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The growth of Brazilian metrics literature

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ABSTRACT

Analysis is presented on the growth of the literature on bibliometrics, informetrics, and scientometrics published in Brazil by Brazilian and foreign authors in the form of journal articles, book chapters, and papers presented at conferences. From 1973 to December 2012, close to 2300 documents were published. This literature is growing exponentially at a rate of 24% per year and doubling in size every 3.2 years.

Keywords: Bibliometrics, Brazil, exponential growth, growth of literature, informetrics, scientometrics

INTRODUCTION

The word "literature" refers to a set of documents published on a particular subject. It encompasses different forms of publications such as journal articles, book chapters, papers presented at conferences, pamphlets, books, theses and dissertations, gray literature, and so forth. Different literatures often have different levels of granularity, referring to a general literature such as "chemical literature", or a particularly narrow area such as literature on "the greenhouse effect". Scientists usually communicate with one another through formal publication of this kind of broader or narrower literature; therefore, knowledge is transmitted through the publication of journal articles, book chapters, papers presented at conferences, pamphlets, books, theses, article preprints, postprints, and gray literature, among other document types. However, what is considered as knowledge in a scientific field extends beyond the formal literature, although most of this knowledge comes from the literature, "We may think of knowledge in a given field as consisting of three layers. First, there are the primary studies that researchers conduct and publish. Next, there are reviews of those studies, whether systematic or conceptual that provides summaries and new interpretations built from but often extending beyond the original literature. Finally, there are the perceptions, conclusions, and interpretations that people share in informal hallway conversations that become part of the lore of the field" (Kennedy, 2007: 141).[1]

The published literature is collected and indexed in specialized bibliographic databases, but for many reasons not everything that is published in a country is collected or even exhaustively indexed. In general, data collection and indexing databases are selective as they follow their own criteria and interests. For example, a search for the topic "bibliometrics" and address "Brazil" in Web of Science produces 167 references, PubMed recovers only 318 references.

The objective of this paper is to analyze the growth of published literature on "metrics" (e.g. bibliometrics, informetrics, scientometrics, patentometrics, archivometrics) in Brazil. The chosen period extends from the first works published on the subject in 1973 to December 2012, a long period as to expect that the published literature accumulate and grow in some way. The growth model, along with other models such as Lotka's law, Zipf's law, the 80/20 rule, obsolescence of literature, citation analysis, among others forms the structure of the

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bibliometric field (Urbizagástegui, 2007).[2] This paper seeks to answer the following basic questions: Is the published literature on Brazilian metrics growing or has it already reached its saturation point? If this literature is growing, what is the shape of this growth? What are their growth and duplication rates?

To achieve this objective, this paper is organized into five parts. The first part provides an introduction to the topic, describing the problem and formulating the research questions. The second section provides a review of the published literature on the topic in Brazil. The third section describes the methodology and the application of the chosen mathematical model with emphasis on data collection and measurement. In the fourth section, findings and discussion are presented. Finally, in the fifth section, references to the literature reviewed are presented.

LITERATURE REVIEW

To the best knowledge of the authors of this article, no researcher has previously studied the growth of bibliometric literature in Brazil. No one has offered analysis of the growth and duplication rates of this literature. Nevertheless, some researchers were interested in the development of bibliometrics in the country. These concerns began with Urbizagástegui (1984)[3] analyzing the Brazilian scientific bibliometric production between 1972 and 1983. His results showed that Bradford's law was the main concern with respect to intellectual production up to the 80s. This could be explained by the immediate practical applications of Bradford's law for the development of core collections of scientific journals in libraries and documentation centers. Nobody followed up this line of research for nearly 20 years until Vanz (2003)[4] analyzed bibliometrics papers published in the journal *Ciência da Informação* from 1972 to 2002. She notes that there are few publications on bibliometrics in the country, although there is an increasing interest on this subject since the late 1990s. Soon after, Machado and Pinto (2005)[5] traced the scientific production on Brazilian bibliometrics from articles published in five national journals in library and information science, covering the period 1990–2004. They identified only 27 articles published in this long period. Annual production, publication type, institutional affiliation of the authors, languages of publications and subjects of the papers were studied. Findings show that scientific production is concentrated in the Southeast of the country (68.75%), and universities (58%) are the largest producers. Then, Machado (2007)[6] re-examined the issue of bibliometrics from 1990 to 2005 in the same five Brazilian journals of library and information science analyzed before. He identified only 31 papers published in this period; 21 of them were published by Brazilian authors, and 10 papers were published by foreign authors. The author's conclusion is that his analysis presents an updated picture of bibliometric studies in Brazil. However, it does not exhaust the possibility of further studies including other sources that might provide a different picture of the development of bibliometrics in the country.

