Open Digital Repositories
The Movement of Open Access in Opposition to the Oligopoly of Scientific Publishers

Ligia E. Setenareski[1], Walter Shima[2], Marcos Sfair Sunye[3] and Letícia M. Peres[3]
[1]*System of Library, Federal University of Paraná, Curitiba, Brazil*
[2]*Department of Economics, Federal University of Paraná, Curitiba, Brazil*
[3]*Department of Computer Science, Federal University of Paraná, Curitiba, Brazil*

Keywords: Information Technology, Marketplace Competitiveness, Market Structure, Open Digital Repositories.

Abstract: This paper shows how the market structure of scientific publications works and how the free-software movement and the open source code have expanded and generated new developments in a period of approximately twenty years, in opposition to an oligopolistic structure. The free-software movement did not happen by chance, and neither did its subsequent developments. Researchers, tired of contributing towards the production of scientific articles for private publishers, and also working as reviewers or taking part in editorial boards, launched many alternatives within the editorial market in clear opposition to the publishing industry, which has been making handsome profits on packaged periodicals sold to academic libraries. Some of these alternatives are: the Copyleft and the Creative Commons in opposition to the Copyright; the Open Access and the Open Digital Repositories of educational and research institutions, freely available on the internet, opposing to the closed repositories of commercial publishers that offer their database at high prices; and the creation of h-index, g-index, Google Scholar Citations (GSC) and other impact measurements that come up against the impact factor controlled by private publishers. In the editorial process, while educational and research institutions, through their researchers, provide all workforce necessary for the production, arbitration and editorial board, publishers are in charge of organizing services, providing reliable browsing on their closed database, and keeping high levels of impact for their publications. Nowadays, search providers like Google also offer reliable search engines to browse open digital repositories. Therefore, Google and the Open Digital Repositories, in a symbiotic relationship, can be in charge of the whole process of scientific publication, as an alternative to oppose the oligopoly of scientific publishers.

1 INTRODUCTION

The global market of scientific publishers is characterized by an oligopolistic structure that retains their collections of periodicals in closed digital repositories. Readers normally have access to content by means of academic libraries, which pay monopoly prices for subscriptions, usually in packages of titles of periodicals or through the purchase of individual articles whose prices are also too high. The main barrier to entry is the impact factor, which is a global measure to evaluate scientific production, of periodicals published by a dominant group.

Generally, publishers control the entire process of publication, distribution and the impact index of their product in this oligopolistic market. Authors participate in the editorial process for free and transfer their copyright to publishers. On the margins of this market there are small publishers that, due to the size of the barriers, are specialized in the publication of specific areas of knowledge (niches). All the competitive dynamics of this market occurs on the internet. The search for articles in these repositories can be done through specific search engines, owned by publishers. In addition, open technological standards have been responsible for positive network effects on the spill over.

On the other hand, in an extra-market dynamics, which is open, public, and does not involve any barriers to entry, there are open digital repositories, built and maintained by educational and research institutions throughout the world, as a tool to publish, store and retrieve periodicals and articles produced by academic communities. The emergence of these repositories represent the development of

Setenareski, L., Shima, W., Sunye, M. and Peres, L.
Open Digital Repositories - The Movement of Open Access in Opposition to the Oligopoly of Scientific Publishers.
In *Proceedings of the 18th International Conference on Enterprise Information Systems (ICEIS 2016) - Volume 2*, pages 583-593
ISBN: 978-989-758-187-8
Copyright © 2016 by SCITEPRESS – Science and Technology Publications, Lda. All rights reserved

the free-software movement, which was led by scientists who were seeking alternatives against the business model of publications imposed by the oligopoly. Thus, in spite of not being guided by market logic, repositories are an important alternative to oppose major commercial publishers, since they have been taking an increasing part of their market. In other words, the repositories, which have a purely scientific perspective, end up competing directly with huge commercial publishers as potential entrants that have increasingly become real.

Therefore, research institutions and universities, producers of scientific content, soon realized the benefits of using the digital repositories freely in order to get a global visibility of this content. This has been fully supported by Google that is highly interested in expanding its content to reach a greater number of users. Thereby, a network of repositories has been evolving, linked by protocols and with benefits such as visibility as well as the share of content available. This work aims to analyse the free-software movement, which has created alternatives for the publication of scientific content, out of the oligopoly of big publishers. The methodology adopted in this study, since the theme has a worldwide scope, was to research the literature available, considering specific and related topics of analysis. The period of time delimited for the search was between the second half of 1980 until mid-2013.

2 NETWORK EXTERNALITIES

The companies or institutions that adopt standards and technologies may, consequently, have the effects of network externalities. The network, whether real or virtual, has a fundamental economic characteristic, which is the dependent value of the number of people who are already connected to them. The proposition of a network value may be named as follows: network effects, network externalities or economies of scale on the demand side. The externalities arise when a market participant affects others without the payment of compensation (Shapiro and Varian, 1999). The network externalities are fundamentally based on Metcalfe's Law, (a well-known law in the field of Information Technology, created by Robert Metcalfe, the co-inventor of Ethernet and the founder of 3Com) “the value of the network is proportional to the square of the number of users.” Externalities have two poles: negative and positive. The positive feedback strengthens the strong competitor and weakens the weak one, leading to extreme results such as market dominance by a single company or technology. In other words, success breeds success and failure breeds failure, which is the essence of the positive feedback (Shapiro and Varian, 1999). The positive feedback and the network externalities have been considered essential for the communications and transportation sectors for a long time where companies need to compete to expand their network, and a network can dramatically increase the market value of these companies by being interconnected to another network. The opposite pole of the positive feedback is the negative feedback. When a process of negative feedback occurs, the strong competitor becomes weak, and the weak competitor becomes strong; both being pushed into a middle ground (Shapiro and Varian, 1999).

