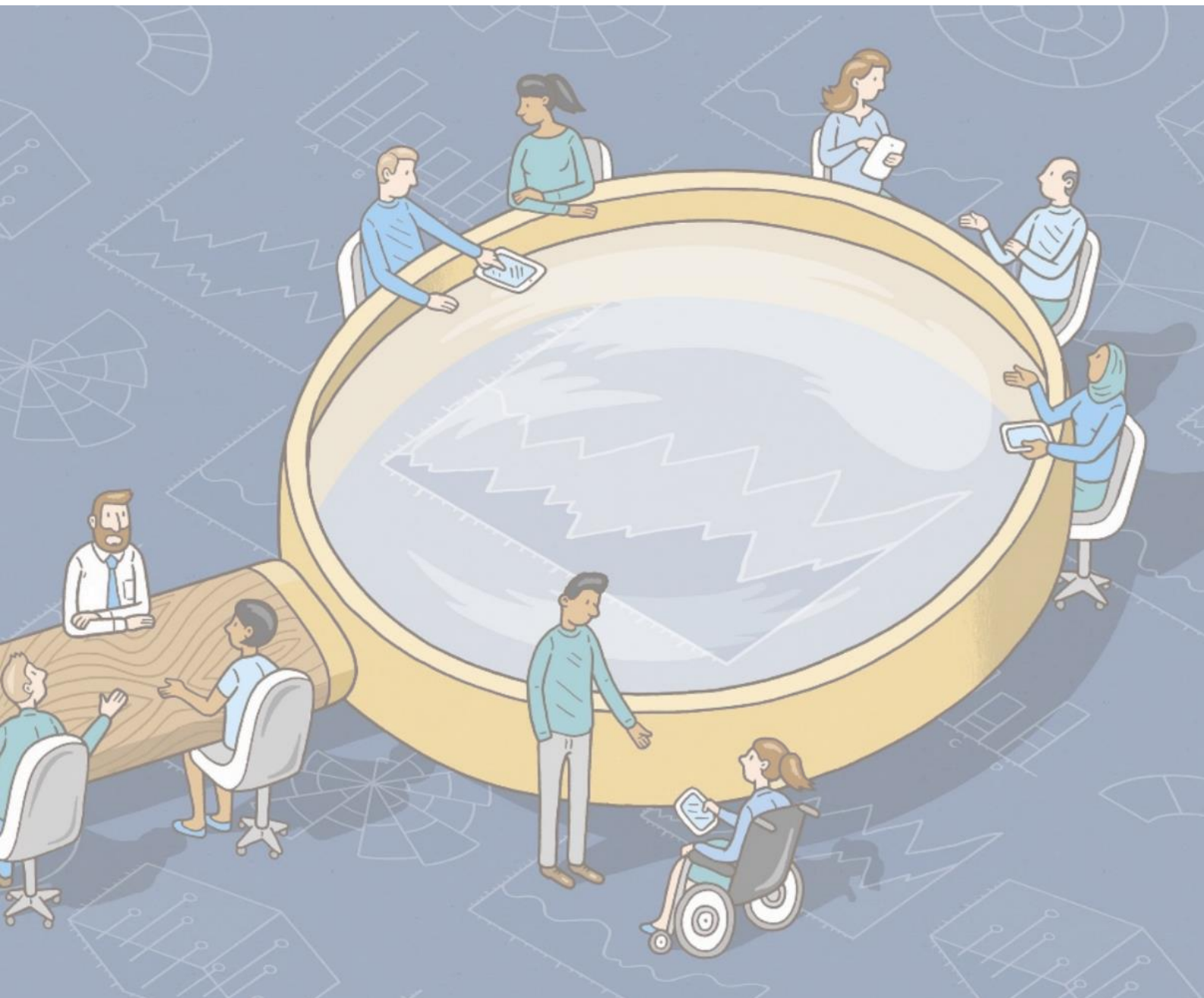
In recent years (2014-2019), 31.4% of Brazilian publications are results of International Collaboration. Brazil reached levels of International Collaboration close to the United States, a research-intensive nation which reached 33.6%.

In this first section, 5 countries were selected to compare levels of international collaboration with Brazil. They are: Australia, Canada, Germany, United States and South Korea. Table 1 shows country performance using 4 additional indicators: Scholarly Output (count of published documents), number of citations received, author count in the period analyzed (2014-2019) and field weighted citation impact (FWCI), a metric that calculates the citation impact according to expected world average, which is weighted by fields of knowledge. The FWCI is measured by the value 1.00. FWCI greater than 1 express impact above the expected world average.

Figure 1 shows a comparison of the 6 countries with respect to International Collaboration. An output is defined as an internationally collaborated document when authors affiliated with institutions from at least two different countries are listed in the authorship byline:
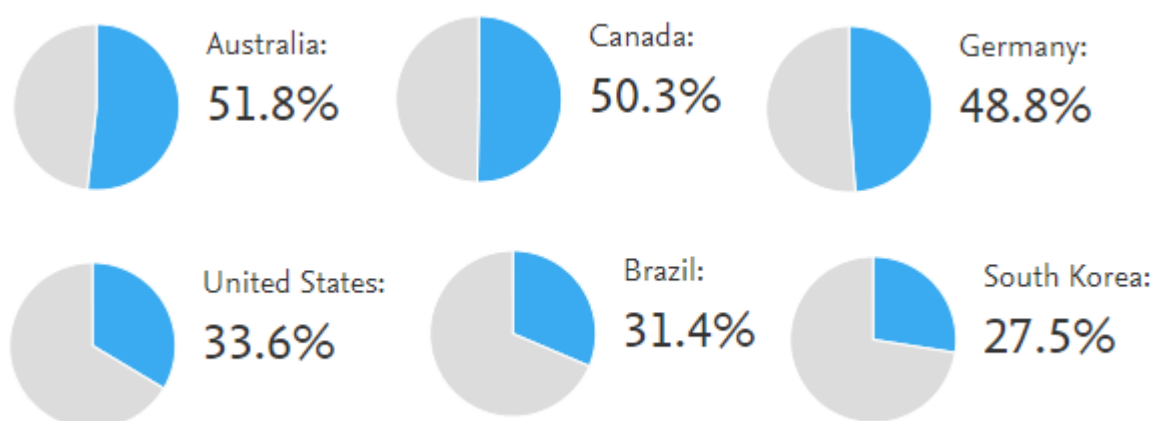
Australia:
51.8%

Canada:
50.3%

Germany:
48.8%

United States:
33.6%

Brazil:
31.4%

South Korea:
27.5%

FIGURE 1
Percentage of International Collaboration of the 6 countries over the period 2014-2019.
Source: SciVal

Brazil achieves higher levels of international collaboration than South Korea, which is ahead of Brazil in the total count of the number of published documents. **The United States, which ranks first in terms of number of publications, performs very close to Brazil in terms of International Collaboration**. Germany produced in the period (2014-2019) almost twice as many publications as Australia (Table 1). Even with this difference, Australian researchers are leading the comparison of this report regarding international collaboration. Please see the Appendices for more details on each measure used.

Country	Scholarly Output	Citations	Authors	Field-Weighted Citation Impact
United States	3794205	31087047	2829489	1,42
Germany	992254	8237964	642769	1,40
Canada	610836	5236093	376815	1,51
Australia	567912	5011526	290189	1,59
South Korea	471743	3111832	392462	1,02
Brazil	425859	2108375	528723	0,90

TABLE 1
Scholarly Output, Citations, Authors and FWCI of the 6 countries over the period 2014-2019.
Source: SciVal