Because the study was focused only on the library and information science field, it enables the possibility for more research on the literature produced and published in all areas of knowledge in the country. Studies of this kind could provide a different picture of the development of bibliometrics in Brazil. For example, Pinheiro and Silva (2008)[7] carried out an extensive analysis of the production of theses and dissertations on metric studies in Brazil from 1972 to 2008. The objective of this paper was to review the historic development of bibliometrics in Brazil, particularly the development of bibliometrics at the Brazilian Institute of Information in Science and Technology (IBICT), but also the production of other institutions. In the period analyzed the authors identified only 57 theses and dissertations produced on Brazilian metrics. Two years later, Meneghini and Packer (2010)[8] collected articles on scientometrics and bibliometrics produced domestically from 1990 to 2006. To collect the data, they used Web of Science, Google Scholar, SciELO Brazil and Lattes platform. A total of 197 documents were found, 78% of which were published in 57 Brazilian journals and 22% in 13 foreign journals. They claim that scientometric and bibliometric publications produced by Brazilian authors grew exponentially, reaching "13 times in the Web of Science database, and 19.5 times in Google Scholar". They attribute this growth of literature, on the one hand, to the development of the Internet and the availability of publications and statistical data in databases such as Web of Science, Google Scholar, and SciELO Brazil. On the other hand, the growth of literature is also attributed to the recognition by the Brazilian scientific community of the usefulness of bibliometric and scientometric techniques in the management and evaluation of science, technology, and innovations.

The following year, Araujo and Alvarenga (2011)[9] analyzed the use of bibliometric techniques examining theses and dissertations of graduate programs in Brazil produced between 1987 and 2007. For data collection, they used

the CAPES (Coordination for the Improvement of Higher Education Personnel) data bank on theses and dissertations employing the term "bibliometrics" in the keyword, abstract, and title fields. They found 82 theses and dissertations produced at institutions of higher education. That same year Azambuja (2011)[10] analyzed the use of bibliometric methods in articles published by 8 Brazilian library and information science academic journals from 2006 to 2011. She found just 33 items, with an average of 5.6 articles published per year. Also Lima; Soares and Oliveira (2011)[11] analyzed the scientific production on "metric studies" indexed in the Brazilian Referential Data Base of Journal Articles on Information Science (BRAPCI) from March 1991 to March 2011. They found a total of 151 research articles produced by 203 authors, but they were more concerned with authors' productivity, co-authorship, and institutional networks. Similarly, Gracio and Oliveira (2012)[12] conducted a diachronic study of the scientific contribution of Brazilians authors on the subject of "metric studies" for the "mainstream" sciences analyzing the journals indexed in the SCOPUS database covering the period 1984–2012. They identified the more productive Brazilian scientists, collaboration networks and levels of citation. After further filtering of data, the population studied was reduced to 263 articles produced by 649 different researchers. Thirty-one Brazilian authors were identified as the most productive ones with 3 or more articles published in 113 different academic journals.

Finally Leta (2012)[13] recounts the development of scientometrics in Brazil emphasizing the need for solving three continuing national challenges: First, to recover and restructure the identity field; second, to recover the basic facets of scientometrics; and third, remove false misconceptions and misuses such as the "comparison between fields and disciplines; citations as a synonym of quality, impact factor of journals as a quality parameter of individual work, indiscriminate use of indices such as the h-index, without considering the effects of the field and number of authors" (Leta, 2012).[13]

As can be seen from the literature reviewed above, in all of those researches there are not the intention to analyze the growth of the literature on bibliometrics published in the country since its inception and in producing growth indicators of the literature. However, it is clear that "the interest in bibliometrics has increased significantly since the 1970s to the present, either due to increases in graduate programs in the country or either the quantitative and qualitative growth of scientific journals. But this growth has occurred in all sciences" (Mattos and Job, 2008).[14] For these reasons, the purpose of this paper is to analyze the growth of the literature on Brazilian bibliometrics and estimate its rate of duplication.

MATERIALS AND METHODS

Data were taken for all academic journal articles, book chapters, and papers presented at congresses which used some of the aspects of metrical studies, their applications to a discipline, and the analysis of specific subfields in Brazil. We excluded books, theses, monographs and gray literature for two reasons. First, books usually begin as articles published in academic journals, and all of these are already units in our analysis. Secondly, books, theses, monographs and gray literatures are not indexed in the bibliographic databases consulted for collecting the data. The period covered is 1973 to December 2012.

To collect the data, searches were conducted using the terms listed in Appendix A, in their different language variations (Portuguese, Spanish, English, French, German, and others), in its multiple Boolean nested combinations, for titles, keywords, and abstracts within the bibliographic databases listed in Appendix B.