3 THE MARKET STRUCTURE IN AN OLIGOPOLY

An oligopolistic market is composed of few firms that hold substantial portions of the market, which only perpetuates through barriers to entry, such as: patents, distribution channels, economies of scale and capital, pricing levels, and product differentiation. Although the barriers to entry have been depicted in the literature for nearly 80 years (Possas, 1999), the nature and extent of these barriers only succeeded in terms of analysis after a study carried out by (Bain, 1956). That study (Bain, 1956) resulted in valuable contributions, such as: the introduction of a dynamic perspective regarding the analysis of markets; the realisation that firms in oligopoly take the external or potential competition into account for their strategy; and a demand for a redefinition of the conventional instruments of analysis in order to suit them to a long-term perspective. Furthermore, considering specifically the price as a barrier to entry, suggests measuring the level of this barrier through a markup, i.e., the relation between the highest price that prevents the entry, or the minimum price that allows the entry, and the competitive price.

This measure can assess how established firms can raise prices, above the competitive price, without letting new firms enter the market. In turn, (Possas, 1999) it is possible to establish a theoretical relation between prices and barriers to entry, in a generic way, since the desire to prevent the entry is a pricing strategy of firms that are established in the

market. This pricing strategy has two objectives: 1) to fix prices and to establish the production volume in order to prevent the competition with small and medium-sized entrants, or at least to limit this kind of competition, seeking to enhance distribution over time; 2) to discourage the competition with big entrants that intend to establish themselves more efficiently in terms of scales, which would threaten the oligopolistic equilibrium and, hence, generate a price war among established firms. However, this kind of discouragement may not be necessarily tied to price set by the market.

3.1 The Market Structure of Scientific Publications

Although the market of scientific publications, especially the market of periodicals, is dominated by few large global publishers that establish all kinds of barriers to entry, there are on the sidelines of this market over 2,000 small publishers specialize in different areas of knowledge, and which meet a specific and specialized audience (McGuigan and Russell, 2008). In this global market, global publishers, through their sales representatives, sell their periodicals all around the world and, therefore, control the distribution channels. The target market of these globalized publishers is the libraries and the researchers from academic communities, universities and research institutions. Researchersplay an important role in this partnership, since the publication of scientific periodicals is only possible with the participation of researchers as authors or reviewers of other researchers' papers, which is called peer review or refereeing. Researchers can also take part in the editorial board. This kind of work is usually free of charge for publishers, who later sell such periodicals to libraries.

3.2 Types of Barriers to Entry

In this market structure, the barriers to entry are organized as follows: a) the authors transfer their copyright to publishers and, for this reason, are obliged to pay for the access of their published content; b) the readers who are not members of any academic community, which provides the access to a library, cannot afford any content, given the prices charged for single articles; c) potential entrants cannot enter the market because the established firms control the distribution channels, sell their periodicals in packages to libraries, and control the impact factor of publications. Not only does the academic community read the content of these periodicals but also cite them, ensuring an increasing positive impact factor for these periodicals, which hinders the entry of new periodicals from potential publishers with low impact.

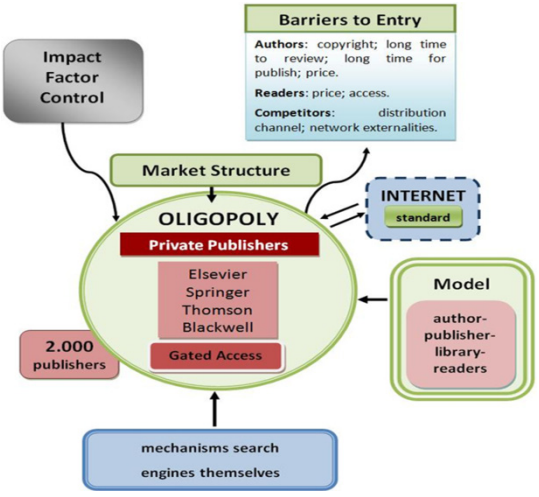

Figure 1: The structure of closed digital repositories in the market of scientific publications.

A report of the European Commission emphasizes that the main barrier is still the ability of new journals to attract a group of publishers, reviewers and authors. Even when a new journal can attract a selected group of distinguished scholars, it is going to take time for it to be recognized since its reputation has not been established yet. Secondly, even if the entry of new periodicals is facilitated, the access to the stock of knowledge is historically controlled by publishers; partly because they own the copyright of authors (European Commission, 2006). Figure 1 above illustrates the structure of closed digital repositories in the market of scientific publications, as described before.

