

Evaluation of the scientific production of Brazilian federal universities indexed in Scopus (2013 - 2022)

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ABSTRACT

Introduction: Evaluating scientific production in bibliographic databases recognized by the scientific community allows us to use indicators to analyze the productivity metrics of researchers, universities and countries, in terms of publications and citations. **Objective:** The aim of this article is to evaluate the behavior of the scientific production of federal universities in the Southeast and North regions between 2013 and 2022, in the Scopus bibliographic database. **Methodology:** The methodology was based on a technical bibliometric study procedure and a quantitative approach, using bibliographic information collected from Scopus. The selection criteria for the universities were the Folha University Ranking, from Folha de São Paulo and Times Higher Education, which resulted in the selection of the Federal University of Minas Gerais and the Federal University of São Paulo, in the Southeast, and the Federal University of Pará and the Federal University of Amazonas, in the North. **Results:** The results showed that the Federal University of Minas Gerais and the Federal University of São Paulo had higher numbers of publications indexed in Scopus than the Federal University of Pará and the Federal University of Amazonas. Among the universities selected, the Federal University of Minas Gerais had an average of 3,275.1 documents indexed between 2013 and 2022, while the Federal University of Amazonas had an average of 343 documents indexed in the period analyzed. With regard to the language of the documents indexed in Scopus from the universities analyzed, there is a concentration of texts in English. **Conclusion:** It can be concluded that the discrepancies in the number of publications indexed in Scopus between the universities are linked to the disparities in the technical-scientific base between the Brazilian regions.

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KEYWORDS

Scientific production. Information metrics studies. Bibliometric indicators. Scopus.

Avaliação da produção científica das universidades federais brasileiras indexadas na Scopus (2013 - 2022)

RESUMO

Introdução: A avaliação da produção científica em bases bibliográficas reconhecidas pela comunidade científica permite por meio de indicadores analisar as métricas de publicação de produtividade dos pesquisadores, universidades, países e citações. **Objetivo:** O artigo tem como objetivo avaliar o comportamento da produção científica das universidades federais pertencentes à região Sudeste e Norte no período de 2013 a 2022 na base

bibliográfica Scopus. **Metodologia:** A metodologia foi feita considerando o procedimento técnico de estudo bibliométrico e abordagem quantitativa por meio das informações bibliográficas coletadas na Scopus. O critério de seleção das universidades foi por meio do Ranking Universitário Folha da Folha de São Paulo e do Times Higher Education no qual resultou na seleção da Universidade Federal de Minas Gerais, Universidade Federal de São Paulo (Sudeste), Universidade Federal do Pará e Universidade Federal do Amazonas (Norte). **Resultados:** Os resultados mostraram que a Universidade Federal de Minas Gerais e a Universidade Federal de São Paulo apresentam números de publicações indexadas na Scopus superiores quando comparadas com as quantidades de publicações da Universidade Federal do Pará e Universidade Federal do Amazonas indexadas na Scopus. Dentre as universidades selecionadas, a Universidade Federal de Minas Gerais apresentou em média 3.275,1 documentos indexados entre 2013 a 2022, enquanto a Universidade Federal do Amazonas obteve em média de 343 documentos indexados no período analisado. Em relação ao idioma dos documentos indexados na Scopus das universidades analisadas, observa-se uma concentração em inglês. **Conclusão:** Conclui-se que as discrepâncias do número de publicações indexadas na Scopus entre as universidades vinculam-se às disparidades da base técnica-científica entre as regiões brasileiras.

PALAVRAS-CHAVE

Produção científica. Estudos métricos da informação. Indicadores bibliométricos. Scopus.

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1 INTRODUCTION

The evaluation of scientific production is characterized by criteria of credibility, reliability, and applicability established by society, governments, and corporations that fund scientific activities, or internally by the scientific community that competes for resources to gain visibility and legitimacy for what it produces (Souza, 2013). An evaluation system that takes into account the complexity of the scientific production process by identifying what can and cannot be considered relevant to science and society is still a challenge (Souza, 2013).

The development of quantitative indicators in science, technology, and innovation has increased due to the recognition by governments and the scientific community of the need to develop tools that can contribute to the definition of public policies for science, technology, and innovation (ST&I), the allocation of resources and investments, the design of programs to reduce inequalities in the technical-scientific base between countries, and the evaluation of activities related to the progress of a country's scientific development, such as scientific production (Mugnaini; Jannuzi; Quoniam, 2004).

According to Tague-Sutcliffe (1992), scientific evaluation indicators are considered from three perspectives: (i) bibliometrics, which focuses on the quantitative analysis of the production, dissemination, and use of information using mathematical models; (ii) scientometrics, which derives from the quantitative study of science, linked to the parameters of discipline and/or economic activity; and (iii) infometrics, which seeks to quantify information on any kind, without being limited to bibliographic data or groups of scientists.

Brazilian scientific production is concentrated in the South and Southeast regions (Albuquerque et al., 2002; Barros, 2000, 2005; Chiarini; Oliveira; Couto Neto, 2013; Chiarini; Rapini; Vieira, 2014; Chiarini; Vieira, 2012), which generates disparities in scientific productivity that constitute the structure of the Brazilian scientific field and intensify the center-periphery dualism in the production of knowledge (Bourdieu, 1994, 2003; Shils, 1992). Barros (2000) argues that the imbalances in technical-scientific production between Brazilian regions pose a challenge to the formulators of public STI policies, since the concentration of scientific production in certain regions contributes to the maintenance of this center-periphery structure.

In this context, the hypothesis of this study is that Brazilian Federal Universities located in the country's knowledge epicenter have a higher volume of scientific production in international bibliographic databases, such as Scopus and Web of Science, compared to universities located outside the epicenter.

To evaluate the Brazilian scientific production, the study by Mugnaini, Jannuzi and Quoniam (2004) analyzed the bibliometric indicators of the Brazilian scientific and technological production in the 1990s, on the French bibliometric database Pascal, observing a growth of the national scientific production in the last twenty years as well as its internationalization. The study by Gomes (2020) considered the insertion and visibility of the scientific production of the Federal University of Pará in the period from 2014 to 2018 in publications on the Scopus database, observing a high level of productivity in the areas of Biological, Exact and Natural Sciences and Health, as well as growth in the areas of Social and Human Sciences.

