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Article

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Patents and technological development in the context of Open Science: perspectives on the influence of informational secrecy and proprietary research

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RESUMO

Introduction: This article proposes a bibliographic review regarding the patenting of knowledge in the context of Open Science, addressing the different perspectives on the influence of informational secrecy and welcoming research. The question of how secrecy interferes with the open sharing of knowledge and the importance of registering patents for the development of science. Objective: It aims to point out the importance of patents in technological development and discuss the relationship between open innovation and Open Science and patents in the context of universities. It is justified by the absence of works on patents in the context of Open Science within the scope of Brazilian information science. Methodology: The methodology adopted searched the literature for relevant subjects through searches in the BRAPCI and WoS databases. Results: It was observed that the open practices proposed by the Open Science movement and the technology and patents resulting from more closed practices are not antagonistic but complement each other as researchers interact and build knowledge collaboratively, such as the collaboration between Universities and companies also represent a form of openness. Conclusion: It concludes that patents are essential tools for technological development; the secrecy required by the patenting process restricts information sharing, proprietary research grows in the university context and proves relevant in research funding, so a balance must be sought between Open Science and proprietary science.

KEYWORDS

Patents. Open science. Technological development.

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As patentes e o desenvolvimento tecnológico no contexto da Ciência Aberta: perspectivas da influência do sigilo informacional e da pesquisa proprietária

ABSTRACT

Introdução: O presente artigo propõe uma revisão bibliográfica a respeito do patenteamento do conhecimento no contexto da Ciência Aberta, abordando as diferentes perspectivas da influência do sigilo informacional e da pesquisa proprietária. Questiona de que forma o sigilo interfere no compartilhamento aberto do conhecimento e qual a importância do registro de patentes para o desenvolvimento da ciência. Objetivo: Objetiva apontar a importância das patentes no desenvolvimento tecnológico, discutir a relação entre inovação aberta e Ciência Aberta e as patentes no contexto

das universidades. Justifica-se pela ausência de trabalhos sobre as patentes no contexto da Ciência Aberta, no âmbito da ciência da informação brasileira. Metodologia: A metodologia adotada buscou na literatura discussões pertinentes por meio de buscas nas bases BRAPCI e WoS. Resultados: Evidencia-se que as práticas abertas propostas pelo movimento da Ciência Aberta e a tecnologia e as patentes resultantes de práticas mais fechadas não são antagônicas, e sim, se complementam à medida que os pesquisadores interagem e constroem o conhecimento colaborativamente, sendo que a colaboração entre as universidades e as empresas também representam uma forma de abertura. Conclusão: Conclui que as patentes são importantes ferramentas para o desenvolvimento tecnológico, o sigilo exigido pelo processo de patenteamento restringe o compartilhamento de informações, a pesquisa proprietária cresce no contexto universitário e se mostra relevante no financiamento de pesquisas, de forma que um equilíbrio deve ser buscado entre a Ciência Aberta e a ciência proprietária

PALAVRAS-CHAVE
Patentes. Ciência aberta. Desenvolvimento tecnológico.

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1 INTRODUCTION

Science has developed from paradigms that have changed over time. According to David (2008), in classical Greece, knowledge was solidified in separate schools of thought and opposed to collaboration between thinkers. This closed model continued throughout the Middle Ages, where political and religious perspectives kept knowledge hidden from the masses, contributing little to the concept of openness, even though some individuals considered it necessary to disseminate knowledge through manuscripts.

The 17th century saw a paradigm shift justified by the social relations established through the invisible colleges. These were made up of groups of researchers from different institutions who kept each other informed of the results of their research. These relationships marked the origin of scientific collaboration (Le Coadic, 1996; Meadows, 1999). Another change factor was the emergence of the first scientific journals, which allowed researchers to communicate formally more quickly and efficiently. Journals replaced the exchange of letters between scientists, a common informal practice in communicating research results until then.