The references identified were then exported to EndNote X5 for the development of a devoted bibliographical database on Brazilian bibliometrics. Then, a thorough reading of each of the documents identified in the search was completed. Special attention was given to every citation made in the document read. Later, if a questionable document on metric studies or applications was detected, each reference was examined and confronted with the database built in EndNote and incorporated to the database, if it had not been identified in the previous searches of bibliographic databases of Appendix B. Duplicate references were removed caring only unique references. The identification of the relevance of the documents was an arduous and difficult task, because very often the keywords were insufficient, and sometimes false, indicators. Through a careful reading, the EndNote database was built containing references of journal articles, book chapters, papers presented at conferences and occasionally editorial notes. This special database has been ongoing construction for a period of 2 years.

However, without knowing the shape the literature's data points, it is difficult to anticipate the measurement trends of the data collected. It is impossible to say in advance if

this literature takes a linear form, exponential one, logistic one, a power form, and/or Gompertz form, among others. Nevertheless, it is expected to be exponential because this form of growth is the most common form found in literature studies spanning long periods as is the case here. The exponential growth represents the increase of the population in a fixed proportion in each unit of time, expressed in percentages, with a constant growth rate and an undefined growth boundary. This model not only provides an average growth rate but also offers a doubling rate that is, a rate or proportion at which the size of the population studied is doubled. Exponential growth generally presumes a concave shape in its initial graphic representation and mathematically is written as:

$$C(t) = CO\ ea^{t}$$

Following Egghe and Ravichandra Rao (1992),[15] this function can be re-written as:

$$C(t) = c\ g^{t}$$

where $c > 0$, $g > 1$ and $t \geq 0$

To estimate the parameters of the exponential distribution, a nonlinear regression curve, with the SPSS 17.0 software for Windows was used. Expected was a high correlation among the dependent and independent variables, therefore, this correlation was explored using a coefficient of determination R^2 at 0.05 significance level.

RESULTS

Table 1 shows the breakdown by years of the 2300 documents found since 1973, when the first papers were published, until December 2012, a long period of 40 years. The volume of documents was divided and organized by 3 year period with the intention of better showing the growth of the published literature.

In the first nine periods, small oscillations of publication of new documents were observed, but in general, growth remained almost constant (among 0.3–1.4%). In other words, the literature did not grow but instead maintained a constant level of publication. Growth begins from the tenth period (1998–2000) onward where the volume of production doubles from the previous 3 years. This doubling of volume production remained a constant characteristic in the subsequent years despite we affirm that this article deals with the growth of the literature and nothing more than the growth of the literature, one of

Table 1: Quantity of documents published by 3 year period

Years	Number of documents	Percentages
2010-2012	1072	46.61
2007-2009	566	24.61
2004-2006	259	11.26
2001-2003	133	5.78
1998-2000	78	3.39
1995-1997	30	1.30
1992-1994	19	0.83
1989-1991	16	0.70
1986-1988	31	1.35
1983-1985	23	1.00
1980-1982	23	1.00
1977-1979	22	0.96
1974-1976	21	0.91
1971-1973	7	0.30
Total	2300	100.00

the reviewers of this paper states "I would welcome more information about which of the many sources gave the best tally of papers, what subject areas the selected papers covered, how international they were, and from which institutions in Brazil, and who were the leading individual authors. Were the papers about bibliometrics methodology, or were they on the application of bibliometrics to one or more areas of science for evaluation purposes?" We believe that to answer these questions it is necessary to produce another paper. Fortunately, this paper was already sent for publication and here the bibliographic reference: Bibliometrics, informetrics, scientometrics and other "metrics" in Brazil. DataGramaZero. In press (2015).

The published literature does not grow in the first nine 3 year periods or spans. Growth begins to emerge more clearly in the 10th span of years (1998–2000) to reach its highest expression in volume in the last period (2010–2012). The form of the growth of the literature produced on bibliometrics, informetrics, and scientometrics in Brazil by years is shown in Figure 1. The "clouds of points" begins in 1973 and only minor fluctuations occur until 2000 contributing to an initial concave shape which increases steadily until 2012. This type of shape shows that we are experiencing an exponential growth of literature.