3.3 The Market Structure of Scientific Publishers

The market of scientific publications is divided into non-profit and for-profit publishers. Some examples of non-profit companies, associations and universities are the Institute of Electrical and Electronics Engineers (IEEE), the Association for Computing Machinery (ACM) and the Oxford University Press. For-profit publishers dominate this market. The journal business is characterized by a relatively inelastic demand, with individual journals that usually have strong support within their particular niche. The market natural niche and the rapid growth of budgets for academic libraries

resulted in the expansion of the market of scientific publications, in such a way that no other market has grown so fast in the media industry over the last fifteen years (Morgan Stanley, 2002). North-American university libraries represent about 60% of the global market of an industry of $ 7 billion dollars, in which Reed Elsevier (Elsevier Science) is the market leader. Along with Elsevier, five other publishers - Wolters Kluwer, Blackwell, Bertelsmann, Wiley, and Taylor & Francis - account for 37% of the best-rated periodicals and 44% of published articles.

The academic publication depends on an unusual economic model, in which the necessary input (articles and editorial services) for the publishing business is provided at no cost. The situation is even more unusual since colleges and universities, which purchase journals, partially subsidize the production of journals by paying the salaries of teachers, authors and publishers. Publishers have a mediatingrole in the industry. They collect, pack and disseminate articles produced by academic authors.

The main users of journals are the same group that produced their content, i.e., the academic teaching staff. Thus, the content is consumed by professors / researchers, who produce more content, and the cycle goes on. Academic libraries acquire and provide access to journals. They work as agents for both the academic staff, who demand certain provide access to journals. They work as agents for both the academic staff, who demand certain journals, and the university administrators, who provide the budget for the purchase of volumes.

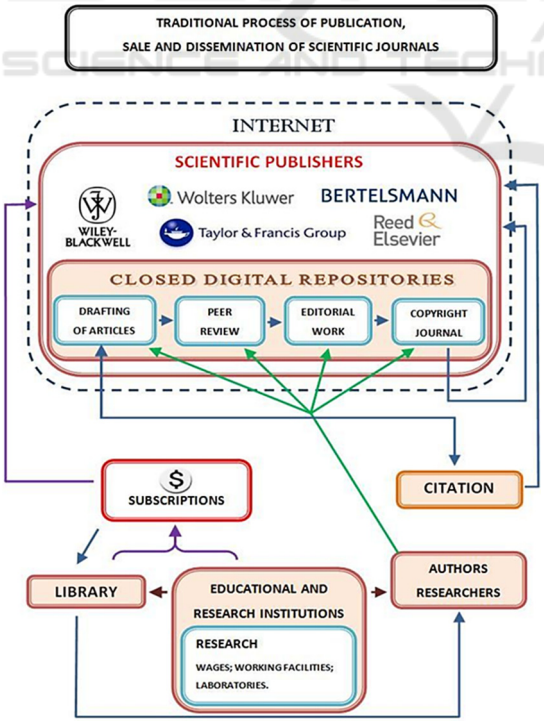

Figure 2: The traditional process of publication, sale and dissemination of scientific journals.

Thereby, considering that publishers act just as intermediaries between the production process and its dissemination, there has been an abusive charge for published articles (McGuigan and Russell, 2008). While the access to newspapers, such as The Times and The Sunday Times, is £ 1.00 for a period of twenty-four hours, in which the user has the right to read and download any articles, the cost to access a publisher's single scientific article is: Elsevier ($ 31.50), Springer (Euro 34.95) and Wiley-Blackwell ($ 42.00). Moreover, publishers perpetually retain the copyright of their publications (Monbiot, 2011). Figure 2 below illustrates how a traditional publication process of scientific journals is.

4 THE OLIGOPOLY OFSCIENTIFIC PUBLISHERS REGARDING THE IMPACT FACTOR

The market of publications of scientific journals is also characterized by the Impact Factor (IF), which is a measure that evaluates the quality of journals (Pritchard, 1969). Also known as Impact Index or Citation Index, the Impact Factor is published as a periodical by dominating publishers in this oligopolistic market. Only two major publishers, providers of the Impact Factor, concentrate the market of publications: Thomson ISI, which publishes the Journal Citation Reports (JCR), and Elsevier, which publishes the SCImagoJournal Ranking Indicator (SJR). Not only do these companies publish the Impact Factor of other major publishers, but also start to enter the market of open access publications. It is a hybrid model, in which dominant publishers accept open publications in their closed repositories (database) and provide the Impact Index of these publications. An example of this model is the Web of Science (WOS) database of Thomson Reuters that provides the Impact Factor through the JCR, which currently contains 12,000 journals, including open access journals such as PLoS One (Web of Science, 2013).