International Collaboration of Brazil
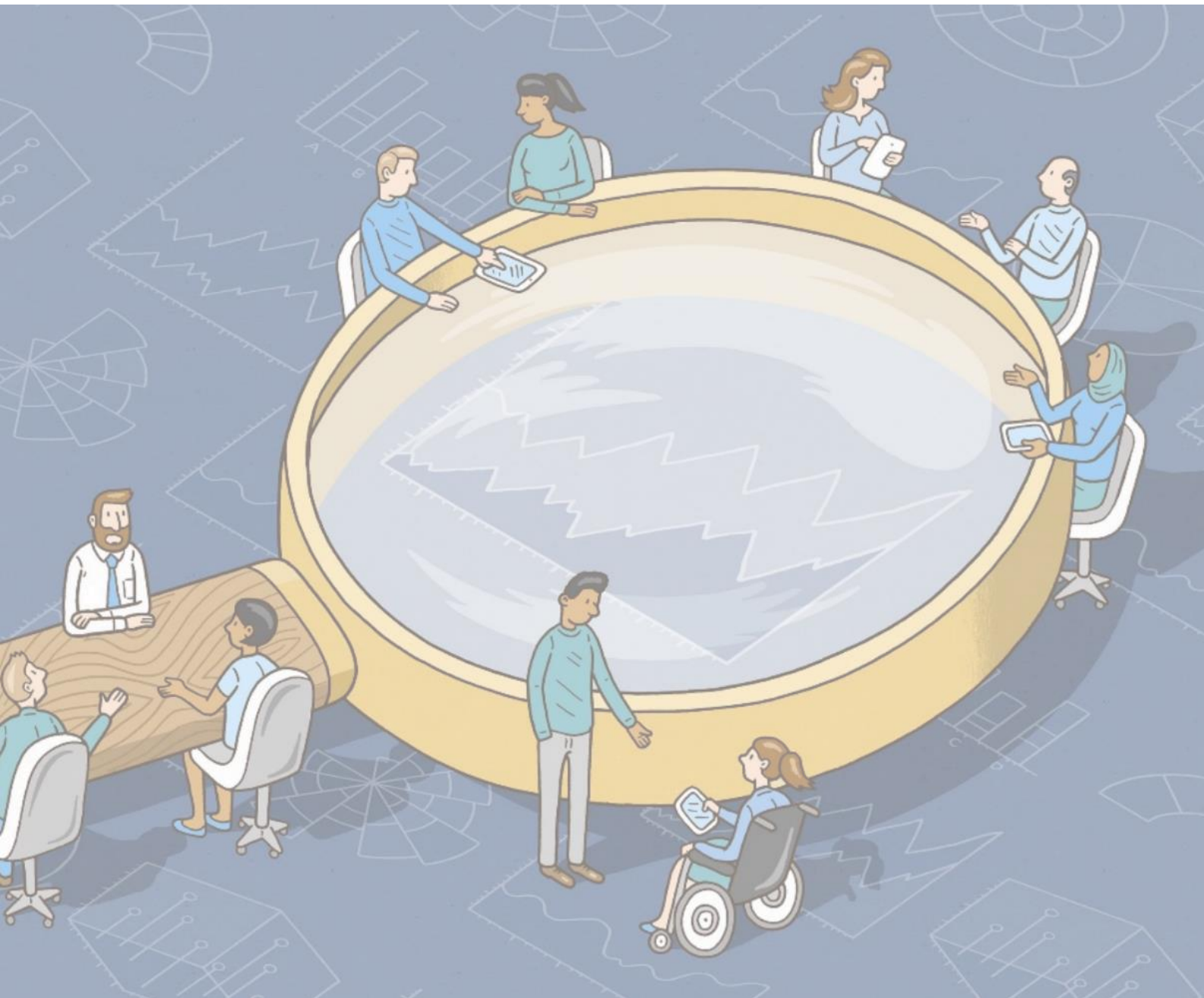
Europe is the continent that collaborated most with Brazil in terms of number of publications. The African continent is the region with the largest number of countries that worked in scientific collaboration with Brazil, with 54 countries.

The African continent is the region with the largest number of countries that worked in scientific collaboration with Brazil, with 54 countries. However, of all continents, collaboration with the African continent was the smallest (6,518 co-authored publications). According to Figure 2, both continents Europe and Asia Pacific have 48 countries each in collaboration with Brazil. Europe is the continent that collaborated most with Brazil in terms of number of publications, reaching a total of 78,264 documents in the period (2014-2019). The Brazilian collaboration with Asia Pacific generated 22,602 works in the period. Middle East (6,589 documents) and South America (17,975 co-authored publications) are the regions with the least collaboration with Brazil. There are 30 North American countries that published researches in collaboration with Brazil, generating 58,002 outputs.

Co-authored publications per country/region:

| 0 | 500 | 2500 | 10,000 | >10,000 |

Number of collaborating countries per region

FIGURE 2

Collaborating countries with Brazil over the period 2014-2019.

Source: SciVal

Among the top 10 countries that collaborate most with Brazil, 7 of them are located on the European continent. The United States takes first place in the international collaboration with Brazil, with over 90,000 co-authors and 47,158 co-authored publications. Following this, United Kingdom appears with more than 27,000 authors, and even with fewer documents, its collaboration with Brazil has had a greater impact (both citations and views) than Brazil's collaboration with the United States. It is also interesting to note that in the list of top 10 countries in collaboration with Brazil, **Australia and The Netherlands** are in the lowest positions in terms of number of co-authored publications and number of co-authors. However, the documents produced by Brazilian scientists in collaboration with these two countries were the ones that had **the highest impact of both citations and visualizations** far above the expected world average (See Table 2).

Countries & regions	Co-authored publications	Co-authors in Brazil	Co-authors in the other country or region	Field-Weighted Citation Impact	Field-Weighted Views Impact
United States	47,158 ▲	68,093 ▲	90,260 ▲	2.28	2.28
United Kingdom	19,192 ▲	27,898 ▲	27,669 ▲	3.34	3.64
France	15,925 ▲	22,215 ▲	21,871 ▲	3.11	3.76
Spain	15,672 ▲	20,886 ▲	19,494 ▲	3.06	4.01
Germany	15,350 ▲	19,649 ▲	22,516 ▲	3.32	4.00
Italy	12,822 ▲	16,044 ▲	21,605 ▲	3.55	4.63
Portugal	12,142 ▲	19,165 ▲	10,944 ▲	2.23	3.71
Canada	11,509 ▲	18,770 ▲	13,881 ▲	3.66	3.60
Australia	8,843 ▲	13,207 ▲	9,832 ▲	4.62	4.80
Netherlands	7,162 ▲	10,080 ▲	8,372 ▲	4.75	5.61

TABLE 2
2014-2019 Top 10 countries in collaboration with Brazil.
Source: SciVal.

Brazilian Institutions in the PrInt Project

This section provides an overview of the general performance as well as levels of collaboration and collaboration impact of the Brazilian institutions that are part of the PrInt Project. Levels of International, National and Institutional Collaboration were examined.

"Research collaboration is a complex and multi-dimensional phenomenon, built from the social interactions of researchers in the course of their day-to-day work; this can happen physically, virtually or digitally. This may take the form of informal discussions and information sharing, which account for as much as half of all collaborations or may be detected in patterns of co-authorship of published articles or acknowledgements within them."

International Comparative Performance of the UK Research Base – 2013: A report prepared by Elsevier for the UK's Department of Business, Innovation and Skills (BIS)."
Available at https://www.gov.uk/government/publications/performance-of-the-uk-research-base-international-comparison-2013.

SCHOLARLY OUTPUT

134.034

All institutions participating in the PrInt Project together produced a total of 134.034 documents resulting from **International Collaboration** in the period 2014-2019.

CITING-PATENTS COUNT

1.332

1.332 patents cited the Scholarly Output in **International Collaboration** published by authors that are linked to institutions participating in the PrInt Project in the 2014-2019 period.

CITATION COUNT

1.399.880

The institutions participating in the PrInt Project in the 2014-2019 period together accumulated a total of 1.399.880 citations from **International Collaboration** outputs.

The rise in International Collaboration continues unabated as low-cost travel, high-speed internet connectivity and funding programs that encourage cross-border partnerships continue to spread. Single-authored articles are becoming less and less common. In this section, 3 types of collaboration are measured (**International Collaboration, National Collaboration and Institutional Collaboration**) using the information provided in the authorship byline in Scopus data. An output is defined as an internationally collaborated document when authors affiliated with institutions from at least two different countries are listed in the authorship byline. National collaboration occurs when authors are affiliated with different institutions in one country. When two or more authors are affiliated with the same institution, the article is counted as an institutionally collaborated article. Figure 3 shows that 31.9% of the collaboration generated by the PrInt Institutions together are results of International Collaborations.

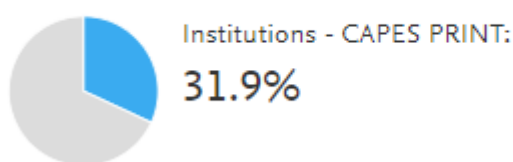Publications co-authored with Institutions in other countries

Institutions - CAPES PRINT:
31.9%

FIGURE 3
2014-2019 Percentage of International Collaboration of the institutions participating in the PrInt Project.
Source: SciVal.