In this sense, the objective of this article is to evaluate the behavior of the scientific production of some federal universities in the Southeast and North regions of Brazil between 2013 and 2022 in the bibliographic database Scopus.

2 THE ROLE OF SCIENTIFIC PRODUCTION

Scientific production plays an important role in analyzing the performance of academic communities and research institutions in terms of the development of disciplines, fields of knowledge, and countries that are leading in the production of knowledge. This position defines and establishes the "elite" of scientific production (Almeida; Gracio, 2019). Scientific production makes it possible to evaluate the technical-scientific evolutionary process of a country by identifying areas with the greatest knowledge production, with collaboration strategies and with the reformulation of public policies aimed at promoting scientific production (Dias; Dias; Moita, 2021).

The scientific production of a country can be measured by three indicators: (i) the generation of scientific products, such as articles, patents, theses, dissertations, reports, etc., and the acceptance of papers at scientific events; (ii) the quantitative analysis of the productivity of researchers and the impact of publications on the academic community, through the number of citations; and (iii) policies for evaluating scientific output, implemented by government agencies or scientific institutions, with the aim of monitoring the evolution of the country's technical and scientific base (Freitas, 1998).

In this process, studies are important to evaluate the processes of visibility and recognition of researchers in the scientific community and, consequently, the relevance of scientific production to society (Silva et al., 2022). Scientific production is structured around instruments based on credibility and recognition of the methods used to generate new knowledge, which determine the quality of the results obtained (Silva et al., 2022).

According to Mugnaini, Digiampietri and Mena-Chalco (2014, p. 240), "[...] the survey of a country's scientific production makes it possible to study one of the aspects that can be qualified as measurable results of the broad system of science, technology, and innovation". Thus, it is necessary to monitor scientific production to understand the complexity of scientific communication, which is similar to the process of producing science (Mugnaini; Digiampietri; Mena-Chalco, 2014).

In the process of scientific communication, science is considered as a system of information production constituted by publications, which allow recording a body of knowledge permanently produced in different formats, making it available for common use by researchers and/or society (Spinak, 1998). Dias, Dias, and Moita (2021) argue that concern about the dissemination of the results of publicly funded research has grown in the face of societal pressures regarding the applicability of research to solve society's problems and, consequently, government demands for public policies that allow for the proper archiving and preservation of the scientific production of researchers so that the population has access to it.

Caballero-Rivero, Sánchez-Tarragó, and Santos (2019) warn that the scientific community's access to research results, tools, and methodologies makes it possible to replicate, reject, and validate these tools, which have become part of society's daily life and, consequently, contribute to technical-scientific progress through the reliability of results replicated in different contexts. Meadows (1999) states that the means of communication used by scientists to communicate research results are related to the type of information and the audience they are trying to reach.

Scientific communication takes place in various ways, with oral and written communication usually being used to disseminate scientific production. Oral scientific communication takes place through lectures, conferences, congresses, round tables, etc., while written scientific communication takes the form of articles, explanatory notes, booklets, journals, books, dissertations, theses, etc., which may be printed or digital (Meadows, 1999).

In turn, Valerio and Pinheiro (2008, p. 160) state that

The knowledge embodied in scientific literature, through scientific journals, is also made available on electronic networks. Electronic versions of printed scholarly journals, as well as electronic-only scholarly journals, are becoming increasingly common on the Web as faithful copies, mirrored or not, of the paper format, increasing the visibility of science and broadening the audience.

The scientific community has adopted indexed journals as the primary means of communicating scientific production, which, through blind peer review, have authority and legitimacy in the dissemination of science among scientists and society (Mueller, 2006). The increased concern with the process of hierarchization between indexed journals is aimed at assessing the level of visibility of scientific production through citations. Publication in high-impact journals is also used by funding agencies as a criterion for awarding research grants to postgraduate programs (Mueller, 2006; Vilhena; Crestana, 2002).

The evaluation of scientific production in bibliographic databases recognized by the scientific community makes it possible, through indicators, to analyze the metrics of publication productivity of researchers, universities, and countries, and to make comparative analyses between regions, scientific production by fields of knowledge, quality of scientific production, and citations, among other performance parameters.

3 SCIENTIFIC PRODUCTION INDICATORS

| 1

The objective of evaluating scientific production is to measure the quality of intellectual production, productivity, and performance of researchers and research institutions, especially universities, through bibliometric indicators that use quantitative publications, citations, collaborative networks and impact factors, among others, as metrics (Souza, 2013). The quality of a researcher's or research institution's scientific output is related to the level of interest that other researchers have in their research, which can be measured by citations as a proxy for quality (Meadows, 1999).

Bibliometrics, according to Tague-Sutcliffe (1992), is the quantitative study of the production, dissemination, and use of information, captured in mathematical models that can be used to establish metrics. Spinak (1998) and Tague-Sutcliffe (1992) argue that bibliometric studies have focused on: (i) statistical models of word frequencies, languages, and productivity; (ii) the distribution of articles, journals, countries, and institutions; and (iii) the evaluation of collaborations, citations, co-citations, and author affiliations.

According to the literature, the indicators that explain the level of scientific productivity are related to the level of investment in ST&I and the geographical location. In universities, these are strongly related to the number of teachers, technicians, and students, institutional careers, scientific productivity grants, links between teachers and postgraduate courses, research groups, the number of orientations at the master's and doctoral level, and collaborative networks with other researchers (Albert; Davia; Legazpe, 2016; Barros, 2000; Fernandes; Garcia; Cruz, 2015; Neiva et al, 2022; Oliveira; Melo, 2014; Prado; Oliveira, 2016; Rowe; Bastos; Pinho, 2013; Schott, 1998).

"[...] bibliometric indicators can be output indicators (or even effectiveness indicators) when they refer to the more immediate results of policies, such as the production of S&T articles or the number of patents" (Mugnaini; Jannuzi; Quoniam, 2004, p. 124). Impact indicators are linked to the impact factor of scientific production,

the rate of technological innovation, and the level of appropriation of national technological production, among others (Mugnaini; Jannuzi; Quoniam, 2004).

The Institute for Scientific Information (ISI), through the Journal Citation Reports (JRC), has designed a set of indicators that have become part of the metrics for evaluating researchers and research institutions (Strehl, 2005), with the aim of evaluating the quality of journals indexed on the Web of Science (WoS), under the responsibility of Clarivate Analytics (Almeida; Gracio, 2019). The indicators are published annually by the JRC, based on the titles of the journals, and include: (i) the immediacy index; (ii) the cited half-life; and (iii) the impact factor (Strehl, 2005).