Another example of this model is the partnership formed in 2012 between Thomson and the Scientific Electronic Library Online (SciELO), which is the

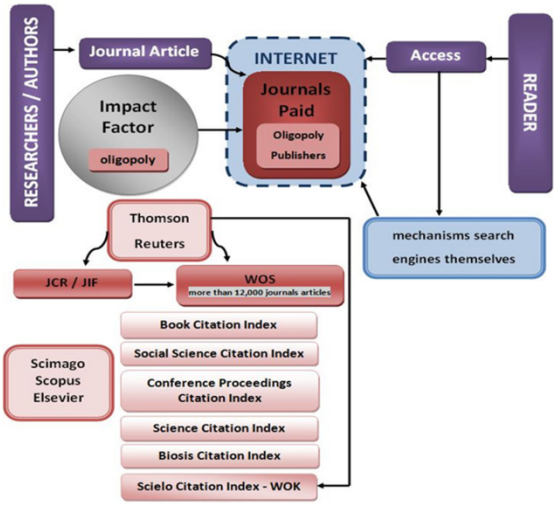

Figure 3: The Oligopolized Market of Impact Factors.

largest open digital repository in Brazil. Thomson hosted SciELO database in its repository, the Web of Knowledge. This partnership aimed to provide better visibility and access to research in emerging economies. Nowadays, SciELO publishes approximately 40,000 new articles every year in more than 900 open access journals in Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Mexico, Portugal, South Africa, Spain, and Venezuela. It also provides 650 titles and more than 4 million cited references at the database WOS, which originated the SciELO Citation Index (Thomson Reuters, 2013). With this partnership, SciELO started using the Impact Factor from Thomson in its repository, provided by JCR. Regarding the metric used by Thomson, the Impact Factor can only be established after two years of publication; hence, as from 2014, SciELO begins to obtain conclusive results relative to the number of citations in its publications. Thus, the Brazilian Research Council (CAPES - Coordination of the Qualification of Higher Education Personnel), uses the metric of Thomson to assess the scientific production.

Another relevant aspect of this competitive dynamics, taking the Impact Factor into account, refers to network effects that act as barriers to entry. For instance: researchers from universities and research institutions throughout the world need to publish the outcome of their work, since it is indicative of quality for future professional assessments. The higher the Impact Factor of journals is, the greater the likelihood of obtaining a favourable assessment and posterior career opportunities is. This kind of incentive does generate positive network externalities, which favour publications in journals by dominant publishers. In addition, the publication of an article in a journal with a high Impact Factor will certainly cause this article to be read and cited more, which will ultimately contribute towards the author's Impact Index as well. Figure 3 above illustrates the market of Impact Factors, controlled by the major publishers of closed repositories; the researchers who need to publish the outcome of their research; the metrics that are used for the analysis of citations; and the search engines owned by major publishers, responsible for seeking content.

4.1 The Dynamics of Prices for Publications in an Oligopoly

The report by the European Commission shows that the scientific publications have become a significant global economic activity and the core of the editorial market (science, technology and medicine) is estimated between $ 7 and 11 billion. The price of scientific journals, which has increased considerably, has been a constant topic of discussion over the past 30 years. In the period between 1975 and 1995, which is known as 'the crisis of periodicals', journal prices have increased by 200% to 300% above inflation. The price rise was followed by a reduction in the number of subscriptions by researchers and libraries. Journal prices far exceeded the natural evolution of the library budgets and such a pressure resulted in the decrease of journal subscriptions. As of 1995, as a result of the evolution of the Information and Communications Technology (ICT), publishers started to adopt the digital distribution and provide access to their journals online through high performance research platforms (European Commission, 2006).

Consequently, new technologies and the Internet have enhanced the accessibility of scientific publications by, but the actual access to literature still depends on the capacity of the libraries to afford subscriptions. Journal prices have risen faster than inflation, but at a slower pace in comparison to the previous 20 years. The digital distribution has allowed the introduction of new business models, which resulted in significant changes in pricing policies on periodicals. Individual prices and the sales of journals were transformed into "Big Deals", i.e., the sales of packages of journals, whose prices vary from place to place, can also range from annual subscriptions to licenses that last for several years. Then, the libraries started to join together as a group in order to form a consortium so they could share the benefits of access and improve their bargaining positions against publishers. In general,

packaging has two effects: a) it can narrow or broaden the consumers' choice in the short term, and b) it can restrict entry in the long term (European Commission, 2006). In his blog (Gowers's Weblog, 2012), William Timothy Gowers, a British mathematician and Professor at Cambridge University, the winner of the Medal 'Fields' of the American Mathematical Society, criticized the commercial practices of Elsevier. He firmly states that he will no longer take part in publications and condemns the business practices of Elsevier: a) prices are too high, far above average; b) There are tying sales (a practice condemned by the antitrust law), which force libraries to purchase a package without being given the choice to choose the journals they want to subscribe. The libraries, which survive on a tight budget and, therefore, cannot afford a reasonable number of subscriptions, are not the only sufferers in this market. Other publishers have also suffered its effects, which is, of course, part of the motivation for the scheme c) if libraries try to negotiate better deals, Elsevier remains implacable in its opposition, threatening to cut the access to all its periodicals; and d) Elsevier supports measures such as: the Research Works Act, an American bill that tries to stop the Open Access movement for researches financially supported by the federal government. Furthermore, Elsevier supports the Stop Online Piracy Act (SOPA) and the Protect IP Act (PIPA), having exerted pressure on their existence.

Gowers's boycott against Elsevier began to spread in the academia and on February 4, 2012, The Economist called this movement Academic Spring (The Economist, 2012).The Cost of Knowledge is a site where researchers can enter to boycott Elsevier by checking the services they intend not to provide. These services are: Publication, arbitration or editorial work. Nowadays, 13,832 researchers from all areas of knowledge and from several parts of the world have already signed the boycott (The Cost of Knowledge, 2013).