The institutions participating in the PrInt project in 2014-2019 published a significant part of their studies in the field of Medicine (15.2%) and Agricultural and Biological Sciences (11.6%). The fields of Engineering and Biochemistry, Genetics and Molecular Biology appear next in relation to the amount of published works, (7.5%) and (7.4%), respectively (See Figure 4).
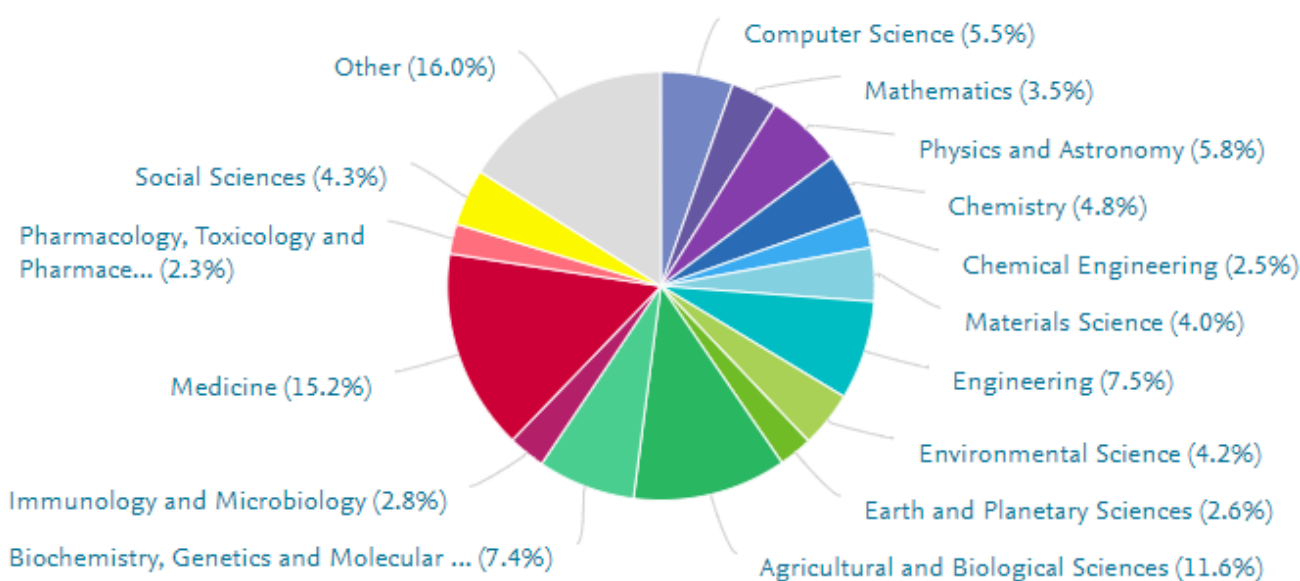

Computer Science (5.5%)
Mathematics (3.5%)
Physics and Astronomy (5.8%)
Chemistry (4.8%)
Chemical Engineering (2.5%)
Materials Science (4.0%)
Engineering (7.5%)
Environmental Science (4.2%)
Earth and Planetary Sciences (2.6%)
Agricultural and Biological Sciences (11.6%)
Biochemistry, Genetics and Molecular ... (7.4%)
Immunology and Microbiology (2.8%)
Medicine (15.2%)
Pharmacology, Toxicology and Pharmace... (2.3%)
Social Sciences (4.3%)
Other (16.0%)

FIGURE 4
2014-2019 Publications of institutions participating in the PrInt Project by Subject Area.
Source: SciVal.

Complementing Figure 4, the top 100 topic clusters by scholarly output of institutions participating in the PrInt Project are presented in Figure 5. Bubble size represents the scholarly output of this group. Between 2014 to 2019, researchers in Institutions participating in the PrInt Project have contributed to 1.493 Topic Clusters and to 42.407 Topics of Prominence in Science. A Topic is a collection of documents with a common focused intellectual interest and can be large or small, new or old, growing or declining. Topics are ranked by Prominence, an indicator of the momentum of a particular field.
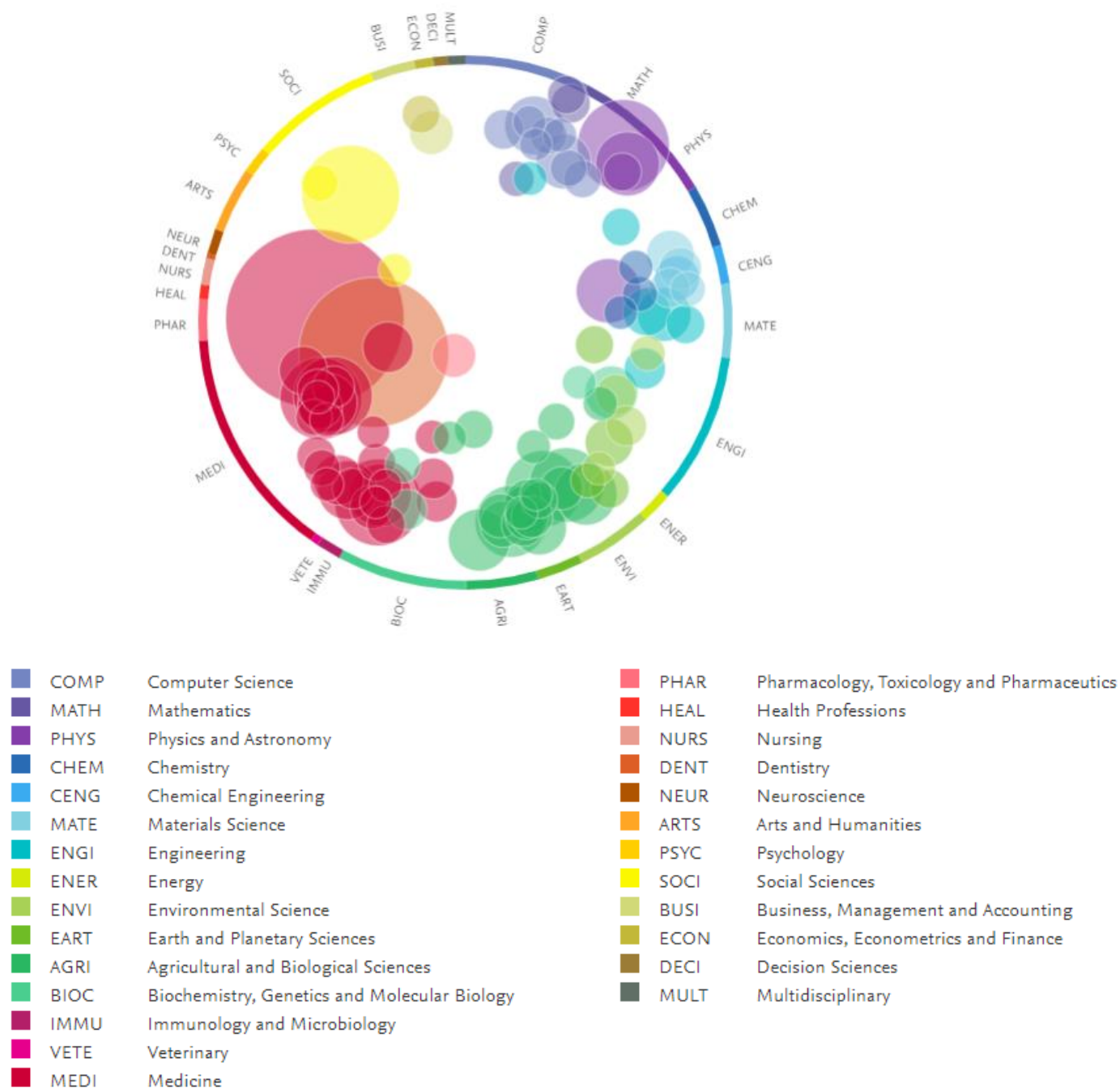

	COMP	Computer Science		PHAR	Pharmacology, Toxicology and Pharmaceutics
	MATH	Mathematics		HEAL	Health Professions
	PHYS	Physics and Astronomy		NURS	Nursing
	CHEM	Chemistry		DENT	Dentistry
	CENG	Chemical Engineering		NEUR	Neuroscience
	MATE	Materials Science		ARTS	Arts and Humanities
	ENGI	Engineering		PSYC	Psychology
	ENER	Energy		SOCI	Social Sciences
	ENVI	Environmental Science		BUSI	Business, Management and Accounting
	EART	Earth and Planetary Sciences		ECON	Economics, Econometrics and Finance
	AGRI	Agricultural and Biological Sciences		DECI	Decision Sciences
	BIOC	Biochemistry, Genetics and Molecular Biology		MULT	Multidisciplinary
	IMMU	Immunology and Microbiology			
	VETE	Veterinary			
	MEDI	Medicine			

FIGURE 5

2014-2019 Top 100 topic clusters by scholarly output of institutions participating in the PrInt Project.

Source: SciVal.

According to Table 3, the Federal University of Rio Grande was the institution with the highest levels of Institutional Collaboration (27.3%). The Federal Rural University of Pernambuco was the institution that presented the largest National Collaboration (65.4%). The National Institute for Space Research (47%) followed by the Federal University of ABC (45%) were the institutions that most collaborated internationally in relation to the number of publications in the period 2014-2019. Overall, **institutions participating in the PrInt Project have higher levels of National Collaboration**.