Bibliometric studies in Brazil began with the implementation of the master's program in information science at the Brazilian Institute of Information in Science and Technology (IBICT) in 1970 (Urbizagástegui, 1984).[3] Responsible for the introduction of bibliometric studies was visiting professor Tefko Saracevic, from Case Western

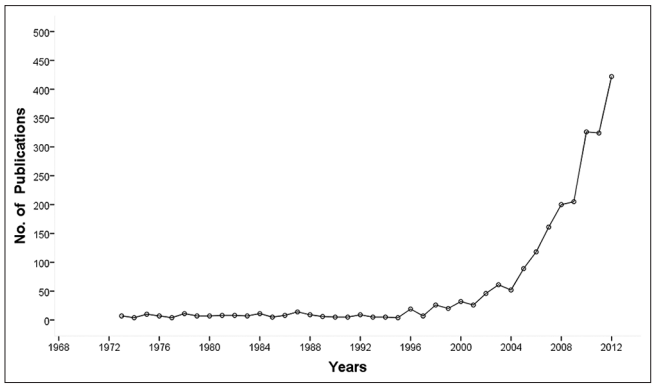

Figure 1: Growth of literature according to years, 1973–2012

Research University in the United States. He acted as a professor in the first Master Program in Information Science at the former Brazilian Institute of Bibliography and Documentation (IBBD), which in 1976 was renamed Brazilian Institute of Information in Science and Technology (IBICT). The course offered by Professor Saracevic was called Data Processing Documentation and included an introduction to bibliometrics (Pinheiro and Silva, 2008).[7] During those years, it was common to invite foreign professors, as Brazil did not have the necessary number of experts to act as advisors and/or counselors of dissertations written by students of this Master program. From the teachings of this group of foreign professors, a critical mass of researchers was formed which gave continuity to Brazilian bibliometric studies. The results of these classes in the form of dissertations converted into articles were initially published in the journal Ciência da Informação (Information Science). This journal was created specifically to disseminate the academic production of this program and also the results of research projects carried out by IBICT. The first conference papers presented at specialized events organized in the country were also published. That's why the first products of this master's program were published in 1973. In that year, seven papers were published by six ex-alumnae of this master's program. Just one document was published by an outsider.

For Oliveira (1984),[16] the years of 1973–1975 were the most productive in bibliometric studies in the country. This contrasts with Araújo (2006)[17] and Hayashi *et al.* (2007),[18] who found a decline in interest in bibliometric practices in Brazil between 1980 and 2000. Our data, however, show neither growth nor decrease, but rather the stable production of bibliometric documents during those periods. Until 2000, the production of documents neither grows nor decreases. By that decade, some criticism of the "quantitative" emphasis of research in library and information science in Brazil had appeared. The critics proposed a change that would emphasize studies using "qualitative" methods. For example, Oliveira (1984)[16] stated that "few authors are concerned with the qualitative aspects of scientific production. Most of them [the librarians] use quantitative methods to measure the volume of scientific production in development. On the contrary, it would be the most important to obtain measurable data to assess the quality of this production and its effects on society". There were also those who had serious doubts about "those highly refined mathematical models and sophisticated ones [that] I regard as an interesting and challenging game, but of little practical use" (Fiuza, 1978).[19] These criticisms may have constrained the "quantitative" research on bibliometrics and momentarily paralyzed the growth of research on this subject. Also, this paralysis of interest could be due, in part, to the retirement of the academic activities of some advocates of bibliometrics studies in the country by those years. We believe that this is the stage of "precursors" of the metric studies in Brazil.

According to Price (1975),[20] this stage is characterized by the occurrence of an initial concave curve of dispersion of the "cloud of points" of the data. This initial curve lasted precisely until 2000. According to Schneider (2009),[21] researchers working on the first stage of evolution of a discipline that is, precursors, are exploring a new field, so they introduce a new language that, more or less, adequately describes the issues studied. These researchers are not necessarily those who discover new facts. Their work is definitional and based primarily on issues already discovered and in experimental techniques already developed by others. In order for scientists of this initial stage can create new frameworks of thought, they often have to be somewhat imprecise and even slightly inaccurate. The reason is that, at the time they conceive a new scientific field the facts are not sufficiently well known or well understood. However, what could be considered as inaccuracies in the description of the events studied, in reality are working hypotheses that are being explored in this first stage as part of a process of successive approximation. This is the case with the precursors of bibliometric studies in Brazil, until 2000, when this precursor stage could be considered closed. Their "qualitative" critics who came later forgot the law of dialectical materialism, which claims to have a leap from the quantitative stage to the qualitative stage and vice versa (Engels, 1968).[22] Brazilian bibliometrics has finally reached this qualitative stage.