For David (2008), collaborative research and the free sharing of knowledge define modern science, indicating that public knowledge is not a natural science attribute but a social construction. In this way, the changes brought about by the internet, which have made it possible to create and share large amounts of data and make it easier to access, have led to a new paradigm: open science, accessible to all.

Open Science is a disruptive global phenomenon that brings socio-cultural and technological changes. This model is based on connectivity and openness and treats open data tools, open access platforms, open peer review, and public engagement, among others, as irreversible trends. Government organizations worldwide recognize Open Science as a great ally in facing current challenges, such as climate change, public health, and sustainable food production (Vicente-Saez and Martinez-Fuentes, 2018).

According to Silveira (2014), Open Science promotes the practice of free licensing of technologies, which can run counter to intellectual property, an established protection practice that guarantees the developer of a given technology the right to exploit it commercially. This includes patents, which are considered technological products.

A significant initiative in this context is open licensing, where patent holders can license their inventions openly, allowing other researchers to use and develop the technology, provided certain conditions are met. Beviláqua *et al*. (2017) point out that open licensing is built on the structures of intellectual property rights, their respective definitions, and relevant international conventions so that the authorship of a given work is safeguarded while at the same time encouraging its reuse and reproducibility.

According to Meyer (2006), patenting has a negative impact on Open Science since the need for secrecy means that knowledge is not shared. Research material is not made available, nor are research results published immediately, which leads to difficulty accessing research data and increases the costs of similar studies that could benefit.

On the other hand, the secrecy of a patent and the consequent commercial benefit of its exploitation can be essential in some areas of research, especially in developing countries, which are thus able to fund their research and contribute to social welfare (Fiani; Vater; Winkler, 2009). In this sense, Azmi and Alavi (2013) point out the importance of patents for developing science, considering them to be one of the main tools for promoting the development of new technologies.

The relationship between open knowledge and intellectual property inevitably arouses the interest of researchers since it interferes with scientific practice. This relationship divides opinion. On the one hand, it is considered that intellectual property limits access to knowledge; on the other, it is argued that it is necessary to objectively evaluate a social transition to a knowledge economy (Rhoten; Powell, 2007).

Patents are technological products from various social sectors, such as research institutions, universities, and companies, often acting collaboratively. This established partnership is characteristic of open innovation aimed at assertive and effective technological development.

This study aims to review the literature on the subject and discuss the relationship between patents and Open Science, seeking to understand the influence of this practice on the open dissemination of knowledge. Considering an increasingly accessible and collaborative science model, the question arises about how secrecy interferes with the open sharing of knowledge. What is the importance of patent registration for the development of science?

This paper aims to highlight the importance of patents in technological development, their influence on science based on their characteristics, and the effects of their secrecy and commercial exploitation. It also looks at the relationship between open innovation and Open Science and patents in the context of universities. This study is justified by the lack of work on patents in the context of Open Science in Brazilian information science.

2 METHODOLOGICAL PROCEDURES

The discussions were based on reference authors on Open Science, intellectual property, and patents. To this end, publications were retrieved from the Reference Database of Journal Articles in Information Science (BRAPCI) and the Web of Science (WoS). BRAPCI used the expressions *patent AND open science* and *university AND open science* in the search field, *all* with no time limit. The WoS used the expression *patent AND open science* in the search field, *all fields*, without time delimitation.

3 OPEN SCIENCE

Several initiatives have been promoted in response to the growing worldwide need to make the results of research accessible to anyone, as well as making the scientific process less costly and faster. One such initiative was the Budapest Open Access Initiative (BOAI) declaration on Open Access, published in 2002. Open Access and the declaration are considered important milestones for the Open Science movement, although the declaration is not the first initiative to point to the emergence of the Open Science movement (Menêses; Moreno, 2019).