Institution	Institutional Collaboration	National Collaboration	International Collaboration
Universidade de Sao Paulo	19.8%	38.7%	37.4%
Universidade Estadual Paulista Julio de Mesquita Filho	20.6%	46.7%	30.1%
Universidade Estadual de Campinas	20.9%	41.3%	33.6%
Universidade Federal do Rio de Janeiro	14.1%	45.8%	35.0%
Universidade Federal do Rio Grande do Sul	22.3%	41.8%	32.8%
Universidade Federal de Minas Gerais	19.0%	46.2%	30.8%
Universidade Federal de Sao Paulo	18.3%	46.9%	31.6%
Universidade Federal de Santa Catarina	22.8%	40.9%	32.5%
Universidade Federal do Parana	19.3%	50.1%	27.6%
Universidade de Brasilia	19.9%	40.8%	32.6%
Fundacao Oswaldo Cruz	10.6%	52.0%	34.3%
Universidade Federal Fluminense	15.3%	50.6%	27.8%
Universidade Federal de Sao Carlos	17.1%	50.4%	29.8%
Universidade Federal de Santa Maria	25.0%	51.7%	21.7%
Universidade Federal de Vicosa	18.6%	56.8%	23.8%
Universidade do Estado do Rio de Janeiro	13.1%	50.3%	31.0%
Universidade Federal do Ceara	17.0%	51.3%	29.9%
Universidade Federal de Pernambuco	18.6%	51.0%	27.6%
Universidade Federal do Rio Grande do Norte	20.3%	46.2%	30.6%
Universidade Federal da Bahia	14.0%	53.0%	28.7%
Universidade Federal da Paraiba	17.5%	56.4%	23.3%
Universidade Federal de Pelotas	19.5%	51.1%	27.5%
Universidade Federal de Uberlandia	21.2%	53.3%	22.8%
Universidade Federal Do Espirito Santo	19.8%	51.3%	26.1%
Universidade Federal de Lavras	20.6%	57.0%	21.8%
Pontificia Universidade Catolica do Rio de Janeiro	17.9%	36.0%	39.9%
Universidade Federal do ABC	11.4%	40.0%	45.0%
Pontificia Universidade Catolica do Rio Grande do Sul	21.8%	42.9%	31.7%
Universidade Federal Rural de Pernambuco	14.2%	65.4%	19.1%
Universidade Federal de Mato Grosso do Sul	13.9%	63.8%	19.9%
Fundacao Universidade Federal do Rio Grande	27.3%	47.5%	23.7%
National Institute for Space Research	12.8%	38.7%	47.0%
Instituto Tecnologico de Aeronautica	19.5%	47.0%	31.9%
Universidade do Vale do Rio dos Sinos	25.1%	46.0%	23.3%
Fundacao Getulio Vargas	13.6%	32.9%	35.3%
Universidade Presbiteriana Mackenzie	20.7%	44.7%	28.0%

TABLE 3

2014-2019 Percentages of Institutional, National and International Collaboration of PrInt Project participating Institutions.
Source: SciVal

Table 4 shows that, regarding the impact of citations considering the expected world average (1.00), the National Institute for Space Research (2.89), together with the Federal University of Pelotas (2.69), the University of Rio dos Sinos Valley (2.47) and the Federal University of Santa Catarina were the institutions that achieved the best performance in International Collaboration. Overall, all the institutions that are participating in the PrInt Project have an **impact of citations above the expected world average, only when they are collaborating internationally**.

Institution	FWCI Institutional Collaboration	FWCI National Collaboration	FWCI International Collaboration
Universidade de Sao Paulo	0.71	0.73	1.81
Universidade Estadual Paulista Julio de Mesquita Filho	0.64	0.63	1.60
Universidade Estadual de Campinas	0.81	0.80	1.67
Universidade Federal do Rio de Janeiro	0.62	0.68	1.74
Universidade Federal do Rio Grande do Sul	0.72	0.73	2.30
Universidade Federal de Minas Gerais	0.69	0.73	2.38
Universidade Federal de Sao Paulo	0.58	0.72	2.21
Universidade Federal de Santa Catarina	0.69	0.65	2.40
Universidade Federal do Parana	0.54	0.58	1.38
Universidade de Brasilia	0.50	0.63	2.08
Fundacao Oswaldo Cruz	0.63	0.75	2.36
Universidade Federal Fluminense	0.62	0.68	1.27
Universidade Federal de Sao Carlos	0.60	0.73	1.18
Universidade Federal de Santa Maria	0.60	0.69	1.29
Universidade Federal de Vicosa	0.63	0.57	1.39
Universidade do Estado do Rio de Janeiro	0.54	0.61	2.06
Universidade Federal do Ceara	0.54	0.63	1.46
Universidade Federal de Pernambuco	0.63	0.63	1.21
Universidade Federal do Rio Grande do Norte	0.51	0.62	1.83
Universidade Federal da Bahia	0.57	0.70	1.67
Universidade Federal da Paraiba	0.51	0.61	1.17
Universidade Federal de Pelotas	0.61	0.73	2.69
Universidade Federal de Uberlandia	0.55	0.58	1.64
Universidade Federal Do Espirito Santo	0.55	0.55	1.65
Universidade Federal de Lavras	0.60	0.56	1.26
Pontificia Universidade Catolica do Rio de Janeiro	0.56	0.65	1.58
Universidade Federal do ABC	0.61	0.73	2.24
Pontificia Universidade Catolica do Rio Grande do Sul	0.65	0.68	2.01
Universidade Federal Rural de Pernambuco	0.42	0.57	1.03
Universidade Federal de Mato Grosso do Sul	0.42	0.49	1.39
Fundacao Universidade Federal do Rio Grande	0.73	0.75	1.37
National Institute for Space Research	0.49	0.65	2.89
Instituto Tecnologico de Aeronautica	0.55	0.56	1.16
Universidade do Vale do Rio dos Sinos	0.60	0.49	2.47
Fundacao Getulio Vargas	0.58	0.48	1.18
Universidade Presbiteriana Mackenzie	0.37	0.43	1.24

TABLE 4
2014-2019 Impact of citations according to expected world average for Institutional, National and International Collaboration of PrInt participating Institutions.
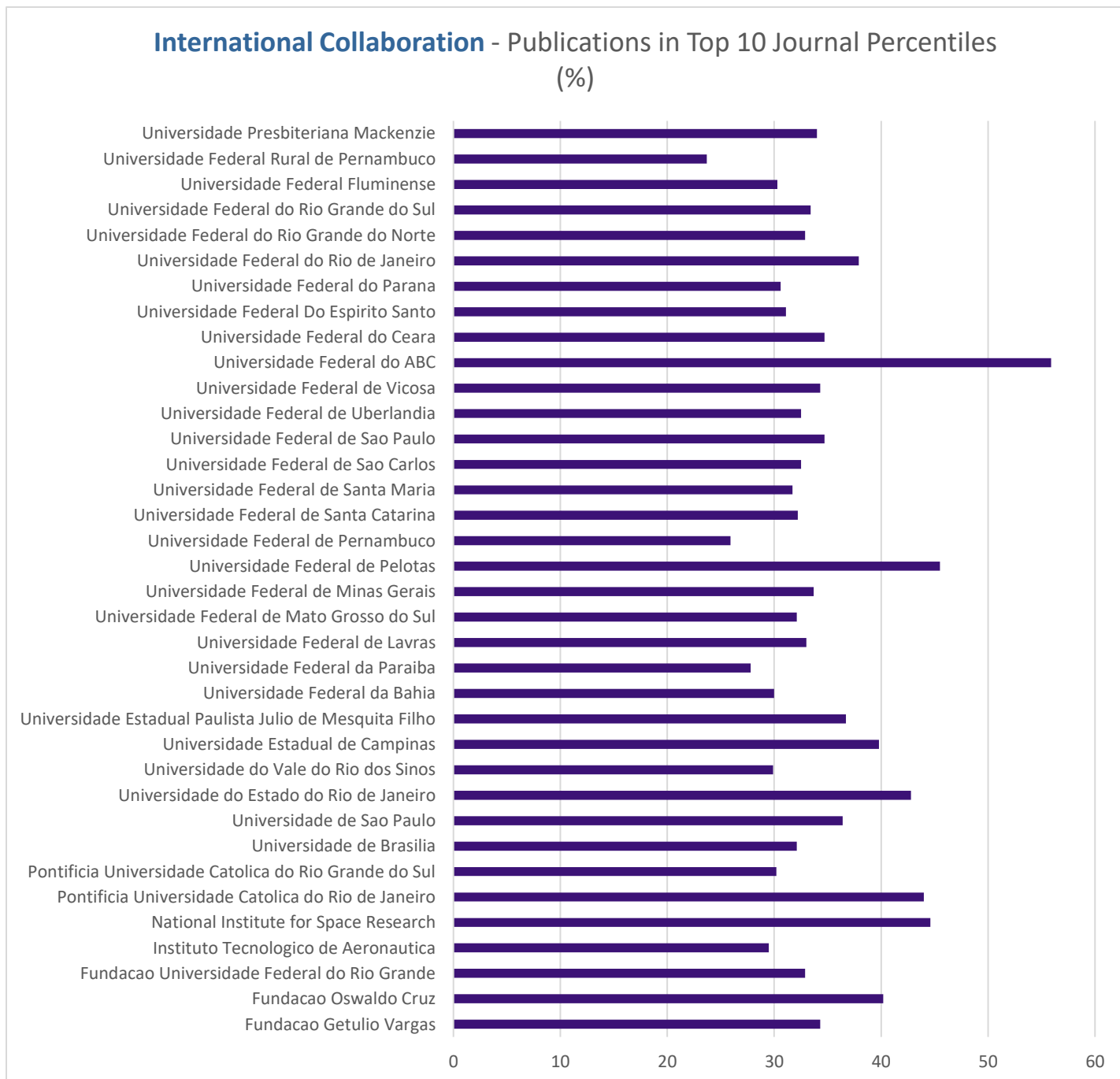*Source: SciVal*