Among the indicators published by the JCR, "[...] the impact factor of a given journal for a given year is defined as the average citation rate in that year of the papers published in the journal in the previous two years" (Miglioli, 2017, p. 20). Aiming to break the hegemony of WoS, Elsevier Science launched the Scopus bibliographic database in 2014, and subsequently, Scopus and the SCImago Group launched the SCImago Journal & Country Rank (SJCR), a platform with information on journals and scientific indicators, including information from the Scopus bibliographic database since 1996 (Scimago, 2023). The platform, called the SCImago Journal Rank (SJR) indicator, was developed by SCImago using the Google PageRank algorithm, and its scope is to show the visibility of journals indexed in Scopus (Almeida; Gracio, 2019; Scimago, 2023).

The SJR is calculated from a network of journal citations, whose nodes are represented by the journals of active origin, by directed links between nodes, or by the citation interactions resulting from them (Guerrero-Bote; Moya-Anegón, 2012; Mira; Oliveira; Shintaku, 2022). Other indicators are also used, but as presented by Barata (2016, p. 26):

The most commonly used indicators are the impact factor, citations per citable document, and the "h" index. Some areas also use the average lifespan or the "immediacy" factor to weight impact measures. The combination of sources and indicators is a way of balancing the characteristics and weaknesses of each of them in isolation.

Other bibliographic databases are the Scientific Electronic Library Online (SciELO), which indexes publications from Latin America and the Caribbean; Scopus, which has the largest number of publications indexed from developing countries, the Brazilian Portal of Scientific Publications and Data in Open Access (Oasisbr), which aims to increase visibility and access to open scientific production in Brazil, among other bibliographic databases that compete for space with ISI, the most widely used in the field of information on the impact and quality of scientific production (Almeida; Gracio, 2019; Barbosa; Pereira Neto; Lima, 2023; Freitas; Rosas; Miguel, 2017; Mugnaini; Strehl, 2008).

According to Mugnaini and Strehl (2008), the impact factor is used as a metric to assess the quality of Brazilian scientific production by *stricto sensu* postgraduate courses, the Coordination for the Improvement of Higher Education Personnel (CAPES), and the National Council for Scientific and Technological Development (CNPq). The indicator to evaluate the quality of the scientific production of professors, researchers, and students in Brazil in quantitative and qualitative terms lies in Qualis Periódicos, which classifies journals at the international, national, and local levels (Barata, 2016), considering the A1, A2, A3, A4, B1, B2, B3, B4, B5, and C extracts based on bibliometric data from JRC, Scopus, and SciELO.

Barata (2016) states that the indicators generated by Scopus have a greater impact on the process of classifying Brazilian scientific journals in the Qualis Periódicos extract

than the JCR and SciELO. Bibliometric indicators are important tools for the scientific community, which seeks to measure the visibility of its scientific production, and they allow governments to analyze disparities in knowledge production between countries and regions with the aim of formulating strategies to minimize these asymmetries.

4 METHODOLOGY

In terms of its nature, this research is classified as fundamental (Silva; Menezes, 2005), descriptive and exploratory (Gil, 2002; Marconi; Lakatos, 2017), with the technical procedure of a bibliometric study (Gil, 2002; Marconi; Lakatos, 2017; Severino, 2013; Silva; Menezes, 2005; Spinak, 1998; Tague-Sutcliffe, 1992). The research approach is characterized as quantitative and, according to Silva and Menezes (2005), it aims to interpret reality through the use of mathematical models or statistical techniques such as correlation coefficients, regression analysis, percentages, descriptive statistics, inference, among others.

The universities were selected using the Folha University Ranking (FUR) and the Times Higher Education (THE). The FUR ranks Brazilian universities by assigning percentages to the variables of teaching (32%), research (42%), market (18%), innovation (4%), and internationalization (4%) (Folha de São Paulo, 2019). The FUR was conceived by Folha de São Paulo in 2012 with the aim of creating a ranking of universities and undergraduate courses in Brazil, based on a set of data collected from Capes, MEC, CNPq, SciELO, INPI, Web of Science, funding agencies and Datafolha surveys (Folha de São Paulo, 2019).

Santos (2015) argues that with the introduction of the FUR, it has been possible to establish a ranking of Brazilian universities, taking into account the specificities of the country and the requirements set by the MEC, since the FUR uses these criteria to classify universities in the list.

THE is linked to the British newspaper The Times and was launched in 2004 with the aim of producing a ranking of the 200 best universities in the world using qualitative indicators such as reputation and prestige and structural performance indicators such as teaching, impact and internationalization (Santos, 2015).

Bizerril (2020) shows that public universities have the role of promoting knowledge and the formation of critical and reflective subjects. This position is one of their core functions. In Brazil, the Federal Universities are the ones that contribute the most to the generation of knowledge in the country, being responsible for 67% of the total scientific production in 2004, a level that reached 77.6% in 2012 (Souza; Filippo; Casado, 2018).

From the Southeast, the Federal University of Minas Gerais (UFMG) and the Federal University of São Paulo (UNIFESP) were selected. UFMG is ranked 4th overall and is the highest ranked university in the state of Minas Gerais. In relation to the State of São Paulo, THE, which places UNIFESP in 5th place in the Latin America University Ranking 2023, considering universities in Latin America and the Caribbean (Times Higher Education, 2023), and in first place in relation to Brazilian Federal Universities, for which it was selected in the State of São Paulo.

From the North, the Federal University of Pará (UFPA) and the Federal University of Amazonas (UFAM) were selected. UFPA is the best positioned in the region (29th in the FUR) (Folha de São Paulo, 2019) and the only one from the North of Brazil to be included in the Latin America University Ranking 2023 (Universidade Federal do Pará, 2023b). UFAM is the second-best university in the North of Brazil in the FUR. Table 1 shows the universities selected to evaluate their scientific performance.