Vicente-Saez and Martinez-Fuentes (2018) conceptualize Open Science as accessible and transparent knowledge developed and shared through collaborative networks. There is consensus that the term Open Science encompasses different meanings and types of practices, such as open Access to research results without restrictions on use and redistribution, the direct participation of non-scientists (Albagli; Clinio; Raychtock, 2014), the use of open software, the management of scientific data that can be accessed and reused (Silva; Silveira, 2019), as well as open laboratory notebooks, scientific blogs, collaborative bibliography and open peer review (Vicente-Saez; Martinez-Fuentes, 2018).

Shibayama (2012) considers Open Science to be based on the assumption that progress depends on the inheritance of past achievements. Thus, the author considers it the norm for this system that scientists contribute openly and unconditionally to the scientific advancement of their peers.

In 2012, the Royal Society published a report highlighting the need to deal with the large amount of data generated in order to exploit its full potential, especially its application in public policy and business. Six areas of action were suggested for scientists and institutions that fund and support research. The document mainly suggested greater openness on the part of scientists, greater recognition of data analysis and communication with common standards for sharing and possible reuse, more experts in data management, as well as new tools to help

analyze the data that can be collected (The Royal Society, 2012). Thus, various actions emphasize and clarify the purposes of Open Science to optimize and disseminate its practice.

According to Silva and Silveira (2019), the practice of Open Science is not yet consolidated in all disciplinary areas precisely because it takes many forms and requires social transformations in the sense of greater transparency, sharing, and collaboration. Albagli, Clinio, and Raychtock (2014) add that there is a solid worldwide movement in favor of Open Science based on the understanding that current forms of scientific communication are inadequate because they are linked to mechanisms that hinder the free circulation of knowledge and its advancement.

Consequently, the debates and initiatives favoring open knowledge in the technical sphere mainly seek to propose requirements that favor access, reuse, and distribution of publications to facilitate machine data retrieval. In the legal sphere, the current intellectual property regime is being challenged. The debates aim to encourage the adoption of free licenses for scientific, artistic, and cultural works (Albagli; Clinio; Raychtock, 2014). These assumptions, aimed at openness and accessibility, make up the lines of thought on which Open Science is based.

Wong, Ramos-Toledano, and Rojas-Mora (2018) consider that the above assumptions do not explicitly see patents essentially protected by intellectual property as an obstacle to Open Science. In this sense, the Horizon 2020 initiative, promoted by the European Union, outlines an innovation macro-policy to disseminate knowledge beyond scientific publications. Patents are, therefore, a natural way of disseminating knowledge.

4 PATENTS IN SCIENCE

The growth of science, both as an institution and as knowledge, has brought it closer to the market and practical applications, making it competitive and participating in developing nations, leading to what is known as the privatization of science (Guimarães, 2014). In this context, Silveira (2014) points out that, in the era of information capitalism, the openness of science is replaced by a model that determines that the ownership of knowledge is essential, as it generates innovation.

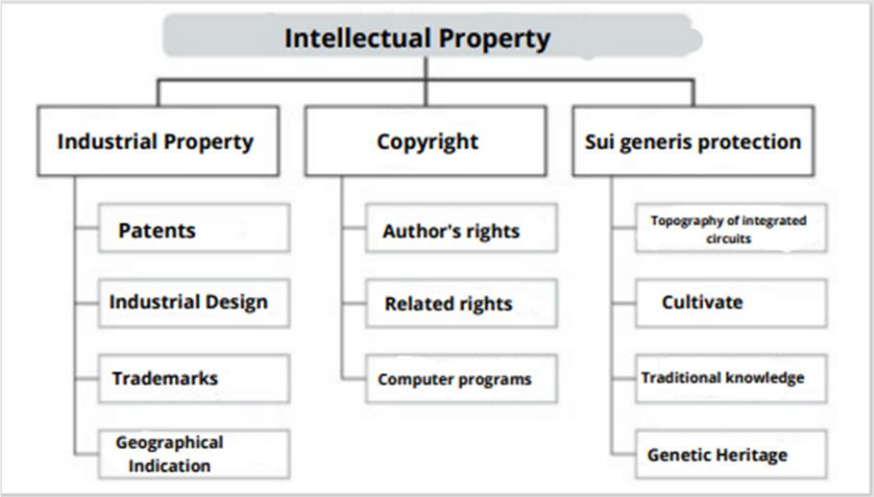
Patents, as sources of information, help technological development and make better use of resources. To this end, the National Council for Scientific and Technological Development (CNPq) has included the item *Research in the Bases of Intellectual Property* for proposals with technological content. This requirement applies to projects seeking public funds, leading them to check the degree of novelty of the project to be funded (Ferreira *et al*., 2022)).