We wonder which are the social phenomena that triggered and drove the growth of publications on metric studies after 2000. Variables were many and diverse. For example, Araujo (2006)[17] and Hayashi *et al.* (2007)[18] stated that at the beginning of the 1990s, with the possibilities of using the computer, there was a great interest in again exploring quantitative methodologies. Meneghini and Packer (2010)[8] noted that one of the major variables could have been the incentive for the publication of articles in journals indexed by the Web of Science provided by CAPES. They also believed that other major causes of this growth were the development of the Internet, the availability of publications and statistical data in the Web of Science, Google Scholar, and SciElo as well as the recognition of the value of bibliometrics and scientometrics in the assessment of science by the Brazilian scientific community. Additionally, the year 2000 saw the publication of "The Green Book of Information Society in Brazil" (2000)[23] as a way to prepare the country to evolve with and come up to terms with this new information society. According to Mueller (2007),[24] the professional class of librarians and information scientists took upon themselves the responsibility to contribute to the success of the goals of the Information Society in Brazil what were the ubiquitous access to important and useful information and communication. Logically, these goals were also reinforced by increased production of publications. For those years, electronic journals became a reality in Brazil, the SciELO Portal was created, and Brazilian scientists gained direct access to the academic journal content enabling them to access all formats and kinds of data. All these actions facilitated more metric studies in the country. The dependence on foreign bibliographic and referential databases was finished. There grew the possibility that an individual with little expertise but familiar with tools like Excel would be able to accomplish quantitative analysis (Lucas, 2013).[25] To Grácio and Oliveira (2012),[12] in those years, there was greater access to mainstream science through the use of journals via the CAPES Portal (officially made available since November 2000), which became one of the largest virtual libraries in the world. By those years, courses on bibliometrics were also formalized at graduate programs in several academic disciplines in Brazil. Therefore, the basis for those individuals with cultural capital and habitus necessary for coding and decoding the bibliometric matrices were also extended and those possessions of cultural capitals also allowed the increase of publications (Bourdieu, 1994).[26] These variables apparently combined to boost the growth of the literature since 2000.

To estimate the fit of this exponential model the nonlinear regression mathematical equation proposed by Egghe and Ravichandra Rao (1992)[15] was used. The adjusted R^2 was equal to 0.986 showing a good fit of the data to the exponential model at 0.05 significance level and 38 degrees of freedom. The estimated value of C was 0.097 with a standard error of 0.027. The estimated value of g was equal to 1.240 and a standard error of 0.009. Therefore, the equation that predicts the exponential growth of these publications can be set as:

$$C(t) = 0.097 \times 1.240^{t}$$

This means that the metric studies in Brazil are growing at a rate of 24% per year and double in size every 3.2 years. This literature is growing very rapidly and at the same rate as physics or chemistry in the United States. Table 2 shows the parameter and values obtained from the application of the exponential model by the method of nonlinear regression.

Price (1975)[20] states that the growth of literature can be linear then become exponential to reach its saturation point with a logistic form. This does not seem to be the case however for the literature on bibliometrics in Brazil. After 40 years, it is still constantly growing and is far from reaching its saturation point. Graphical representations of the observed and estimated values are shown in Figure 2. Note how close growth is of both observed and expected values.

DISCUSSION AND CONCLUSIONS

The differences between the numbers of publications found in this research with the earlier ones are mainly due to the time-span of the research. While these researchers focused their attentions on short time-spans, this study covers a 40 years period (1973–2012). Those scholars also reduced their research to the analysis of a single journal (Vanz, 2003)[4] or between 5 and 10 library and information science academic journals (Machado and Pinto, 2005;[5] Machado, 2007;[6] Azambuja, 2011).[10]

Table 2: Parameter values of the exponential model

Parameters	Values	SE	CI (95%)	
			Minimum level	Maximum level
c	0.097	0.027	0.043	0.151
g	1.240	0.009	1.222	1.259

SE=Standard error, CI=Confidence interval

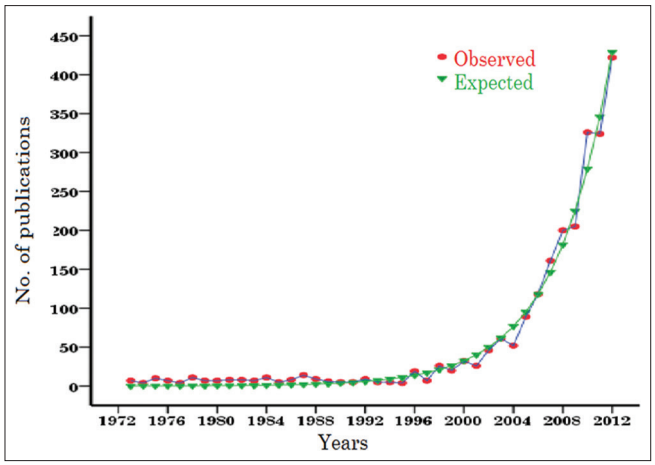

Figure 2: Observed and expected data growth

Others only to theses and dissertations (Pinheiro and Silva, 2008;[7] Araujo and Alvarenga, 2011).[9] Whereas this research collected all the documents published in the country and those published by Brazilians authors abroad. That is, the coverage is much wider and more representative of the Brazilian bibliometric practice.