The 36 institutions participating in the PrInt Project are among the top 100 Brazilian universities with the largest number of publications in the 2014-2019 period. **Field-Weighted Views Impact** indicates how the number of views received by an entity's publications compares with the average number of views received by all other similar publications in the same data universe. A Field-Weighted Views Impact of more than 1.00 indicates that the entity's publications have been viewed more than would be expected based on the global average for similar publications in the same database; for example, 3.87 means 287% more views than world average within the same database. In the 2014-2019 period, the Federal University of ABC achieved an impact of visualizations of its works resulting from international collaboration of 525% above the expected world average. Other institutions that stood out in this regard were the Rio de Janeiro State University (FWVI = 4.35) and the Federal University of Pelotas (FWVI = 3.87) (See Graph 1).

Field-Weighted Views Impact - **International Collaboration**
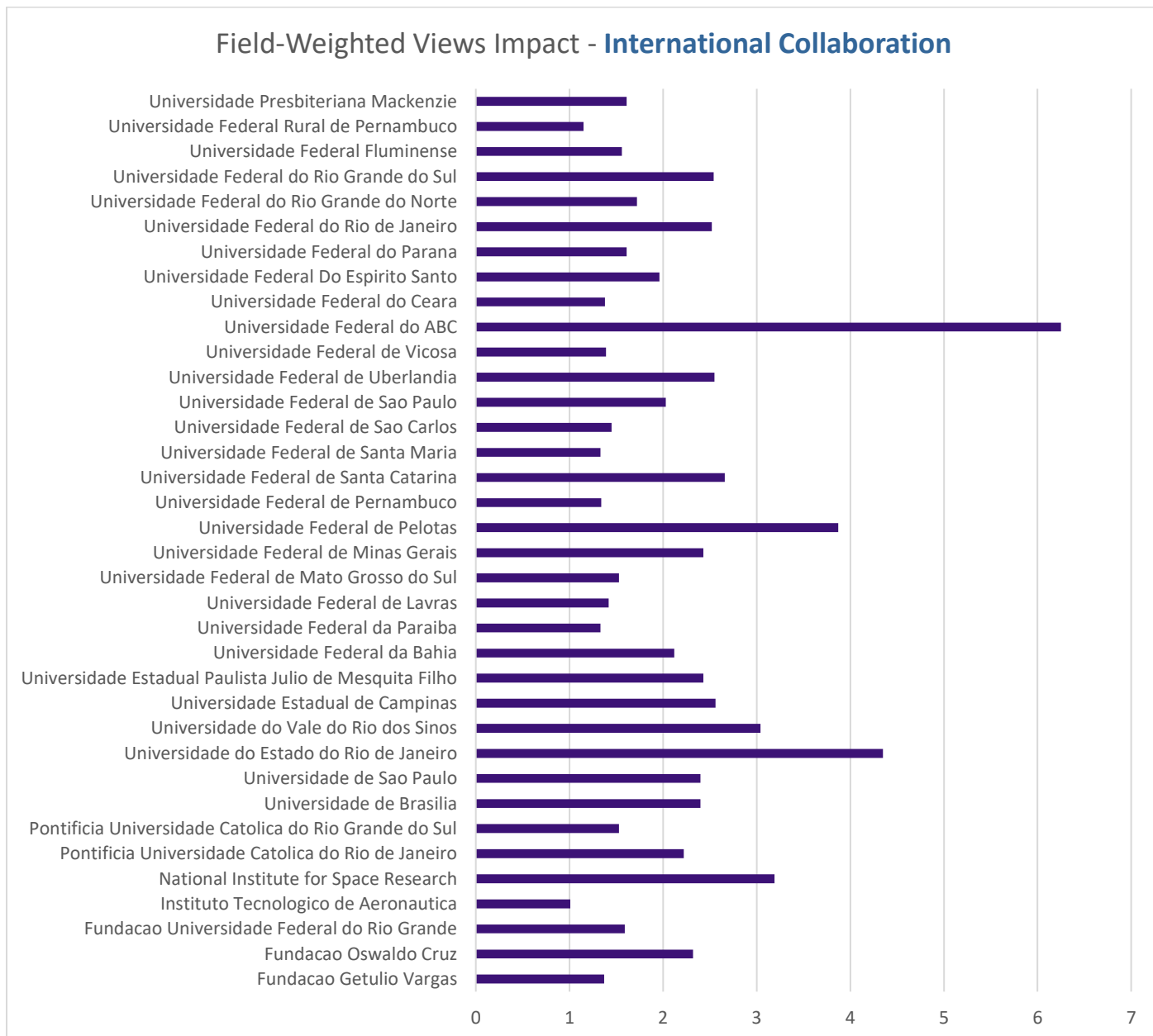
GRAPH 1

2014-2019 Field-Weighted Views Impact of the documents published in International Collaboration of the PrInt Project participating Institutions.

Source: SciVal

Publications in Top Journal Percentiles refers to the number of publications of a selected entity that have been published in the world's top journals. The vast majority of institutions participating in the PrInt Project have **more than 30% of publications resulting from International Collaboration published in the world's top journals**. The publications in International Collaboration of the Federal University of ABC (55.9%), Federal University of Pelotas (45.5%), National Institute for Space Research (44.6%), Catholic University of Rio de Janeiro (44%) and State University of Rio de Janeiro (42.8) exceeded 40% (See Graph 2).

International Collaboration - Publications in Top 10 Journal Percentiles (%)

GRAPH 2

2014-2019 - % of publications in International Collaboration that are in the Top 10 Journal Percentiles (%) of the PrInt Project participating Institutions.
Source: SciVal

Academic-Corporate Collaboration indicates the degree of collaboration between academic and corporate affiliations, in other words, to what extent are this entity's publications co-authored across the academic and corporate, or industrial, sectors. Table 5 shows the number of published documents (all publication types) which are the **results of International Collaboration only** from the universities participating in the PrInt Project, for the period (2014-2019). University of São Paulo, Federal University of Rio de Janeiro and State University of Campinas are the top 3 in terms of scholarly output.

Institution	Academic-Corporate Collaboration
Universidade de São Paulo	1232
Universidade Federal do Rio de Janeiro	644
Universidade Estadual de Campinas	507
Universidade Federal do Rio Grande do Sul	395
Pontifícia Universidade Católica do Rio de Janeiro	379
Universidade Federal de Minas Gerais	257
Universidade Federal de São Paulo	257
Universidade Federal de Santa Catarina	185
Universidade Estadual Paulista Júlio de Mesquita Filho	176
Fundação Oswaldo Cruz	159
Universidade de Brasília	146
Universidade Federal do Paraná	131
Universidade Federal do ABC	112
Universidade Federal da Bahia	111
Universidade do Estado do Rio de Janeiro	94
Universidade Federal de Viçosa	91
Pontifícia Universidade Católica do Rio Grande do Sul	89
Universidade Federal de Pernambuco	83
Universidade Federal do Ceara	82
Universidade Federal Fluminense	73
National Institute for Space Research	67
Universidade Federal do Rio Grande do Norte	65
Universidade Federal de São Carlos	59
Universidade Federal de Pelotas	57
Instituto Tecnológico de Aeronáutica	47
Universidade Federal de Uberlândia	45
Universidade Federal de Santa Maria	44
Universidade Federal da Paraíba	38
Universidade Federal Do Espirito Santo	35
Fundação Getúlio Vargas	29
Universidade Federal de Lavras	26
Universidade Federal Rural de Pernambuco	23
Universidade Federal de Mato Grosso do Sul	20
Universidade Presbiteriana Mackenzie	13
Fundação Universidade Federal do Rio Grande	12
Universidade do Vale do Rio dos Sinos	12