4.2 The Open Access Movement for the Publication of Scientific Content in Opposition to Traditional Publication

A new initiative to share open academic journals for free through repositories emerged from the free-software movement, the creation and subsequent availability of technological standards, and the creation of software for interoperable open repositories. This initiative started from the late 90s as a worldwide movement, in which several countries, academic and research institutions, and funding agencies took part. This movement was named Open Access - OA and its main requirement was the right to have free access to scientific content from open repositories. This access was also thought to be free in relation to the restrictions imposed by the copyright. The issue of open access to scientific information has led some countries to discuss the regulation for the implementation of institutional repositories. In addition, researchers from all fields of knowledge will probably face a change of paradigm while major publishers will have to take into account unavoidable changes in their policies (Carvalho, 2009).

In the OA model, the process of scientific publication, especially periodicals, occurs as follows: a) the institutions take charge of the necessary conditions for their researchers by paying their salaries and keeping adequate physical facilities such as furniture and equipment as well as laboratories and digital repository; b) the researchers/authors are responsible for activities related to articles, peer review and the editorial process for the publication in the open repository; c) libraries deal with the maintenance and recovery of content kept in a repository, which provides support to researchers in relation to the dissemination of content, and also provides a better use of this informational resource available. Thereby, researchers, who are also the main readers, will read, cite and produce new texts, continuing the process. In this model, all articles are available in creative commons or copyleft licenses instead of copyright, which will give the authors the right to retain their copyright, without any transfer. In other words, the institutions along with their libraries and the academic community will be in charge of the whole process, without the involvement of oligopolized publishers as intermediaries in the organization of editorial activities and dissemination of content, as illustrated in Figure 4.

The adoption of open standards and the OA movement were instrumental in the development of software for digital repositories that emerged after the arXiv, the first open repository (Luce RE, 2001) that represents a philosophy of publication within the free-software movement. By allowing service providers and search providers scan their database, the open repositories have fostered the emergence of tools that allow measuring the impact of publications within these repositories, out of the oligopoly of traditional publications. Nowadays, the system of electronic journal management and the system of

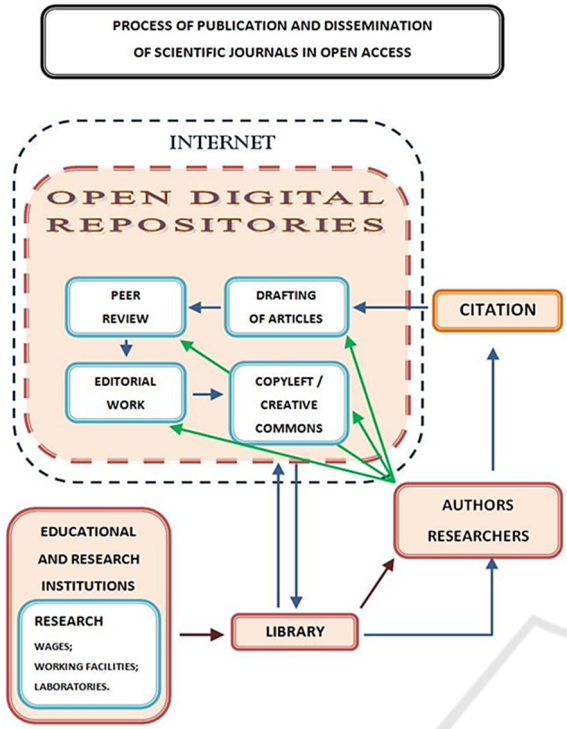

Figure 4: The process of publication and dissemination of scientific journals in open access.

digital libraries more used are, respectively: OJS (www.pkp.org) and DSpace (www.dspace.org). They adopt open standards that facilitate the implementation of impact measurement.

4.3 H Index, G Index and Other Impact Factors out of the Oligopoly of Publishers

The term Impact Factor (IF) was created by Eugene Garfield in 1955 (Garfield, 2006).Over the years, it has been used generically as an impact index of citations, referring to an author's impact factor, for example, or any bibliographic material. The Citation Impact is the measurement of the number of citations in an article. The average citation impact by article can also be used for collections, authors, periodicals, institutions, etc. Until the early 2000s, there were only impact indexes controlled by closed commercial publishers in the market, but as of 2000, several other tools were created and made available in the market, as an alternative for researchers, publishers and institutions that need to assess the quality of publications.

Other databases that index quotes have emerged and are vying for the ISI space (Institute for Scientific Information/Thomson Reuters) in the business of information generation to measure the impact of scientific publications (Mugnaini and Strehl, 2008). Among these tools to measure impact, there are the Citebase, 2001 (Brody, 2003); the h index, 2005 (Hirsch, 2005), the G-Index, 2006 (Google Scholar, 2013), the GSC, and the GSM (Google Scholar, 2013). The software Publish or Perish was also developed and made available in the market. Besides being free of charge this software tracks and measures impact by using all the tools mentioned above (Publish or Perish, 2013).