Another difference relates to the keywords used for retrieval of the documents. Some authors did not write down the keywords used (Vanz, 2003)[4] and others reduced their search terms to five keywords (Lima *et al.*, 2011).[27] Still others used a Boolean combination of 17 keywords (Grácio and Oliveira, 2012).[12] Naturally, this also produced differences in both the amount of documents retrieved and the number of authors of those documents. For example, Vanz (2003)[4] found only 40 authors, four of them publishing before the 90s. This small quantity of authors led her to states "the lack of research on the subject since the authors occasionally publish on this matter" (Vanz, 2003, p. 13).[4] Another fact that would confirm the absence of formal research on bibliometrics in Brazil would be the circumstance that two of the four most productive authors were foreigners (Vanz, 2003, p. 14).[4] However, it is necessary to keep in mind that she is referring to data collected from a single journal and to the 90s. Similarly, Lima *et al.* (2011)[27] identified 151 papers produced by 203 researchers, with 20 of them having at least three publications. In addition, Grácio and Oliveira (2012)[12] found only 31 researchers with at least three articles published that is, large producers. Again, the results of this research contradict those statements since were found 2,300 documents produced by 3,320 researchers, ratifying the existence a research field in full development.

In relation to the growth of the literature on bibliometrics, Kumar *et al.* (2009)[28] found fluctuations in the growth of global bibliometric literature but they did not estimate the growth rate neither the doubling time of the literature. Similarly, Patra, Bhattacharya and Verma (2006)[29] also observed that the literature of bibliometrics, in general, does not have a definitive form of growth, but they also did not estimate the growth rate neither the rate of duplication of this literature.

Growth of the literature has sociological implications as well as it involves potential access problems for the use of the literature (Egghe, 1994).[30] Such analysis and projection are important to predict future specialized literature development. A simple way to compare the diverse rates of exponential growth is through the annual growth rate and the doubling time-span rate (Gilbert, 1974;[31] Braun; Lyon and Budjosó, 1977).[32] For example, the Mexican bibliometric literature grows in exponential form at 8.2% per year and doubling in size every 9 years (Urbizagástegui and Restrepo, 2013).[33] A similar case was observed in the Argentinean bibliometrics, the growth of this literature follows the exponential form doubling in size every 5 years (Miguel and Dimitri, 2013).[34]

In this research, it was observed that the growth of the published literature on bibliometrics in Brazil fits the exponential model (R^2 = 0.986) with an annual growth rate of 24% per year and doubling in size every 3.2 years. The annual growth rate is above the 5.5% observed by Holt (1968)[35] for the literature of economics and the 6.5% annually observed for the growth of the literature on the medicinal plants of Peru (Urbizagástegui and Urbizagástegui-Lane, 2008).[36] This means that the literature on metric studies in Brazil is growing faster than these areas.

The rate of duplication of this literature is well below the 10 years stated by Brookes (1973)[37] to the literature of science in general and below 15 years observed by Menard (1971)[38] in geology. It is also far from the expectations range from 11 to 15 years observed by Price (1951,[39] 1956)[40] for physics and chemistry. This means that the literature on bibliometrics in Brazil is doubling faster than the literature of these areas. To the best knowledge of the authors of this article, no researcher has previously studied the growth of bibliometric literature in Brazil.

It seems that the growth rate of literature is independent of the fields, whether these are hard sciences or social sciences,

but seems to be the result of research intensity, funding and therefore the volume of researchers working in those areas: The greater the funding and number of researchers working in a given field, the greater the chances of producing more literature, therefore, the faster the growth of the literature. If in a certain field, for example, there are 1000 researchers and if each one publishes a paper every year, they add 1000 papers annually to those previously existing in the field, but if there are only 100 researchers and if each of them also publishes a paper every year, only 100 articles are added to the previously existing papers. Therefore, the doubling time of those 1000 researchers will be faster than the hundred ones of the other fields. This feature was observed by Menard (1971)[38] in geology paying attention to the fact that several sub-disciplines grew at different rates and for better prediction had to pay attention to the relationships among the sub-disciplines.