TABLE 5

2014-2019 Academic-Corporate Collaboration resulting from International Collaboration outputs of the PrInt Project participating Institutions.
Source: SciVal

Conclusion
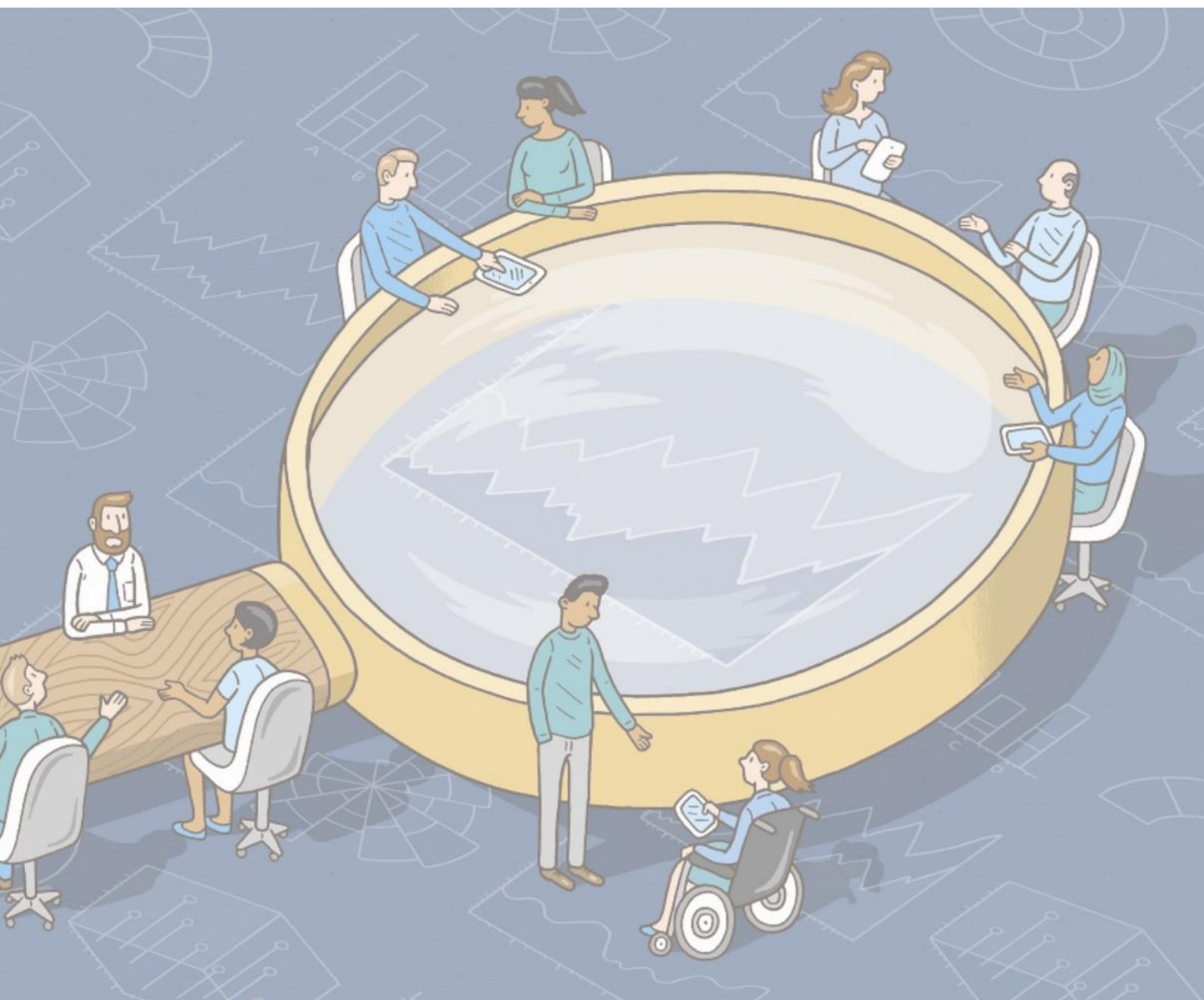
The impact of publications of Brazilian institutions in International Collaboration is generally greater than twice the impact of works coming from National Collaboration. This justifies the importance of initiatives that stimulate the production of works co-authored with other countries.

The first section of this report provided a brief comparison of Brazil's International Collaboration with some research-intensive countries. In recent years (2014-2019), 31.4% of Brazilian publications are results of International Collaboration. Brazil reached levels of International Collaboration close to the United States, a research-intensive nation which reached 33.6%.

The second section showed that Europe is the continent that collaborated most with Brazil in terms of number of publications. Among the top 10 countries that collaborate most with Brazil, 7 of them are located on the European continent. These data are important for internationalization project management groups, especially to identify not only existing collaborations, but especially potential collaborations.

The 3 levels of collaboration (Institutional, National and International) that this report presented brought interesting results for evaluation. 31.9% of all the types of collaboration generated by the PrInt Institutions together are results of International Collaborations. The data collected indicated that institutions participating in the PrInt Project have higher levels of National Collaboration; and yet, that all the institutions that are participating in the PrInt Project have an impact of citations above the expected world average, only when they are collaborating internationally. This justifies the importance of Brazilian initiatives that stimulate the production of works co-authored with other countries.

Regarding the scope and impact of visualizations that the international collaborative works of the institutions participating in the PrInt Project received, it was evident that the publications of all institutions have been viewed more than would be expected based on the global average for similar publications in the same database. This impact is probably related to the authors' choice of English-language journals when deciding where to publish their work, since the readership reach of the work is much larger.

It has been observed that institutions participating in the PrInt Project have more than 30% of publications resulting from International Collaboration published in the world's top journals. This is a number that institutions can explore, comparing with peer countries and institutions, and identifying in which internationally renowned journals such peers have published their work.

Academic-Corporate Collaboration is a field to be further explored by Brazilian higher education institutions. It is an activity that generates mutual benefit for the parties. One of the biggest benefits for academic institutions is industry feedback and guidance. Universities know that some problems cannot be solved in isolation in a lab, and industry feedback is key to taking an invention or product from conception to market. Innovation agencies are being strategically created in the major Brazilian universities to act in this direction