Chart 1. Brazilian universities selected to evaluate scientific production

Selected universities	Region	FUR/THE
Universidade Federal de Minas Gerais	South East	Fourth position
Universidade Federal de São Paulo	South East	Sixteenth position (5th in Latin America and 2nd in the state of São Paulo)
Universidade Federal do Pará	North	Twenty-ninth position (and 1st in the North)
Universidade Federal do Amazonas	North	Sixtieth position (and 2nd in the North)

Source: prepared by the authors

According to Almeida and Gracio (2019) and Freitas, Rosas and Miguel (2017), the Scientific Electronic Library Online is one of the largest national and regional bibliographic databases whose scope is to map the profile of scientific production in peripheral countries of the world. Scopus is characterized as an international bibliographic database with the largest number of Brazilian journals indexed (Almeida; Gracio, 2019; Freitas; Rosas; Miguel, 2017). Web of Science is a globally recognized bibliographic database in the scientific field, with a wide coverage (Almeida; Gracio, 2019; Freitas; Rosas; Miguel, 2017). In this study, Scopus was chosen as the basis for evaluating the scientific output of the selected universities. Scopus is one of the largest mainstream databases of scientific production, providing access to abstracts, citations, peer-reviewed scientific articles, books, conference proceedings, and tools that allow the analysis of global scientific production (Gomes, 2020; Silva et al., 2022).

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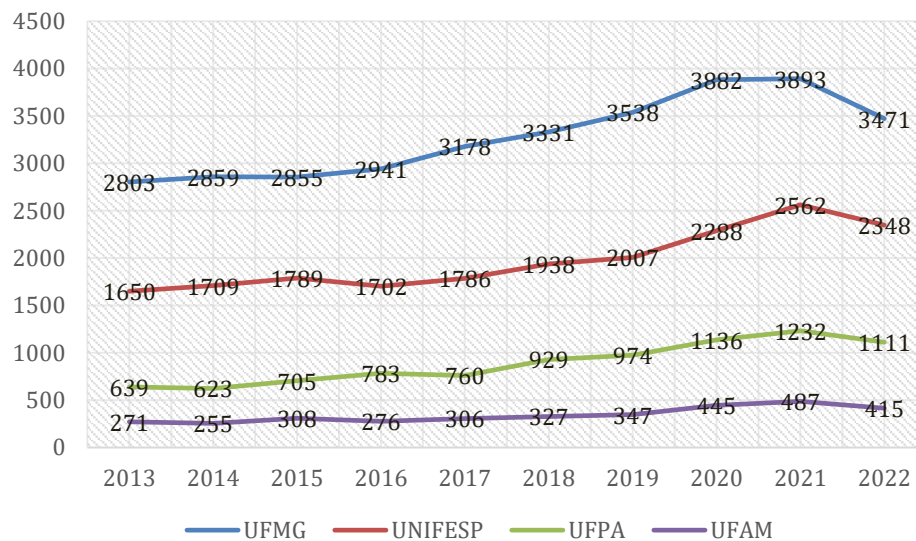
The data of the selected universities were extracted from the Scopus database, accessed through the CAPES Journals Portal in April 2023, considering the number of documents published per year, the type of document (article, conference, review article, book chapter, note, letter, editorial, errata, short research, book, data paper, etc.) and the total number of documents per language. The words "affiliation" were used as search filters, using the terms "Universidade Federal de Minas Gerais" and "Federal University of Minas Gerais", "Universidade Federal de São Paulo" and "Federal University of São Paulo", "Universidade Federal do Pará" and "Federal University of Pará", and "Universidade Federal do Amazonas" and "Federal University of Amazonas", and "affiliation ID", using the terms "Universidade Federal de Minas Gerais (60030074)", "Universidade Federal de São Paulo (60014992)", "Universidade Federal do Pará (60001890)" and "Universidade Federal do Amazonas (60000943)", from 2013 to 2022. The period in question was chosen because it had the largest volume of documents from the selected universities indexed in Scopus, which allowed the analysis proposed in this research to be carried out.

The data were tabulated and organized using the Microsoft® Excel® program from the Microsoft 365 MSO suite (version 2307, build 16.0.16626.20086, 64-bit). This program was used to generate the descriptive statistics, the growth rate, the number and percentage of publications per language for each university, as well as the comparative evolution graph between universities in terms of publications per year and production per Ph.D. student.

5 RESULTS AND DISCUSSIONS

The analysis of the evolution of publications shows that UFMG shows a growth in the volume of documents indexed in Scopus between 2016 and 2021, regardless of the type of document indexed in Scopus between 2013 and 2022, while UNIFESP shows a growth between 2017 and 2021. UFPA shows a linear growth in the total number of documents indexed in Scopus between 2017 and 2021, while UFAM remained constant over the period analyzed, showing an oscillation in growth only between 2019 and 2021 (Graph 1).

Graph 1. Evolution of UFMG, UNIFESP, UFPA and UFAM publications indexed in Scopus between 2013 and 2022



Source: prepared by the authors

According to Barros (2005) and Schott (1998), the structure of knowledge production is linked to a central zone, a secondary zone and a tertiary zone, in which the peripheral regions seek alliances with the central zones in order to gain visibility and scientific recognition. The data analyzed show that although UFMG and UNIFESP are located in regions with the highest rates of scientific production in the country, the performance of UFMG is in the central zone of Scopus, while that of UNIFESP is in the secondary zone. Chiarini and Vieira (2012) show that between 2000 and 2008, UFMG was responsible for 42.02% of the scientific production of all federal universities in the state of Minas Gerais.

UFMG ranked third in the country in terms of the number of research productivity grants (a total of 962 grants), behind the University of São Paulo and the Federal University of Rio de Janeiro, which ranked first and second, respectively (Neiva et al., 2022). The high number of productivity grants awarded to UFMG researchers in 2019 is indicative of the growth in the number of documents published by UFMG and indexed in Scopus, from 2019 to 2020.

Analyzing the descriptive statistics of UFMG publications indexed in Scopus from 2013 to 2022 (Table 1), the data show an annual average of 3,275.1 ($s=394.2$) documents published, with a maximum production of 3,893 texts. This output is divided into different types of scientific production, including: articles (2,709.8); conferences (206.3); review articles (182.9); book chapters (56.7); notes (22.2); letters (34.1); editorials (35.1); errata (15.5); short surveys (7.4); books (3.7); and data papers (1.4).