Patents as an object of study are often approached within the scope of proprietary science. Proprietary science is a concept that refers to a more closed scientific approach with characteristics geared towards investment in the market and private sector resources as a means of technological and scientific development. Guimarães and Hayashi (2016) point out that the definition of proprietary science is strongly related to the idea of post-academic science, where the scientific knowledge generated is configured as the property of companies or the state and should not be public, as well as assuming utilitarian and commercial characteristics in terms of its validation and purpose.

According to the National Institute of Industrial Property (INPI), a patent is a temporary property title the State grants to its owner or successors, whether an individual or a legal entity. The owner is granted the exclusive right to the asset, which can be a product, manufacturing process, or improvement of existing products and processes. Thus, patents are divided into *Invention Patents* and *Utility Model Patents*. Those of the first type refer to new technologies and are valid for 20 years from the filing date, while those of the second type add some kind of improvement in use or manufacture and are valid for 15 years from the filing date (Instituto..., 2021).

Patents must meet the requirements of inventive step, novelty, and industrial application. They are part of the industrial property category, which, together with copyright and *sui generis* protection, compose intellectual property (Figure 1). Intellectual property was consolidated in the French Revolution to protect inventors and other artists (Bochi; Gabriel Júnior; Moura, 2020).

Figure1. Intellectual Property Infographic.



Source: Bochi; Gabriel Júnior; Moura (2020).

According to Hullmann and Meyer (2003), patents are filed to protect inventions, guaranteeing the exclusive right of economic exploitation for a certain period. They can be filed in several countries with the aim of broad protection and greater chances of economic success.

For Fiani, Vater, and Winkler (2009), the exclusive appropriation of the economic factor is the main incentive to stimulate innovation. Murray and Stern (2007) consider that the incentives promoted by intellectual property attract high-quality researchers in specific research areas.

On the other hand, the monopolizing nature of patents and intellectual property rights in general meant that throughout the 20th century, there was significant resistance to exclusivity rights. However, over time, what was originally a privilege has become one of the leading indicators of funding agencies (Silveira, 2014).

Patents are considered outputs, i.e., products of research, and are configured as technological innovations, adding value to institutions. In this sense, the world's leading academic rankings, which classify the best universities and consider the innovation indicator in their scores, stand out. For David (2003), patents are also a way of assessing the future value of the technological efforts of companies, especially young ones, whose other types of intangible assets are often not measurable.

Guimarães (2014) points out that two opposing visions emerge when Open Science is contrasted with proprietary science. On the one hand, there is the claim for the independence and impartiality of science and, on the other, the understanding that science is subject to market forces and thus promotes scientific success that leads to prosperity.

According to Meyer and Bhattacharya (2004), these differences arise because of fundamental distinctions between science and technology. Scientific research is based on an Open Science regime, while technology can have the character of a private good represented by a patent.

As such, the antagonism mentioned is significant regarding Open Science, which advocates specific practices that facilitate indiscriminately access to information for everyone at any time. However, when it comes to science as a whole, a study by Moura and Caregnato (2011) on the interaction between scientific and technological production rejects the notion that science and technology are antagonistic. For the authors, there is a feedback loop as the same

researchers pass through, repeat partnerships, and build both types of knowledge in an interactive process.

Patents have characteristics that can interfere with the process of science. It can be seen that the cost of developing research, the secrecy required by registration offices, the forms of scientific reward, funding agencies, and even collaborative work between institutions are factors that give rise to different perspectives recorded in the literature. Thus, the patenting process can be influenced by the patent system concerning the disclosure of information and the commercial monopoly within companies and universities.