Appendices
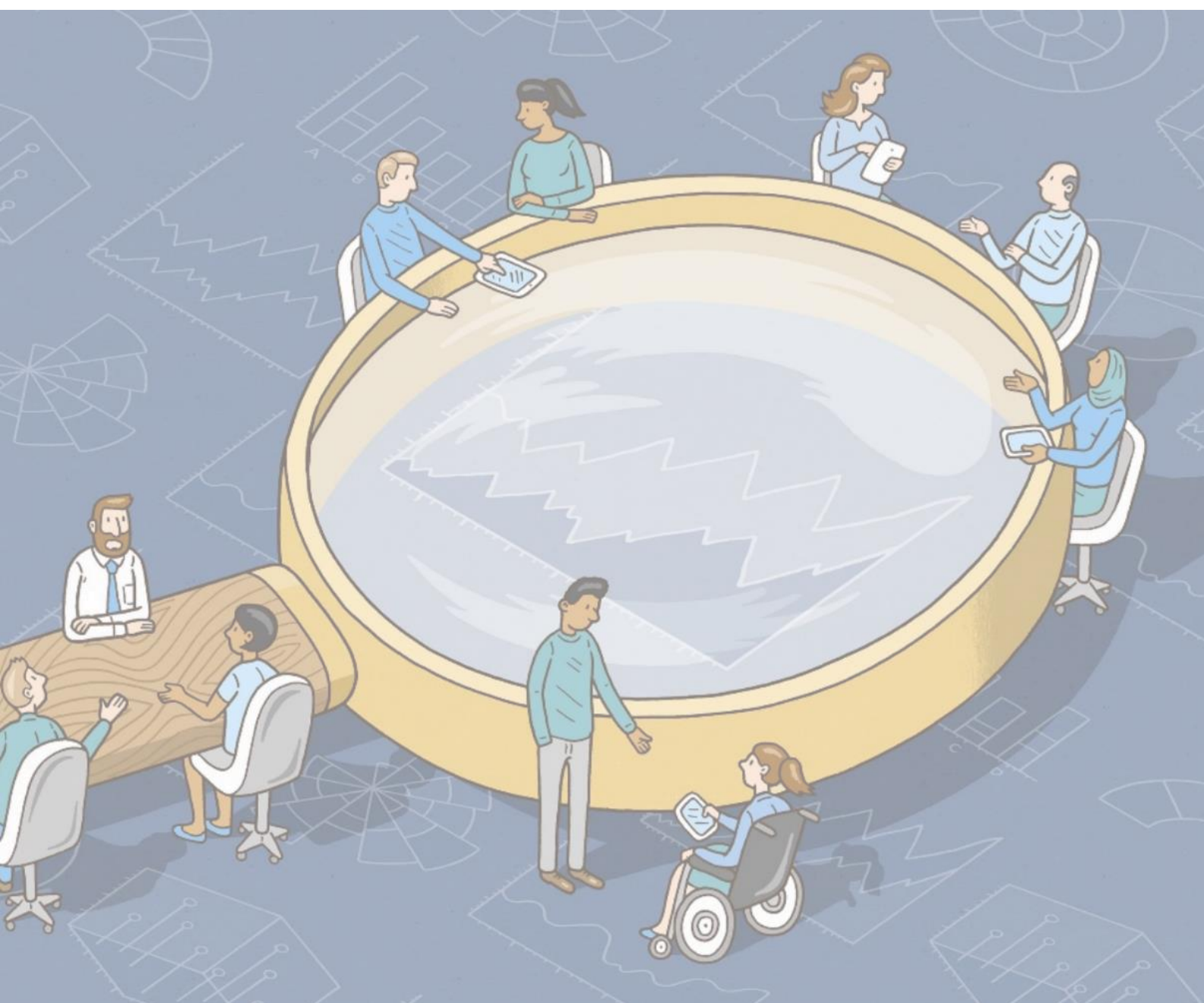
Appendix A

Methodology

Methodology and rationale

Our methodology is based on the theoretical principles and best practices developed in the field of quantitative science and technology studies, particularly in science and technology indicators research. The Handbook of Quantitative Science and Technology Research: The Use of Publication and Patent Statistics in Studies of S&T Systems (Moed, Glänzel and Schmoch, 2004).[1] gives a good overview of this field. It is based on the pioneering work of Derek de Solla Price (1978),[2] Eugene Garfield (1979).[3] and Francis Narin (1976).[4] in the USA, Christopher Freeman, Ben Martin and John Irvine in the UK (1981, 1987).[5], and researchers in several European institutions including the Centre for Science and Technology Studies at Leiden University, the Netherlands, and the Library of the Academy of Sciences in Budapest, Hungary.

The analyses of bibliometric data in this report are based upon recognised advanced indicators (e.g., the concept of relative citation impact rates). Our base assumption is that such indicators are useful and valid, though imperfect and partial measures, in the sense that their numerical values are determined by research performance and related concepts, but also by other, influencing factors that may cause systematic biases. In the past decade, the field of indicators research has developed best practices that state how indicator results should be interpreted and which influencing factors should be considered. Our methodology builds on these practices.

Publication types used in the analysis

Throughout this report, analyses include all publication types that are indexed in Scopus to present a complete view of scholarly output. Listed according to their representation in Scopus from 2014 onwards, these are: articles, conference papers, reviews, book chapters, notes, editorials, letters, articles in press, short

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[1] Moed H., Glänzel W., & Schmoch U. (2004). *Handbook of Quantitative Science and Technology Research*, Kluwer: Dordrecht.

[2] de Solla Price, D.J. (1977–1978). "Foreword," *Essays of an Information Scientist*, Vol. 3, v–ix.

[3] Garfield, E. (1979). Is citation analysis a legitimate evaluation tool? *Scientometrics*, 1 (4), 359-375.

[4] Pinski, G., & Narin, F. (1976). Citation influence for journal aggregates of scientific publications: Theory with application to literature of physics. *Information Processing & Management* 12 (5): 297–312.

[5] Irvine, J., Martin, B. R., Abraham, J. & Peacock, T. (1987). Assessing basic research: Reappraisal and update of an evaluation of four radio astronomy observatories. *Research Policy*, 16(2-4), 213-227.

surveys, errata, books, conference reviews, business articles, abstract reports, retracted publications, and reports.

Counting

All analyses make use of whole counting rather than fractional counting. For example, if a paper has been co-authored by one author from Brazil and one author from Germany, then that paper counts towards both the publication count of Brazil, as well as the publication count of Germany. Total counts for each country are the unique count of publications.

Appendix B
About SciVal

SciVal provides quick and easy access to the research performance of 15,500 research institutions and 230 countries worldwide. The solution uses an integrated modular platform that brings together the four core elements that support any evidence-based research tool: data, technology, metrics, and visualizations.

Using Scopus as the data source, the peer-reviewed database of abstracts and citations, the new generation of SciVal allows users to configure, view and export information according to their personal needs and preferences.

Users can combine any set of metrics to measure the productivity of an institution or country, the impact of production, collaborate more logically and accurately to understand their position against their peers, as well as against global and national standards. SciVal can be used to:

Get immediate access to global search.

Observe an instant summary of your search performance at various levels.

Evaluate your performance against any peer group.

Adjust the what-if scenarios by creating virtual teams and new research areas.

Create collections of publications for grant requests and reports.

Establish local or global partnerships.

Track and monitor data weekly to track market changes.

Analyze research trends from any area to help inform strategic decisions on a given problem.

Metrics

SciVal offers a broad spectrum of easy-to-interpret metrics, including Snowball Metrics, which are metrics defined and agreed by higher education institutions for strategic institutional decision making through benchmarking.

http://www.snowballmetrics.com/

Appendix C

Glossary

Citation

is a formal reference to earlier work made in an article or patent, frequently to journal publications. A citation is used to credit the originator of an idea or finding. The number of citations received by a publication or patent from subsequently-published articles is a proxy of the influence or impact of the publication. In this report, 'citations' refer to citations by any Scopus-indexed publications while citations made by other types of documents (e.g. patents, clinical guidelines) specifically reference the type of document that the citation was made in (e.g. as 'patent citations' or citations in clinical guidelines).

Field Weighted Citation Impact (FWCI)

Field Weighted Citation Impact (FWCI) is an indicator of the citation impact of a publication. It is calculated by comparing the number of citations actually received by a publication with the number of citations expected for a publication of the same document type, publication year, and subject. A Field-Weighted Citation Impact of more than 1.00 indicates that the entity's publications have been cited more than would be expected based on the global average for similar publications; for example, 2.11 means 111% more than the world average. A Field-Weighted Citation Impact of less than 1.00 indicates that the entity's publications have been cited less than would be expected based on the global average for similar publications; for example, 0.87 means 13% less than the world average.

In general, the Field-Weighted Citation Impact (FWCI) is defined as:

$$FWCI = \frac{C_i}{E_i}$$

with

C_i= citations received by publication i

E_i= expected number of citations received by all similar publications in the publication year plus following 3 years

When a similar publication is allocated to more than one subject, the harmonic mean is used to calculate FWCI.

To calculate mean FWCI for the publication set, we use the formula:

$$\overline{FWCI} = \frac{1}{N} \sum_{i=1}^{N} \frac{C_i}{E_i}$$

Where N = the number of Scopus-indexed publications in the publication set.

FWCI is always defined with reference to a global baseline of 1.0 and intrinsically accounts for differences in citation accrual over time, differences in citation rates for different document ages (e.g. older documents are expected to have accrued more citations than more recently published documents), document types (e.g. reviews typically attract more citations than research articles), as well as subjects (e.g. publications in Medicine accrue citations more quickly than publications in Mathematics is one of the most sophisticated indicators in the modern bibliometric toolkit.[6].

FWCI uses an un-weighted variable 5-year window. The mean FWCI value for 2012 publications, for example, is calculated for documents published in 2012 using their citations in 2012-2017. For recent output with less than five years since publication, all citations available at the date of data extraction are used in the calculation. For instance, if an article is published in 2016, and the data are extracted in 2018, the article's FWCI is calculated using the article's 2016-2018 citations.

Field-Weighted Views Impact (FWVI)

Field-Weighted Views Impact indicates how the number of views received by an entity's publications compares with the average number of views received by all other similar publications in the same data universe: how do the views received by this entity's publications compare with the world average for that database? Similar publications are those publications in the database that have the same publication year, publication type, and discipline, as represented by the Scopus classification system.

A Field-Weighted Views Impact of 1.00 indicates that the entity's publications have been viewed exactly as would be expected based on the global average for similar publications in the same database; the Field-Weighted Views Impact of "World", that is, the entire Scopus database, is 1.00.

A Field-Weighted Views Impact of more than 1.00 indicates that the entity's publications have been viewed more than would be expected based on the global average for similar publications in the same database; for example, 3.87 means 287% more views than world average within the same database.