With respect to the total number of UNIFESP publications indexed in Scopus between 2013 and 2022 (Table 1), the average was 1,978 documents ($s=300.9$), with a maximum of 2,562 and a minimum of 1,650. Of the published documents, 1,563 were journal articles, 42 conferences, 160 review articles, 34 book chapters, 31 notes, 82 letters, 44 editorials, ten errata, eight short surveys, two books, and one data paper.

The statistics of publications by type of document indexed in Scopus between 2013 and 2022 show that, in the category of articles, UFMG had an average of 2,709.8 articles, with a maximum of 3,232 and a minimum of 2,370 in the period analyzed, while UNIFESP had an average of 1,563, with a maximum of 1,988 and a minimum of 1,330 in the same period. In addition to the high production, Chiarini, Oliveira, and Couto Neto (2013), analyzing the scientific production in the states of São Paulo, Rio de Janeiro, Minas Gerais, and Rio Grande do Sul between 2000 and 2010, found that Minas Gerais had one of the highest growth rates (357%), while in the state of São Paulo it was possible to observe a decrease in scientific production (291%).

Table 1. UFMG and UNIFESP publication statistics, by type of document, from 2013 to 2022

Type of publication	Average/year		Standard deviation		Median		Maximum		Minimum	
	UFMG	UNIFESP	UFMG	UNIFESP	UFMG	UNIFESP	UFMG	UNIFESP	UFMG	UNIFESP
Article	2.709,8	1.563	322,7	215,6	2.654	1.481	3.232	1.988	2.370	1.330
Conference	206,3	42	33,8	8,3	213	41	245	52	144	27
Review article	182,9	160	67	52	197	150	244	244	88	98
Book chapter	56,7	34	14,6	9,1	52	36	93	45	41	22
Note	22,2	31	5,6	9,4	22	29	35	53	15	18
Letter	34,1	82	6,4	31,8	31	69	45	139	28	49
Editorial	35,1	44	15,3	8,4	35	43	58	59	15	34
Errata	15,5	10	7,1	4,7	16	11	28	17	6	2
Short research	7,4	8	3,2	5,6	8	7	10	18	3	1
Book	3,7	2	1,3	1,4	4	2	6	5	1	0
Data paper	1,4	1	2	0,9	0	1	5	2	0	0
Total publications	3.275,1	1.978	394,2	300,9	3.255	1.864	3.893	2.562	2.803	1.650

Source: prepared by the authors, based on Scopus (2023)

Looking at the total statistics of UFPA publications indexed in Scopus between 2013 and 2022 (Table 2), we can see that the average number of documents published was 889.2 ($s=207.8$), with a median of 856, a maximum of 1,232, and a minimum of 623. Analyzing the university's publications in Scopus by type of document in the same period, there were averages of 786.5 articles; 38.9 conferences; 34.1 review articles; 5.7 book chapters; 9.8 notes; 1.6 letters; 4.1 editorials; 4.3 errata; 3.4 short surveys; 0.1 books; and 0.7 data papers.

The statistics for UFAM publications in Scopus between 2013 and 2022 show 434.7 indexed documents, with an average of 343.7 ($s=75.2$), a median of 318, a maximum of 487, and a minimum of 255. In terms of publications by type of document, between 2013 and 2022, UFAM published an average of 291.1 articles, 24.8 conferences, 14.1 review articles, 4.6 book chapters, 0.3 short surveys and 0.2 books in Scopus.

Comparing the publication statistics of UFPA and UFAM articles indexed in Scopus between 2013 and 2022, it can be seen that UFPA has an average of 786.5, with a maximum of 1,107 and a minimum of 553, while UFAM has an average of 291.1 texts, with a maximum of 421 and a minimum of 216. It can be seen that UFPA has twice as many texts as UFAM. According to Gomes (2020), UFPA is considered the largest university in the North of Brazil, with a multi-campus structure, headquartered in the capital of Pará, Belém, and with campuses in 11 municipalities of Pará, with about 550 research groups registered in the CNPq Directory of Research Groups in Brazil and about 1,310 research projects under development (in 2019), coordinated by researchers of the institution, with the aim of generating knowledge and technological development.

UFPA is the only university in the Northern Region of Brazil to appear in national and international rankings, occupying 71st place in the Latin America University Rankings 2023 and is one of the five Brazilian universities ranked in the Times Higher Education Impact Rankings 2023. UFPA is also among the 400 best performing higher education institutions in the world and is the only representative of the northern region of the country in this list (Universidade Federal do Pará, 2023b).

Table 2. UFAM and UFPA publication statistics, by type of document, from 2013 to 2022

Type of publication	Average/year		Standard deviation		Median		Maximum		Minimum	
	UFAM	UFPA	UFAM	UFPA	UFAM	UFPA	UFAM	UFPA	UFAM	UFPA
Article	291,1	786,5	68,4	192,7	265	736	421	1.107	216	553
Conference	24,8	38,9	4,8	22	24	41	34	73	18	8
Review article	14,1	34,1	7,2	14,3	13	35	32	61	6	15
Book chapter	4,6	5,7	2,7	3,5	4	6	9	11	1	1
Note	2,7	9,8	1,6	3,2	3	9	6	15	0	6
Letter	2,6	1,6	1,4	1,9	2	1	6	6	1	0
Editorial	1,5	4,1	1	2,8	1	4	4	8	0	1
Errata	1,4	4,3	0,5	1,9	1	4	2	7	1	1
Short research	0,3	3,4	0,6	2	0	2	2	7	0	1
Book	0,2	0,1	0,4	0,3	0	0	1	1	0	0
Data paper	0,4	0,7	0,7	0,5	0	1	2	1	0	0
Total publications	343,7	889,2	75,2	207,8	318	856	487	1.232	255	623

| 1

Source: prepared by the authors, from Scopus (2023)

Looking at the scientific output of UFMG and UNIFESP (Table 1) and that of UFPA and UFAM (Table 2), it can be seen that universities in the Southeast (UFMG and UNIFESP) have a greater number of publications indexed in Scopus between 2013 and 2022 than universities in the North (UFPA and UFAM), showing a disparity in scientific output between these Brazilian regions (Albuquerque et al, 2002; Barros, 2000; Chiarini; Oliveira; Couto Neto, 2013; Gomes, 2020).