5 PATENT SECRECY AND ITS INFLUENCE ON OPEN SCIENCE

When a patent is filed with the Brazilian patent office, it remains confidential for 18 months. However, the inventor can use the so-called embargo period, which in Brazil is 12 months, to disclose the knowledge on which the patent was applied. Otherwise, according to Moura and Caregnato (2011), maintaining secrecy "[...] does not allow critical debate, the exchange of ideas and experiences between scientists, restricting the free flow of information."

According to Pimenta (2017), patent documents contain a large amount of information, proving to be essential for developing scientific research. However, this information is often unavailable in any other type of publication. David (2003) corroborates this by stating that the late release of information worries the research community about how the patent system restricts access to new scientific and technological discoveries.

In this sense, the secrecy and novelty that must be preserved influence the creation of technological knowledge, making it closed and making it difficult to study the behavior of this type of creation. Thus, the protection offered by intellectual property benefits individual researchers, while the scientific community would benefit from the free dissemination of knowledge (Murray; Stern, 2007).

Walsh and Huang (2013) conducted a study with almost 1,000 Japanese scientists to understand their secrecy practices in relation to the results of patentable research. Data analysis showed that 43.0% of researchers do not publish their results in total, which would allow them to be used by colleagues. Meanwhile, 25.0% reported delaying publication, showing that researchers may be willing to prevent the entire disclosure of their results.

This practice is not in line with Open Science, where the free sharing of information is fundamental so that it can be used as a basis for developing more knowledge. The cooperative nature of research is an essential characteristic of Open Science, which considers trustworthy knowledge to be a collective process and not an individual pursuit (David, 2008; Silveira, 2014).

In defense of open knowledge, Nelson (2003) points out that maintaining openness in science is the most effective way to allow society to obtain practical scientific benefits. In the same way, openness enables other scientists to test and validate the results of their colleagues, building their work on these results. Another consideration made by the author is that much of the research product comes from public funding, which does research and, consequently, the material benefits from knowledge of a publicly supported common good.

Understanding that discoveries are in the public domain encourages data and information to be shared, used, and reused indefinitely, promoting faster growth of knowledge. This perspective contrasts with the restrictions on access that usually accompany appropriating the financial benefits of owning knowledge.

6 THE OBSTACLES OF SHARING AND THE IMPORTANCE OF COMMERCIAL EXPLOITATION

The option of proprietary, patented research, for which monopoly rights are acquired, is aimed at commercial exploitation (David, 2008). Wong, Ramos-Toledano, and Rojas-Mora (2018) state that knowledge can be an essential economic asset since it can help to perceive opportunities and results, optimizing possible profitability. Despite this, Silveira (2014, p. 576) states, "There is undoubtedly much resistance to this process of patenting and monopolizing scientific and technological knowledge."

It is undeniable that patents provide financial results. Thus, the result can be considered an excellent incentive for inventions, given the high costs of scientific processes (Silveira, 2014). David (2008) defends the commercial monopoly, arguing that the indiscriminate entry of competitors can jeopardize the profitability necessary for continued investment in research and development, given the high resources required for research. Another factor to consider, according to Rhoten and Powell (2007), is that proprietary research is a way of compensating for the frequent reductions in government funding.

In the financial context, Open Science as a social organization can prove to be a flawed mechanism since adherents of the open standards of scientific communication it advocates cannot become self-sustaining. The rapid dissemination of research results means that researchers give up on the economic exploitation of their work, requiring the support of sponsors or public funding agencies, which are often unavailable (David, 2008).

Some areas and realities are more sensitive to the practice of patenting. For example, developing countries can benefit or be harmed by the food, health, and safety patent system.

Fiani, Vater, and Winkler (2009) point out that patents on medicines can have a negative impact on public health in countries that need to negotiate patented medications. However, when the developing country holds the patent, exploiting it is advantageous commercially.