[6] Amrita Purkayastha, Eleonora Palmaro, Holly J. Falk-Krzesinski, Jeroen Baas, Comparison of two article-level, field-independent citation metrics: Field-Weighted Citation Impact (FWCI) and Relative Citation Ratio (RCR), *Journal of Informetrics*, Volume 13, Issue 2, 2019, Pages 635-642, ISSN 1751-1577, https://doi.org/10.1016/j.joi.2019.03.012, http://www.sciencedirect.com/science/article/pii/S1751157718303559.

Publication

denotes all Scopus-indexed publications.

Scholarly Output

indicates the prolificacy of an entity: how many publications does this entity have indexed in Scopus.

Researchers

"are professionals engaged in the conception or creation of new knowledge, products processes, methods, and systems, and in the management of the projects concerned".[7] This definition is provided in the 2002 edition of the Frascati Manual and provided to the national statistical agencies that compile the data on research inputs made available by the OECD. This definition includes members of the armed forces who perform R&D, managers and administrators engaged in the planning and management of the scientific and technical aspects of a researcher's work, and PhD students engaged in R&D. Researchers are distinct from "authors" as defined above because they may include those who have not been listed as an author in a Scopus-indexed publication.

Publications in Top Journal Percentiles

indicates the extent to which an entity's publications are present in the most-cited journals in the data universe: how many publications are in the top 1%, 5%, 10% or 25% of the most-cited journals indexed by Scopus? The most-cited journals are defined by the journal metrics CiteScore, SNIP (Source-Normalized Impact per Paper) or SJR (SCImago Journal Rank). This report used CiteScore metric.

Citing-Patents Count

This is the count of patents citing the scholarly output published by the entity (e.g. a university) in which you are looking. The count of patents may be higher than the number of scholarly outputs cited, since multiple patents could refer to the same piece of output. The count of outputs may be higher than the number of patents since one patent can refer to multiple scholarly outputs.

Example: 200 patents have cited articles published by Athena University over the past five years. The Citing-Patent Count metric equals 200.

[7] https://stats.oecd.org/glossary/detail.asp?ID=2318

Appendix D

Data Sources

Scopus

is Elsevier's abstract and citation database of peer-reviewed literature, covering 75 million from 23K serials, 100K conferences and 204K books from more than 5000 publishers and 105 countries.

Scopus coverage is multi-lingual and global: approximately 46% of titles in Scopus are published in languages other than English (or published in both English and another language). In addition, more than half of Scopus content originates from outside North America, representing many countries in Europe, Latin America, Africa and the Asia Pacific region.

Scopus coverage is also inclusive across all major research fields, with 12,200 titles in the Physical Sciences, 13,800 in the Health Sciences, 6,800 in the Life Sciences, and 10,905 in the Social Sciences (the latter including some 4,000 Arts & Humanities related titles). Titles which are covered are predominantly serial publications (journals, trade journals, book series and conference material), but considerable numbers of conference papers are also covered from stand-alone proceedings volumes (a major dissemination mechanism, particularly in the Computer Sciences). Acknowledging that a great deal of important literature in all fields (but especially in the Social Sciences and Arts & Humanities) is published in books, Scopus has begun to increase book coverage in 2013. As of 2018, Scopus includes 1.5 million books, 400,000 of which are in the Social Sciences and 290,000 of which are in Arts & Humanities.

For this report, a static version of the Scopus database covering the period 1996-2019 inclusive was aggregated by country and subject. Subjects were defined by ASJC subject areas (see Appendix E for more details).

Appendix E

Subject Classification

Titles in Scopus are classified under four broad subject clusters (Life Sciences, Physical Sciences, Health Sciences and Social Sciences & Humanities) which are further divided into 27 major subject areas and 300+ minor subject areas. Titles may belong to more than one subject area.

Scopus 27 Subject Classification	Broad Cluster
General (multidisciplinary journals like Nature and Science)	All
Agricultural and Biological Sciences	Life Sciences
Arts and Humanities	Social Sciences
Biochemistry, Genetics and Molecular Biology	Life Sciences
Business, Management and Accounting	Social Sciences
Chemical Engineering	Physical Sciences
Chemistry	Physical Sciences
Computer Science	Physical Sciences
Decision Sciences	Social Sciences
Earth and Planetary Sciences	Physical Sciences
Economics, Econometrics and Finance	Social Sciences
Energy	Physical Sciences
Engineering	Physical Sciences
Environmental Science	Physical Sciences
Immunology and Microbiology	Life Sciences
Materials Science	Physical Sciences
Mathematics	Physical Sciences
Medicine	Health Sciences
Neuroscience	Life Sciences

Nursing	Health Sciences
Pharmacology, Toxicology and Pharmaceutics	Life Sciences
Physics and Astronomy	Physical Sciences
Psychology	Social Sciences
Social Sciences	Social Sciences
Veterinary	Health Sciences
Dentistry	Health Sciences
Health Professions	Health Sciences

TABLE 6

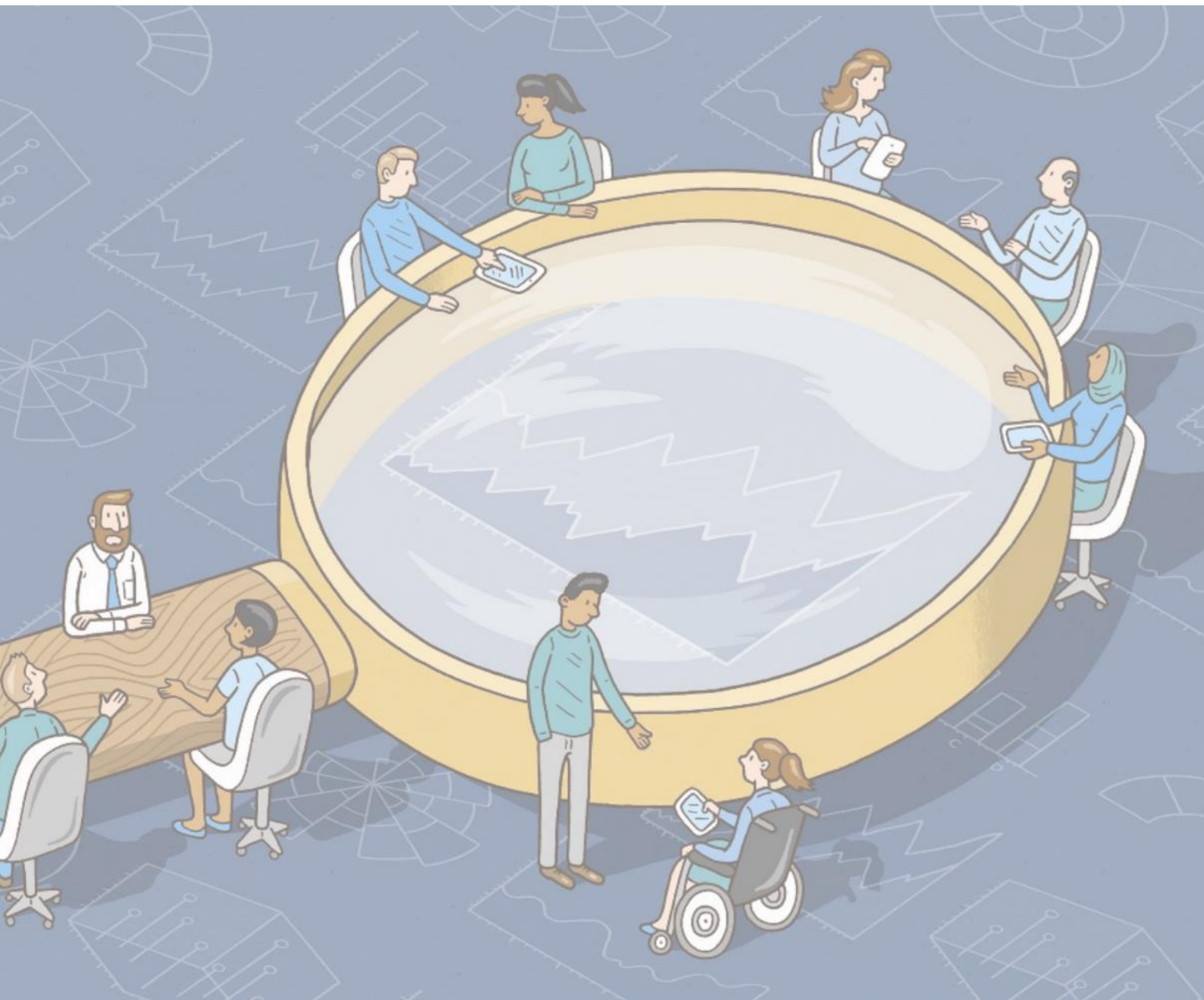Scopus Subject Classifications and broad clusters

About

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Author

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Research Intelligence