REFERENCES

1. Kennedy MM. Defining a literature. Educ Res 2007;36:139-147.
2. Urbizagástegui Alvarado R. A bibliometria: Historia, legitimação e estrutura. In: Toutain LMBB. Organizadora. Para entender a ciência da informação. p. 185-217. Salvador, Bahía, Brasil: EDUFBA, 2007.
3. Urbizagástegui Alvarado R. A bibliometria no Brasil. Ciên Inf 1984;13:91-105.
4. Vanz, SAdeS. A Bibliometria No Brasil: Analise Tematica Das Publicacoes Do Periodico Ciencia Da Informacao (1972-2002). In ENANCIB: Encontro Nacional de Pesquisa em Ciência da Informação (5to. : Belo Horizonte : 2003). Anais do ENANCIB. Belo Horizonte: UFMG, 2003 Belo Horizonte, Minas Gerais, 10 a 14 November: ANCIB, 2003.
5. Machado RdasN. Pinto EV. Mapeamento da produção científica em bibliometria (1990-2004). In ENANCIB: Encontro Nacional de Pesquisa em Ciência da Informação, Florianópolis, SC. Anais do VI Enancib. Florianópolis: Universidade Federal de Santa Catarina, 2005.
6. Machado RdasN. Análise cientométrica dos estudos bibliométricos publicados em periódicos da área de biblioteconomia e ciência da informação (1990-2005). Perspect Ciên Info Bra 2007;12:2-20.
7. Pinheiro LVR. Silva, GS. Cartografia histórica e conceitual da bibliometria / informetria no Brasil. In Conferencia Ibero-Americana de Publicacoes Eletronicas no Contexto da Comunicacao Cientifica, Ii Cipecc., 2008, Rio de Janeiro, RJ. Rio de Janeiro, RJ, Brasil, 17 a 21 November de 2008.
8. Meneghini R. Packer AL. The extent of multidisciplinary authorship of articles of scientometrics and bibliometrics in Brazil. Interciencia 2010;35:510-514.
9. Araújo RF. de; Alvarenga, L. A bibliometria na pesquisa científica da pós-graduação Brasileira de 1987 a 2007. Encontros Bibl Rev Eletrônica Biblioteconomia Ciên Infor 2011;16:51-70.
10. Azambuja APdeA. A bibliometria nos periódicos de ciência da informação no Brasil. Rio Grande, Universidade Federal do Rio Grande, Instituto de Ciências Humanas e da Informação, Curso de Biblioteconomia. Trabalho de conclusão de curso de biblioteconomia, 2011.
11. Lima LS. Soares, CF. Oliveira EFTde. Investigação da produção científica no tema "estudos métricos" na Base de Dados Brapci: Uma análise bibliométrica." Rev EDICIC 2011;1:299-310.
12. Grácio MCC. Oliveira EFTde. A inserção e o impacto internacional da pesquisa brasileira em "estudos métricos": Uma análise na base Scopus. Tendências Pesqui Bras Ciên Inf 2012;5. Available from: http://inseer.ibict.br/ancib/index.php/tpbci/article/view/71/113. [Last accessed on 2015 Mar 30]
13. Leta J. Brazilian scientometrics: From little to big? ISSI Newsl 2012;8:34-37.
14. Mattos AM. Job I. A produção científica brasileira no periódico Scientometrics de 1978 até 2006. Encontros Bibl Rev Eletrônica Biblioteconomia Ciên Inf 2008;13:47-61.
15. Egghe L. Ravichandra Rao IK. Classification of growth models based on growth rates and its applications. Scientometrics 1992;25:5-46.
16. Oliveira SMde. Aplicações e limitações dos processos bibliométricos. Rev Bras Biblioteconomia Doc 1984;17:55-65.
17. Araújo CA. Bibliometria: Evolução histórica e questões atuais. Em Questão, PortoAlegre 2006;12:11-32.
18. Hayashi MCPI. Hayashi CRM. Silva AM. Maycke Yde. Um estudo bibliométrico da produção científica sobre a educação jesuitica no Brasil colonial. Biblios 2007;8:1-18.
19. Fiuza MM. Considerações sobre o uso de estudos bibliométricos na formação de coleções básicas. Rev Esc Biblioteconomia UFMG 1978;7:59-68.
20. Price JDdeS. Diseases of science. In su: Science since Babylon. Enlarged edition. New Haven and London: Yale University Press; 1975. p. 161-195.
21. Schneider AM. Four stages of a scientific discipline: Four types of scientist. Trends Biochem Sci 2009;34:217-223.
22. Engels F. Dialectics of nature. 3rd rev. ed. New York, International Publishers; 1968.
23. Livro verde da Sociedade da informação no Brasil. Takahashi T. organizador. Brasília : Ministério da Ciência e Tecnologia, 2000.
24. Mueller SPM. Estudos sobre comunicacao e informacao cientifica na Ciencia da Infomacao. In: VIII ENANCIB: Encontro Nacional de Pesquisa em Cienica da Informacao: 28 a 31 October, Salvador, Bahía, Brasil, 2007.
25. Lucas LOde. Comunicación personal, 2013.
26. Bourdieu P. Structure, habitus, power: Basis for a theory of symbolic power. In: Dirks NB. Eley G. Ortner SB. editors A reader in contemporary social theory. Princeton, NJ : Princeton University Press; 1994. p. 155-182
27. Lima LS. Soares CF. Oliveira EFTde. Investigação da produção científica no tema "estudos métricos" na Base de Dados Brapci: Uma análise bibliométrica. Rev EDICIC 2011;1:299-310.
28. Kumar A. Prakasan ER. Mohan L. Kademani BS. Kumar V. Bibliometric and scientometric studies in Physics and Engineering: Recent ten years analysis. In National Conference on "Putting Knowledge to Work: Best Practices in Librarianship". 1-2 May 2009.
29. Patra SK. Bhattacharya P. Verma N. Bibliometric study of literature on bibliometrics. DESIDOC Bull Inf Technol 2006;26: 27-32.
30. Egghe L. A theory of continuous rates and applications to the theory of growth and obsolescence rates. Inf Process Manage 1994;30: 279-292.
31. Gilbert GN. Woolgar S. The quantitative study of science: An examination of the literatura. Sci Stud 1974;4:279–294.
32. Braun T. Lyon WS. Bujdosó E. Literature growth and decay: An activation analysis résumé. Anal Chem 1977;49:682A-688A.
33. Urbizagástegui Alvarado R. Restrepo Arango C. La bibliometría, informetría y cienciometría en el Brasil. XIV Encontro Nacional de Pesquisa em Ciência da Informação (ENANCIB 2013) GT 7: Produção e Comunicação da Informação em CT&I. Anais. 2013.
34. Miguel S. Dimitri PJ. La investigación en bibliometría en la Argentina: Quiénes son y qué producen los autores argentinos que realizan estudios bibliométricos. Inf Cultur y Soc 2013; 29:117-138.