The growth rate of total UFMG publications indexed in Scopus between 2013 and 2022 was 2% in 2013 and negative in 2014 (-0.1%), but shows growth since 2020: 2015 (3.0%); 2016 (8.1%); 2017 (4.8%); 2018 (6.2%); 2019 (9.7%); and 2020 (0.3%). In 2021, most likely due to the pandemic, there was a decline to -10.8%. The growth rate of total UNIFESP publications in Scopus was 3.6% in 2013, followed by steady increases in the following years (except in 2015 and 2021, which were negative): 2014 (4.7%); 2015 (-4.9%); 2016 (4.9%); 2017 (8.5%); 2018 (3.6%); 2019 (14%); 2020 (12%); and 2021 (-8.4%) (Table 3).

When analyzing the growth rate of the total number of publications indexed in Scopus for the period 2016 to 2021, UNIFESP achieved a growth rate of 43%, while UFMG achieved 29%. In 2019, UNIFESP's growth rate for review articles was 47%, while UFMG's was 20.2% for the same period. Similarly, in 2020, UNIFESP showed a growth rate of 12.5% in the publication of articles and an increase of 33.3% in the production of conference papers, while UFMG's rates were 0.2% and -26.9%, respectively.

Table 3 also shows the total growth rates by type of document indexed in Scopus between 2013 and 2022, which was 33.7% in the case of UNIFESP, considering the type of document article, while UFMG's growth rate was 20.9%. Regarding the growth rate of the document type review article, UFMG recorded a rate of 121.7%, compared to 83.8% for UNIFESP. Finally, in terms of the total growth rate of conference type documents, both UFMG and UNIFESP recorded negative growth rates - -26.1% and -15.7%, respectively. When analyzing the growth rate of total publications between 2013 and 2022, UNIFESP recorded a 38% increase in the number of documents indexed in Scopus, while UFMG recorded a 23.2% increase.

Although UNIFESP had higher growth rates than UFMG, the study by Chiarini and Vieira (2012) points out that UFMG is the main higher education institution in the state of Minas Gerais, having published 42.02% more papers per year between 2000 and 2008 than the other federal universities in the state, making it the main player in the production of knowledge in the state of Minas Gerais.

Table 3. Growth rate of UFMG and UNIFESP publications from 2013 to 2022

Years	Article		Conference		Review article		Total publications	
	UFMG	UNIFESP	UFMG	UNIFESP	UFMG	UFMG	UNIFESP	UFMG
2013-2014	-0,4%	4,4%	6,3%	2%	30,7%	-6,7%	2%	3,6%
2014-2015	1,9%	3,2%	-6,4%	2%	-12,2%	8,2%	-0,1%	4,7%
2015-2016	-1,3%	-6,1%	9,8%	-17,3%	37,6%	29,2%	3,0%	-4,9%
2016-2017	8,8%	4,8%	8,9%	-9,3%	36,7%	-0,7%	8,1%	4,9%
2017-2018	4,9%	8,4%	-4,1%	30,8%	10,5%	19,1%	4,8%	8,5%
2018-2019	7,3%	6,1%	2,1%	-29,4%	-3,3%	2,5%	6,2%	3,6%
2019-2020	10,7%	8,9%	-17,9%	-25%	20,2%	4,7%	9,7%	14%
2020-2021	0,2%	12,5%	-26,9%	33,3%	25,4%	-0,8%	0,3%	12%
2021-2022	-11,2%	-8,5%	2,1%	-2,8%	-23,9%	-14%	-10,8%	-8,4%
Total fee	20,9%	33,7%	- 26,1%	- 15,7%	121,7%	83,8%	23,2%	38%

| 1

Source: prepared by the authors, based on Scopus (2023)

If we analyze the growth rate of the total number of UFPA publications indexed in Scopus from 2013 to 2022, we see that it varies greatly, being negative in 2013 (-2.5%) and positive in the following years, except for 2016 and 2021, the year of the pandemic. Here are the figures: in 2014, 13.2%; in 2015, 11.1%; in 2016, -2.9%; in 2017, 22.7%; in 2018, 4.8%; in 2019, 16.6%; in 2020, 8.5%; and in 2021, -9.8%. In relation to the growth of the total number of UFAM publications indexed in Scopus between 2013 and 2022, the following rates were observed: 2013 (-5.9%); 2014 (20.8%); 2015 (-10.4%); 2016 (10.9%); 2017 (6.9%); 2018 (6.1%); 2019 (28.2%); 2020 (9.4%); and 2021 (-14.8%) (Table 4).

When analyzing the total growth rate in the production of review article-type documents between 2013 and 2022, it can be seen that UFAM had a growth rate of 216.3%, while UFPA had a rate of -46%. In 2014, UFAM achieved a growth rate of 128.6% in the review article document type, while UFPA's rate was 38.9%. Similarly, in 2020 UFAM had a growth rate of 88.2%, while UFPA's growth was 40%. In 2017 alone, UFPA had a growth rate of 76.9% in the dissemination of review articles, while at UFAM this increase was 22.2%.

In relation to the total growth rate by type of conference document, it can be seen that UFPA had an increase of 308.4%, compared to 51.7% for UFAM. In 2014, 2015 and 2017, UFPA's growth rates in conference documents were 125%, 88.9% and 140.7%, respectively, while UFAM's figures were lower or negative (47.8%, -35.3% and -6.5%, respectively). Finally, when analyzing the total growth rate of the article document type in the period from 2013 to 2022, it can be seen that UFPA's growth rate was 65.1%, while UFAM's was 50.9%. Considering all types of publications over the period studied, UFPA's growth rate was 61.2% and UFAM's 51.2%.

Although the difference between the growth rates of UFPA and UFAM is only 10% in the period studied, UFPA has more publications indexed in Scopus, in relation to UFAM. When comparing the growth rate of total publications indexed in Scopus, it is observed that UFPA obtained the highest growth rate (61.2%), compared to UFAM (51.2%), UNIFESP (38%), and UFMG (23.2%) (tables 3 and 4).

Gomes (2020) observed that, between 2014 and 2018, UFPA publications indexed in Scopus, specifically in the areas of Social Sciences and Humanities, presented the best growth rates in international scientific journals when collaboration networks between researchers from this university and those from the South and Southeast regions increased.

Bourdieu (2003) argues that agents less positioned on the scales of the scientific terrain use diversified strategies, such as maintenance and subversion, in order to obtain scientific legitimacy and authority, as well as visibility, in the structure of the field.