The arXiv, as well as other open digital repositories that have emerged after it, represent alternative tools that are used for the publication of scientific production in universities and research institutions around the world. Due to these tools, thousands of researchers around the world were able to show the outcome of their work openly and free of charge. Similarly, the dissemination of content from repositories was made by service and search providers. The increase in the visibility has led some researchers to develop tools to measure the impact of content in the academia. All these impact metrics show the concern and the efforts of many scientists at creating new alternatives as well as making them available in the market for free, opposing to traditional measurements of impact controlled by scientific publishers. Thus, open repositories along with free search engines and impact indexes free of charge have spread globally.

Figure 5 illustrates the open market of impact indexes, created as an alternative to the impact factor controlled by the oligopoly; the relationship between this market and the researchers, who need to publish the outcome of their work; the relationship between this market and the repositories, where these metrics are used for the analysis of citations; and also the

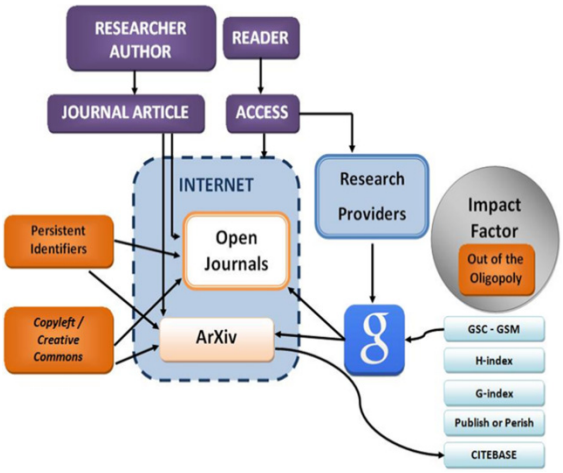

Figure 5: The open market of impact index.

relationship with Google, responsible for searching the content to be analysed.

4.4 The Impact Index of Private Publications versus Public Publications

The outcome of the comparisons between the impact of open and closed publications, including the metrics used for these comparisons, is still very incipient. The studies that will be discussed below refer to specific analyses such as: the comparison of the impact of publications, both in the repository of Thomson and ArXiv; the boycott in which researchers take part against the impact factor of Thomson; and the ranking of open publications measured by Google.

The Internet, as an open database, is allowing users to generate statistics of citation of researches published free of charge (Butler, 2008). The Open access is cooperating with giants like Elsevier, inserting data from its publications on Scopus base, a database of abstracts created by Elsevier in 2004. Elsevier also owns the database The SCImago Journal & Country Rank that makes the analysis of data stored in the Scopus, concerning the data mining from the universities of Granada, Extremadura, Carlos III and Alcalá de Henares, all in Spain. This database classifies periodicals and countries that use citation metrics such as H Index, and also includes a new metric: the SCImago Journal Rank (SJR). It is difficult to compare the results of the analyses of SJR with other impact factors because their database is different.

And, on the other hand, Google Scholar has already indexed much more from the literature than the Web of Knowledge or Scopus (Butler D, 2011). Thomson holds a monopoly on the number of citations per year and its subscription products include the Web of Science, the Journal Citation Report, and the Essential Science Indicators. However, researchers are negotiating with Thomson, requesting greater transparency on how the citation metrics are calculated and on its datasets as well (Butler D, 2008). In an editorial published in the Journal of Cell Biology, the head of Rockefeller University Press and colleagues said that their analysis of database provided by Thomson showed different values for the metrics in comparison to those published by this company (Rossner M, Van Epps H, Hill E, 2007). And Thomson opened a web forum to formally respond to this editorial (Thomson Reuters, 2014).

In 2004, James Pringle, vice president for development, academic markets, and government of Thomson ISI, USA, conducted a study on the impact factor of the entire content of Web of Science, concerning closed and open access. At that time, the base had 8,509 closed access journals and 191 open access journals (Harnad and Brody, 2004). A rigorous selection was made in this study and only the journals that were directly accessible on the Internet, without any cost, fitted the concept of open access. Among them there were different types of journals, such as: the BMJ, with a long history and prestige that migrated to this new model of open publication; and the Brazilian Journal of Microbiology, an important regional journal that uses open access as a way to expand global awareness. There are several ways to make the access open and the objectives of each publisher can be different (Pringle, 2004). The outcome of this study points out that the open access does neither result in more nor fewer citations in these journals, since the increase in the number of readers of journals does not change the relevance of a researcher's article and its fundamental value in a journal. Moreover, it does not seem that the increase in the number of potential readers will necessarily change a journal impact.

However,two researchers disagree with Pringle when he says that open access journals and non-open access journals have the same impact. According to these authors, the comparison was made between only 2% of OA journals indexed by the ISI (191), against 98% of non-OA journals (8,509)(Harnad S, Brody T,2004). New study was made using the citation database ISI, on a CD-ROM, with references of 7,000 journals from 1991 to 2001 and the content of arXiv.org. The CD-ROM ISI had the metadata and references of 14 million articles, and the arXiv.org base, in January 2004, had 260,000 complete texts of e-prints. From this amount, 95,012 articles were found both in the ISI and arXiv database. The comparison between Open Access and Non-Open Access articles, in all Physics fields, from 1992 to 2001, showed that the superiority of Open Access Citation Impact Ratios, increases from 253% in 1992, to 557% in 2001(Brody et al., 2004). The access is not a sufficient condition for citation, but it is necessary. The OA dramatically increases the number of potential users by just allowing them to access a particular article, which otherwise would not be possible due to its high cost. Thereby, the OA increases both the use and the impact (Harnad and Brody, 2004).