Castro (2018) points out that, although patents are commonly associated with the protection of technological innovations, they have great relevance in areas of health such as pharmacy and the pharmaceutical industry, since the acquisition of resources for research in this area takes place mainly by investors from the pharmaceutical industry, a context in which the patent protection of medicines and pharmaceutical inputs, in general, has a significant impact on financial transactions.

Souza and Atalanio (2020) argue that the patent protection of drugs and pharmaceutical inputs has some aspects that conflict with the principles of Open Science since private sector investors defend the patent protection of drugs to obtain a return on their investments in research, even if this protection restricts access to relevant research data and information. However, Open Science advocates opening up this data and information so that the academic community can collaborate more closely in the development of medicines and the search for solutions to health problems.

According to Alvarenga and Costa (2020), peripheral and semi-peripheral countries, such as Brazil, end up being at a disadvantage when it comes to patent protection for medicines, as they have poorer territories that are exploited without the available resources being returned to the country's development, becoming "[...] spaces that have been and are colonized by the thought, knowledge, technology and economy of the central countries" (Alvarenga; Costa, 2020, p. 414).

Barreto (2011) points out that the patent protection of medicines can also affect access to medicines for the poorest population since such protection tends to generate competitiveness in the market and increase the value of the medicine. Alvarenga and Costa (2020) also point out that, although the prospect is that peripheral and semi-peripheral countries will end up at a disadvantage because they cannot produce medicines on a large scale, including generics, they

could still benefit from patenting medicines in a scenario of more equal competitiveness, since a patent instrument has a capital differential in the market, generates competitiveness and creates restrictions on certain products, generating profit for the country.

There is a two-way relationship where the patent instrument can act in favor of national scientific production, generating more resources and investment in research, and can restrict the access of the country's researchers to these resources. Once again, there is a need to balance the guidelines advocated by Open Science, which call for greater openness and collaboration, and the need to protect a country's inventions and use this in favor of its development.

In this context, Souza and Atalanio (2020) and Barreto (2011) highlight the Doha Declaration as an innovative initiative, as the document was created to make the international marketing of medicines more flexible and served as a political instrument for peripheral and semi-peripheral countries to make policies to regulate access to patented pharmaceutical inputs used in the creation of medicines to treat diseases more flexible. This is an initiative that proposes a balance between patent protection in the area of health and Open Science initiatives since, at the same time as safeguarding the security of medicines, it creates greater flexibility in their access for countries that are usually at a disadvantage.

According to Rhoten and Powell (2007), the global movements for open access have broadened discussions on the ownership of knowledge by pointing out the need to formulate international policies that consider human rights and environmental sustainability. Concerning food crops, Maskus (2006) states that the high cost of research, the uncertainty of the results, and the expensive and time-consuming tests justify intellectual protection. On the other hand, patenting can have a possible adverse effect by preventing innovation from reaching small producers, for example.

In any case, agricultural research is funded by the government in developing countries or large companies in developed countries (Maskus, 2006). In both cases, large sums are earmarked for this type of research, generating a movement towards intellectual property so that these inventions can be protected somehow. This reality means that the ideal of Open Science loses importance, and research becomes private property due to the need for profitable returns (Azmi; Alavi, 2013).

According to Maskus (2006), public laboratories and universities in developing countries are efficient at generating new knowledge but inefficient at commercializing it through products. Thus, university patents help to remedy this deficiency by guaranteeing the right to a given invention and allowing licensing to those interested in taking advantage of the innovation.

Considering the benefits provided by Open Science and research based on proprietary information, it can be seen that they are part of institutionally distinct systems. Thus, the challenge is keeping these systems in productive balance so that both peculiarities can increase mutual productivity (David, 2008).

Azmi and Alavi (2013) suggest that a balance between patents and Open Science should be sought to move the economy up the value chain. Moura, Rozados, and Caregnato (2006) also point out that the purpose of the patent system is precisely to encourage economic development, which justifies the importance of patents.