Table 4. Growth rate of UFAM and UFPA publications from 2013 to 2022

Years	Article		Conference		Review article		Total publications	
	UFAM	UFPA	UFAM	UFPA	UFAM	UFAM	UFPA	UFAM
2013-2014	-6,5%	2%	27,8%	-11,1%	16,7%	-41%	-5,9%	-2,5%
2014-2015	10,6%	7,8%	47,8%	125%	128,6%	38,9%	20,8%	13,2%
2015-2016	-2,1%	13,2%	-35,3%	88,9%	-37,5%	-28%	-10,4%	11,1%
2016-2017	9,0%	-2,5%	40,9%	-20,6%	-10%	-27,8%	10,9%	-2,9%
2017-2018	7,8%	16,7%	-6,5%	140,7%	22,2%	76,9%	6,9%	22,2%
2018-2019	8,4%	10,1%	-17,2%	-24,6%	27,3%	-26,1%	6,1%	4,8%
2019-2020	28,5%	18,7%	4,2%	18,4%	21,4%	-55,9%	28,2%	16,6%
2020-2021	9,9%	8,2%	-20%	25,9%	88,2%	40%	9,4%	8,5%
2021-2022	-14,7%	-9,1%	10%	-34,2%	-40,6%	-23,8%	-14,8%	-9,8%
Total fee	50,9%	65,1%	51,7%	308,4%	216,3%	-46%	51,2%	61,2%

Source: prepared by the authors, from Scopus (2023)

When analyzing the percentage of the publication of documents by languages indexed in Scopus in the period, it is observed that UFAM has 80.5% of its documents indexed in English, 18.5% in Portuguese, 0.80% in Spanish, 0.11% in French, and 0.03% in Italian. UFPA presented a percentage of 78.8% of documents in English, 19.9% in Portuguese, 1.12% in Spanish, 0.11% in French, and 0.02% in German. In the analyzed period, UNIFESP obtained a percentage of 84.2% of documents published in English, 14.6% in Portuguese, 1.10% in Spanish, 0.11% in French, 0.019% in Polish, and 0.005% in German, Italian and Russian. Finally, UFMG presented 83.1% of documents in English, 15.7% in Portuguese, 0.95% in Spanish, 0.15% in French, 0.02% in Italian, 0.01% in German, and 0.006% in Russian and Polish (Table 5).

Table 5. Percentage of documents from the universities studied published in Scopus between 2013 and 2022, by language

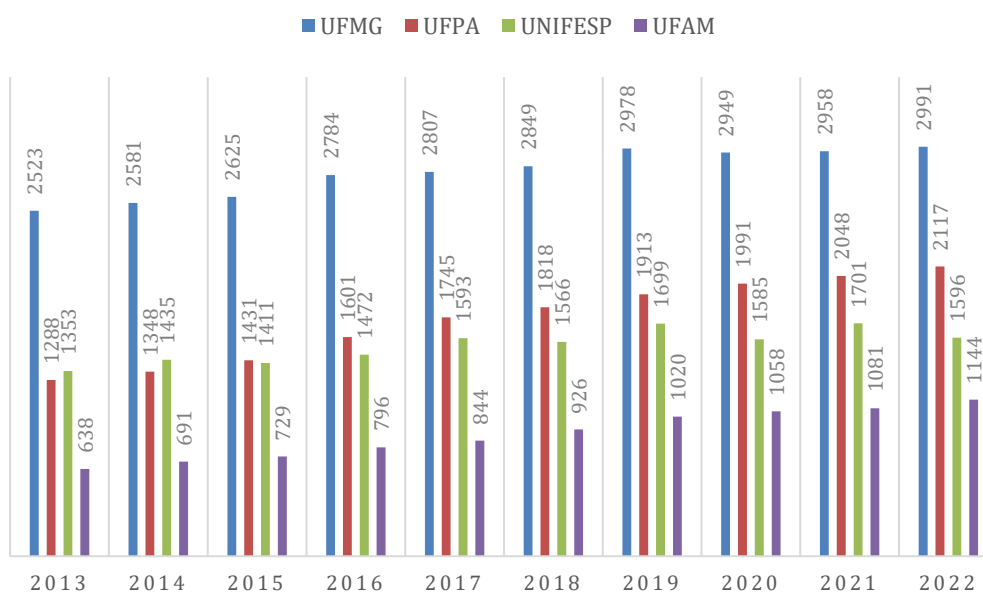
Languages	UFAM	%	UFPA	%	UNIFESP	%	UFMG	%
English	2,913	80.5	7,316	78.8	18,073	84.2	28,668	83.1
Portuguese	670	18.5	1,847	19.9	3,134	14.6	5,430	15.7
Spanish	29	0.80	112	1.21	237	1.10	329	0.95
French	4	0.11	10	0.11	23	0.11	51	0.15
German	0.00	0.00	2	0.02	1	0.005	4	0.01
Italian	1	0.03	0.00	0.00	1	0.005	6	0.02
Russian	0.00	0.00	0.00	0.00	1	0.005	2	0.006
Polish	0.00	0.00	0.00	0.00	4	0.019	2	0.006
Total	3,617	100	9,287	100	21,474	100	34,492	100

Source: Prepared by the authors, from Scopus (2023)

It is observed that the documents of UFAM, UFPA, UNIFESP and UFMG indexed in Scopus in the period under investigation focus on the English language, showing that the process of internationalization of Brazilian scientific production is advancing, aiming at recognition and visibility in the structure of the world scientific field. In the scientific field, recognition, legitimacy, and authority to produce science are intrinsically linked to those best positioned in the structure of the field. In the contemporary period, most of the publications are made by the United States, the European Union, Japan, and, more recently, by China, which has sought to break the hegemony of this triad in World Scientific production (Barros, 2005; Bourdieu, 1994; Fernandes; Garcia; Cruz, 2015; Prado; Oliveira, 2016).

This study works with the hypothesis that publications are strongly related to the number of doctoral professors present in the institutions. In the case study, UFMG led, in terms of the number of professors with doctoral degrees, in the period studied, followed by UFPA, UNIFESP and UFAM (graph 2).