On December 16, 2012, during the annual meeting of the American Society for Cell Biology (ASCB), the San Francisco Declaration on Research Assessment, (known as DORA), was presented and signed by more than 150 researchers and 75 academic institutions such as the American Association for the Advancement of Science. This declaration was a response to the urgent need to improve the ways in which the production of scientific research is assessed by development agencies, academic institutions and other parties. As a general recommendation, the metrics based on journals, such as Journal Impact Factors (Thomson Reuters), should neither be used as a measure of quality of individual research articles, nor in decisions related to hiring, promotion and funding (DORA, 2012).

Another source of tension between publishers and researchers is the lack of access to database of journals, even for those who have paid for it. On 22 May 2013, researchers and librarians withdrew from the European Commission's negotiations on this subject because the publishers, supported by the copyright, did not allow the access to their closed database. While researchers and librarians long to see thousands of articles and research content online through closed or open access, perform data extraction, build a single research database, and establish association standards, e.g., between genes and diseases, the publishers, in turn, fear that their content may be redistributed for free, which makes them block search programs, even for institutions that have paid for the access to their database (Van Noorden, 2013). For these reasons, publishers begin to realize that the market is changing and that the alternative of open access is breaking the barriers to entry, regarding the publication, the distribution, the dissemination, and the access of scientific journals by readers, as well as the impact factor of these journals.

5 CONCLUSIONS

This paper analyses how the market structure of scientific publications work and how open digital repositories have become a viable alternative to rebalance this market. In fact, the symbiosis between the services provided by major search engines and the ideals espoused by the open access and free-software movements have created an environment that is so favourable that the scientific market behaviour has completely changed in less than 15 years. These movements have emerged from the establishment of major search engines as a centralizing element to recover scientific papers, ensuring the recovery of relevant information through an exhaustive scan of the Web. At the same time, open access movements, originated by free-software movements, have provided the scientific community with high quality software for content file. Academic institutions promptly began to create large repositories of high quality scientific content.

Subsequently, the open file software has established interoperability standards of scientific files that were quickly assimilated by major search engines. Through these new standards, major search engines not only add visibility to open scientific content, but also decode and highlight this content, through open standards of large repositories, which are managed by the academic community. The third and last movement sets new impact indexes that are measured through all scientific data available on the Internet opposing to the traditional impact indexes controlled by the oligopoly of major publishers. The process of generation, retrieval and classification of scientific information, which was a privilege of publishers for more than a century, began to be carried out on the open internet. Such a system deals with a vast amount of scientific information provided free of charge by major academic institutions.

On the other hand, the oligopoly of publishers still has the full power over the market of scientific publication as follows: a) publishers own the authors' copyright - regarding the oligopoly of periodicals, the copyright is transferred from authors to the publishers when an article is accepted for publication, though there are some differences in concept, legislation and treatment from one country to another; b) publishers control the distribution channels - sales representatives throughout the world sell their packages of periodicals to their most important customers, the academic libraries; c) the libraries provide these periodicals to researchers, promoting their use; d) researchers read the content of periodicals and cite them; e) publishers obtain a high rate of citations for their periodicals.

Thus, the control cycle is closed in regard to the publication of journals and the citation impact. In the future, the repositories will probably change this traditional model in which publishers fulfil both functions of certification and dissemination. The certification of periodicals is currently done through editorial work and peer review while their dissemination is achieved through search providers like Google.

It is fundamental, however, the analysis of new

studies on open digital repositories in order to contribute towards this paper, such as: a) a study on an eventual lock -in of technologies linked to open digital repositories, due to technical, economic and institutional aspects. This could adversely affect the storage and availability of digital content; b) Analyses of public policies on storage and access to digital scientific content stored on open digital repositories, with a focus on technical, political and economic interests. These interests involve technological standards, trajectories of storage, and distribution technologies of digital content; c) An evaluation of the social impact on open digital repositories regarding research development and the number of published papers by researchers from underdeveloped or developing countries; d) a survey on incentive measures for innovation that are promoted by the free access to scientific literature of open digital repositories, and posterior assessment of these measures. This study shows that the visibility of open repositories and their growing impact index have demanded an efficient and neutral search engine to provide the necessary information. Any change in this current business model of search engines, or in the concept of Net Neutrality will influence the OA community. The analysis of this study is vital and so is the establishment of new paths for the development of open repositories, if the concept of net neutrality is reassessed.

REFERENCES

Shapiro C, Varian HR (1999) *A economia da informação*: como os princípios econômicos se aplicam à era da internet. Rio de Janeiro: Elsevier. 397 p.

Possas ML (1990) *As estruturas de mercado*: primeira aproximação (2nd.ed.). São Paulo: Hucitec. pp.87-191.

Bain JS (1956) *Barriers to New Competition*. Cambridge: Harvard University. 329 p.