The practice of patenting can be better aligned with Open Science when combined with open innovation. The open innovation paradigm, widely used by companies, considers research and development an open system where ideas can come from inside and outside the institution, accelerating innovation based on collaborative ideas (Chesbrough, 2006). Silva and Silveira (2019) consider that one of the foundations of Open Science is precisely collaboration between research institutions, companies, and society with common interests.

For Orlando *et al*. (2021), open innovation fosters and optimizes patenting activity because, through collaboration, it is possible to reduce costs and share knowledge between partners. Thus, at least to some extent, information circulates more openly.

An extremely relevant partnership in open innovation is between companies and universities. Universities play a fundamental role in developing new technologies applied to industry and are relevant sources of technological opportunities for industrial innovation (Almeida, Bastos; Santos, 2018).

Garcia, Rapini, and Cário (2018) state that interaction with universities has been gaining ground in business strategies, as the complexity of some products and processes means that a company needs new knowledge. In this sense, Bochi, Gabriel Júnior, and Moura (2020) point out that activities related to technology and innovation have been growing in universities and making them gain notoriety in corporate environments, facilitating the formation of partnerships.

Concerning partnerships, Verbeek, Debackere, and Luwel (2003) highlight the advantages of interaction, heterogeneity, and transdisciplinarity in generating knowledge. University-industry interactions enable scientific and technical advances that come from the exchange between partners. Thus, academic research represents knowledge transfer to companies, a vital input for innovation.

To make this interaction possible, the university infrastructure has been changed with the creation of technology institutes that have made it possible to increase incentives for entrepreneurship. Among the facilities universities offer is the service of patent attorneys, who deal with the legal side and help find industry partners. In addition, financial incentives have also proved relevant, as many universities allow researchers to license their discoveries (Shibayama, 2012).

7 UNIVERSITY PATENTING

In terms of adapting to Open Science, Brazilian universities are at an early stage in terms of ongoing initiatives and the lack of policies and guidelines to guide these actions (Ribeiro, Oliveira, 2019). Patents generated in universities or with the participation of universities are called university patents. As a product resulting from academic research, patents are controversial, as they raise questions related to the private gain from publicly funded research or research developed at public universities (Muller; Perucchi, 2014).

It is worth highlighting the importance of university patents in the Brazilian scenario. In 2010, it was observed that the production of patents was related to technology-intensive sectors, mainly in the health area (Póvoa, 2010). In 2013, university patents accounted for 15.0% of resident applications in Brazil (Soares *et al*., 2016), a figure that has continued to grow, reaching 23.0% of patents registered by the INPI in 2020 (Instituto..., 2020).

Therefore, the growth in patent registrations is highly significant in scientific and technological development, as it demonstrates that previous patents motivate studies and serve as input for subsequent research that can be developed. On the other hand, the secrecy required in the process can negatively influence university research.

Open access to research data is one of the practices advocated by Open Science. It is well known that open data provides advantages for future research, so it needs to be available to be easily found and reused. Unavailable data, as required in the patenting process, often negatively affects knowledge development.

Oliveira *et al*. (2022) analyzed how issues involving the reuse and citation of open-access research data have been addressed in Latin American literature. The study identified predominant themes in scientific literature, such as data management, the ethical and legal aspects of data citation, and psychological conditions that positively or negatively influence researchers to make their data available in open access. The authors also identified that researchers are afraid to deposit their research data in open access because their data could be

used to invalidate their research or reused in new studies without properly citing the data and acknowledging the original authors.

On the other hand, Rosa, Silva, and Pavão (2021) research showed that emergencies, such as the pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), generate different behavior. Emergencies tend to foster and increase the practice of open sharing of research data, also demonstrating that openness and collaboration involving research data makes the scientific flow faster, increasing scientific productivity and solving essential research problems more quickly and accurately.