Graph 2. Evolution of the growth of doctoral professors in universities between 2013 and 2022



Source: Prepared by the authors

Although UFPA showed growth in the number of professors with a doctorate degree, in absolute terms, over the period, when analyzing the total number of effective teachers of the institution in 2022, it is noted that 83.91% of the University's teaching staff have a doctorate degree and 13.52% have a master's degree (Federal University of Pará, 2023a). UFAM has 56.90% of its teaching staff with a doctor's degree, 32.27% with a master's degree, and 8.05% with a specialist degree (Federal University of Amazonas, 2023). UFMG has 96.04% of its teaching staff with a PhD degree and only 3.73% with a master's degree (Universidade Federal de Minas Gerais, 2022). UNIFESP has the largest staff of teachers with doctorates (97.7%), while it has 1.9% of teachers with master's degrees and 0.3% with specialization (Universidade Federal de São Paulo, 2020).

When analyzing the scientific production of universities in Scopus between 2013 and 2022, made by professors with doctoral degrees, it is observed that the professors of UNIFESP and UFMG present scientific productions in higher numbers, in relation to those of UFAM and UFPA (Table 6).

Tabela 6. Scientific production by doctoral professors of the universities studied in Scopus between 2013 and 2022

Year	UFAM	UFPA	UNIFESP	UFMG
2013	0.42	0.50	1.22	1.11
2014	0.37	0.46	1.19	1.11
2015	0.42	0.49	1.27	1.09
2016	0.35	0.49	1.16	1.06
2017	0.36	0.44	1.12	1.13
2018	0.35	0.51	1.24	1.17
2019	0.34	0.51	1.18	1.19
2020	0.42	0.57	1.44	1.32
2021	0.45	0.60	1.51	1.32
2022	0.36	0.52	1.47	1.16

Source: Prepared by the authors

Note: The production per professor refers to the total number of documents indexed in Scopus per year, divided by the total number of professors with a doctorate degree per year, at each university.

Chiarini, Oliveira and Couto Neto (2013), when analyzing the scientific production of Brazilian states registered in the directory of CNPq research groups per researcher, regardless of degree, in the period 2000–2010, found that, in 2000, scientific production was 2.52 per researcher in the state of Amazonas, 2.58 in Pará, 3.86 in São Paulo, and 4.53 in Minas Gerais. It is still possible to verify that, in 2010, scientific production per researcher grew in all Brazilian states, reaching 6.80 in the state of São Paulo, 5.93 in Minas Gerais, 3.44 in Pará, and 2.87 in Amazonas. These results corroborate the data in Table 6, in which it is possible to observe that the scientific production made by doctoral professors from universities in the Southeast region is higher than that of those located in the North Region.

It is also observed that only the equalization of the number of doctoral professors between UFMG, UNIFESP, UFPA and UFAM does not explain, in its entirety, the better institutional performance of the universities in the center of the country; therefore, other factors, such as the number of professors linked to graduating from school, the number of master's and doctoral students, course grades, length of existence of courses, amount of research grants and productivity, etc., are determinants to elucidate institutional performance, linked to scientific production.

The regional differences in the Brazilian technical-scientific base are linked to the number of PhDs, which are found in greater numbers in the South and Southeast regions of Brazil because they are the regions that hold the most Masters and PhDs and hold 81.98% of Brazilian financial resources invested in research and CT&I programs (Barros, 2000). The variables that explain the level of productivity, in the view of Meadows (1999), are linked to the number of articles published, the number of staff (teachers and technicians), the number of students, access to financial resources, and the availability of support services (libraries). Universities that offer the best conditions for research development attract high-quality researchers and, consequently, have higher institutional and individual productivity. In this case, the most productive researchers have more access to financial resources, assistants, and doctoral students (Meadows, 1999).

Albert, Davia and Legazpe (2016), when analyzing the determinants of research productivity in Spain, present a set of variables, which explain that academic productivity is related to the form of funding, the time of completion of the doctorate, the type of research developed, sex, age, academic career, personal motivations (promotion, innovation, and contribution to society) and institutional characteristics of doctors.

In turn, Rowe, Bastos and Pinho (2013) found that the variables scientific productivity grant, coordination of research projects and guidance of master's and doctoral students, and linkage to graduate programs strongly influence the level of productivity of teachers. In Brazil, the criteria adopted to measure academic productivity, in the view of Oliveira and Melo (2014), are linked to bibliometric indicators such as the quantitative total of articles authored, the H-index, the average impact factor of publications and number of citations.

6 CONCLUSION

The article aimed to evaluate the behavior of the scientific production of some federal universities belonging to the Southeast and North regions of Brazil in the period from 2013 to 2022, in the bibliographic base Scopus. The results show that UFMG and

UNIFESP have higher numbers of publications indexed in Scopus, in relation to those of UFPA and UFAM. It was also possible to observe that UFMG presented an average of 3,275.1 documents indexed between 2013 and 2022, while UFAM presented the lowest amount of publications among universities in the analyzed period, obtaining an average of 343.7 documents.

In relation to the language of the documents of the analyzed universities indexed in Scopus, the concentration of texts produced in English is observed, evidencing the effort that the universities have adopted, so that their scientific productions have insertion and visibility in the international scope. Another observed result focused on the discrepancies in the quantitative indexed documents of the Universities of the Southeast Region (UFMG and UNIFESP), when compared with the Universities of the North Region (UFPA and UFAM).

The unequal distribution of the number of documents indexed in Scopus shows that the Brazilian scientific field still has, as a challenge, the implementation, through government agencies, of public policies that can favor equality of conditions among Brazilian universities in scientific production, with a consequent reduction in the disparities of the technical-scientific base between the regions. The article presents, as a contribution, the evaluation of the scientific production of some Brazilian federal universities, whose insertion regions present different socioeconomic realities, which allows the Constitution to create new perceptions capable of subsidizing new research and the interests of governments, researchers, and society interested in the theme.

It is important to emphasize that this study adopted only Scopus as a bibliographic base as well as sought to evaluate the scientific production of some selected universities, which does not allow generalization of its results, relative to other bibliographic bases, such as WoS, SciELO, etc. Likewise, the growth rates of publications were calculated and linked to the types of documents, conferences, and review articles because the other documents did not present significant variations in the analyzed period.

It is recommended, as a future study, the evaluation of the scientific publication of UFMG, UNIFESP, UFPA and UFAM indexed in the three main bibliographic bases (WoS, SciELO and Scopus), for the construction of a comparative analysis of the behavior of indexed publications in the last ten years.

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