McGuigan GS, Russell RD (2008). The business of academic publishing: a strategic analysis of the academic journal publishing industry and its impact on the future of scholarly publishing. E-JASL: *Electronic Journal of Academic and Special Librarianship* 9: 1-11.Available:http://southernlibrarianship.icaap.org/content/v09n03/mcguigan_g01.html. Accessed 2 May 2013.

European Commission (2006) Study on the economic and technical evolution of the scientific publication markets in Europe. *Final Report*. European Commission, Bruxelles.

Morgan Stanley (2002) *Scientific publishing: knowledge is power*. Available: http://www.econ.ucsb.edu/~tedb/Journals/morganstanley.pdf. Accessed 6 July 2013.

Monbiot G (29 Aug. 2011) How did academic publishers acquire these feudal powers?*The Guardian*. Available: http://www.monbiot.com/2011/08/29/the-lairds-of-learning/. Accessed 8 september 2013.

Pritchard A (1969) Statistical bibliography or bibliometrics?Journal of Documentation 25: 348-349.

Web of Science (2013). Available: http://thomsonreuters.com/web-of-science/. Accessed 8 september 2013.

Thomson Reuters (2013). Available: http://thomsonreuters.com/. Accessed 6 July 2013.

Gowers's Weblog (2012) Available: http://gowers.wordpress.com/2012/01/21/elsevier-my-part-in-its-downfall/. Accessed 2 September 2013.

The Economist (4 Febr. 2012) *The prince of information*: academics are starting to boycott a big publisher of journals.Available:http://www.economist.com/node/21545974. Accessed 7 September 2013.

The Cost of Knowledge (2013). Available: http://thecostofknowledge.com/. Accessed9september 2013.

Carvalho MMGR (2009) *O repositório aberto*: recuperar, preservar e difundir o conhecimento "em qualquer lugar do mundo". Dissertation, Universidade Autônoma de Lisboa.

Luce RE (2001) E-printsintersectthe digital library: insidethelos Alamos arXiv. *Issues in Science and technology Librarianship*, 29. Available: http://webdoc.sub.gwdg.de/edoc/aw/ucsb/ist1/01-winter/article3.html. Accessed 31 May 2013.

Garfield E (2006) The history and meaning of the Journal Impact Factor. *JAMA:The Journal of the American Medical Association* 295: 90-93. Available: http://jama.jamanetwork.com/Issue.aspx?journalid=67&issueID=5006&direction=P. Accessed6January 2013.

Mugnaini R, Strehl L (2008) Recuperação e impacto da produção científica na era Google: uma análise comparativa entre o Google Acadêmico e a Web of Science. *Encontros Bibli*: n. esp.: 92105. Available:http://www.periodicos.ufsc.br/index.php/eb/article/view/1518-2924.2008v13nesp1p92. Accessed 30 May 2013.

Brody T (2003) *Citebase search*: autonomous citation database for e-print archives. Available: http://eprints.soton.ac.uk/260677/1/brody_sinn03_paper.pdf. Accessed 7 September 2013.

Hirsch JE (2005) An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Science* 102: 16569-16572. Available: www.pnas.org/cgi/doi/10.1073/pnas.0507655102. Accessed 30 May 2013.

Egghe L (2006) Theory and practice of the g-index.Scientometrics 69: 131-152.

Google Scholar (2013) Available: http://scholar.google.com.br/. Accessed 8 September 2013.

Publish or Perish (2013). Available: http://www.harzing.com/pop.htm. Accessed 7 September 2013.

Butler D (2008) Free journal-ranking tool enters citation market data base offers on-the-fly results. *Nature* 451:6.Available:http://www.nature.com/news/2008/080102/full/451006a.html. Accessed 9 September 2013.

Butler D (2011) Computing giants launch free science metrics. *Nature* 476:18.

Rossner M, Van Epps H, Hill E (2007) *Show me the data*. J. Cell Biol., 179: 1091-1092.

Thomson Reuters (2014) *The citation impact centre*.Available:http://scientific.thomson.com/citationimpactforum. Accessed 8 September 2014.

Harnad S, Brody T (2004) Comparing the impact of open access (OA) vs. Non-OA articles in the same journals. *D-Lib Magazine*10: 1-3. DOI: 10.1045/june2004-harnad.

Pringle J (19 Sept. 2004) Do open access journals have impact? *Nature Publishing Group*. Available: http://www.nature.com/nature/focus/accessdebate/19.html. Accesssed 5 September 2013.

Brody T, Stamerjohanns H, Vallières F, Harnad S, Gingras Y, Oppenheim C (2004) *The effect of open access on citation impact*. Available: http://eprints.soton.ac.uk/259941/1/OATAnew.pdf. Accessed 2 September 2013.

DORA.*Declaration on Research Assessment* (2012). Available: http://am.ascb.org/dora/. Accessed 8 September 2013.

Van Noorden R (2013) Tensions grow as data-mining discussions fall apart. *Nature: International Weekly Journal of Science* 498: 7452. Available: http://www.nature.com/news/tensions-grow-as-data-mining-discussions-fall-apart-1.13130. Accessed 22 September 2013.

SCITEPRESS
SCIENCE AND TECHNOLOGY PUBLICATIONS