35. Holt CC.; Schrank WE. Growth of the professional literature in economics and other fields, and Some Implications. Am Doc 1968;19: 18-26.
36. Urbizagástegui Alvarado R. Lane-Urbizagastegui S. El crecimiento de la literatura sobre plantas medicinales del Perú. Rev AIBDA 2008;29. Available from: http://132.248.9.34/hevila/RevistaAIBDA/2008/vol29/no1-2/4.pdf. [Last accessed on 2015 Mar 30]
37. Brookes BC. Numerical methods of bibliographical analysis. Libr Trends 1973;22:18-43.
38. Menard HW. Science: Growth and Change. Cambridge, Mass.: Harvard University Press; 1971.
39. Price JDdeS. Quantitative measures of the development of science. Archives Internationales d'Histoire des Sciences. Quatrieme Annee 1951;14:86-93.
40. Price JDdeS. The exponential curve of science, Discovery 1956;17:240-243, 1956. Reprinted in: Barber B. Hirsch W. editors. The sociology of science New York: The Free Press of Glencoe; 1962. p. 516-524.

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Appendix A: Search terms

Brazil
h-Index
Elitism
Research front
80/20 rule
Obsolescence of literature
Growth of literature
Half-life
Epidemic theory
Visibility
Pratt index
Price index
Immediacy index
Price law
Bibliometric indicators
Scientometric indicators
Goffman's law
Bradford's law
Lotka's law
Zipf's law
Transition point
Invisible colleges
Impact factor
Immediatism factor
Citation analysis
bibliographic coupling
Co-citation
Social networking
Co-authorship
Scientific collaboration
Collaboration index
Circulation of the collection
Core journals
Science and technology indicators
Bibliometrics
Scientometrics
Informetrics
Patentometrics
Bio-bibliometrics

Appendix B: Databases searched

BRAPCI
Plataforma Lattes
Scielo Brasil
LICI (IBICT)
PERI: Base De Dados De Periodicos (UFMG)
DEDALUS: Banco De Dados Bibliograficos Da USP
SPELL: Scientific Periodicals Electronic Library
Biblioteca Virtual em Saude (Brasil)
Biblioteca Virtual da Universidad de São Paulo (Brasil)
Library Literature and Information Science Full Text
Library and Information Science Abstract
Library, Information Science and Technology Abstracts
Hispanic American Periodical Index
Article first
Science Citation Expanded Index
Web of Science
Scopus
JSTOR
Google
Google Scholar
ISOC
ICYT
Dialnet
INFOBILA (México)
Periodica
Redalyc
Scielo México
Scielo Venezuela
Scielo Colombia
Scielo Chile
Scielo Argentina
Scielo Bolivia
Portal del Ricyt
Agrícola
Biosis
CAB Abstracts
Medline
Anthropological Literature
Anthropological Index
Anthropology Plus

WorldCat and 120 bibliographic databases available in the University of California at Riverside