A study conducted by Vogeli *et al*. (2006) interviewed 1077 doctoral and post-doctoral students in the life sciences in the United States. The survey aimed to understand whether these students had already requested data from other researchers and the consequences if it was withheld. Access requested and denied was reported by 43.6% of respondents. The authors observed that withholding of research data caused 48.5% of the interviewees to suffer losses in their research progress, 45.0% reported that the quality of their relationships with other researchers was negatively affected, and 33.0% reported a loss of quality in their education. The results of this study show that denied access to data, contrary to Open Science, harms scientific development, not only in terms of costs and speed of research but also in terms of human development.

In accordance with the above, Shibayama (2012) corroborates this by stating that the greater a university's actions toward entrepreneurship, the less likely it is that its researchers will follow the rules of Open Science. Pro-property rights restrictions encourage uncooperative and secretive behavior.

On the other hand, Shibayama (2012, p. 525) considers that, despite pointing to proprietary research in universities as an obstacle to Open Science, there is "[...] potential compatibility between academic entrepreneurship and the Open Science tradition, at least at the normative level". In this sense, Rhoten and Powell (2007) argue that science is moving from a binary system of public versus proprietary science to arrangements combining public and private elements. This change is motivated by social factors, which mix the need for funds to continue research and the need to keep knowledge open. In order to achieve a balance between these models, new research techniques and agendas, alternative organizational configurations, and new professional incentives are shaping 21st-century science.

A viable alternative to reversing the secrecy of patenting could be the so-called embargo period. This period consists of a set time before the filing date of a patent application, in which the inventor can disclose his invention without interfering with the novelty aspect (European..., 2022).

According to the International Association for the Protection of Intellectual Property (AIPPI), several countries provide for a period of between six and 12 months. This period allows inventors to voluntarily disclose the results of their research before filing a patent application. When making use of the embargo period, it is necessary to pay attention to the law of the country because, as not all countries provide for this period, the patent application may be denied in some countries that will no longer consider the novelty required after some type of disclosure (International, 2013).

Brazil foresees an embargo period of 12 months, which allows any act or disclosure of knowledge and disclosure or exhibition by third parties against the inventor's will (International, 2013). Such disclosure does not interfere with the unpublished nature of the patent and could be a solution for knowledge to remain open and accessible.

On the other hand, the disclosure of knowledge during the embargo period can make the invention vulnerable, as third parties can be inspired and develop a similar alternative before the patent is applied for, or an improvement can be proposed, preventing the original inventor from widely exploiting his invention. These issues divide opinion and make the embargo period an intensely debated subject worldwide (International, 2013).

6 CONCLUSION

Open Science values accessible knowledge developed collectively and shared for everyone's reuse. Based on this premise, society can benefit from knowledge often built on public investment, and the scientific community can develop new understanding requiring less cost and time.

The growth and institutionalization of science have led to new developments, including proprietary science, due to technological development and the expansion of scientific knowledge into business. Patents thus emerged as technological products resulting from research, intending to protect inventions.

The relevance of patents to the development of science and new technologies is widely accepted. Patents represent informational and financial value, which justifies their importance and is also an indicator of productivity. The licensing that comes from them offers a financial return that is mainly needed to maintain research activities.

The patenting process is characterized by secrecy, but the embargo period favors Open Science, which advocates that all knowledge be accessible to generate more knowledge. Thus, using the embargo period, available in several countries, can mitigate the obstacles promoted by secrecy since knowledge can be disclosed in the months before the patent application is published without harming the process. However, the issue of reproduction of this disclosed knowledge by third parties must be considered.

Patents can be exploited commercially, which is attractive to excellent researchers and promotes interaction between universities and companies. Licensing often serves as a substitute for scarce public funding, promoting self-sufficiency in research and rewarding scientists.

Depending on a country's level of development, patents can be harmful in that they interfere with social welfare or keep essential products out of the hands of vulnerable sectors. Developing countries, on the other hand, can benefit from patent ownership but need to look for alternatives so that industries with less access are not harmed.

Although science is based on open practices and technology on closed practices, they are not antagonistic but complement each other as researchers interact and build knowledge collaboratively. The partnerships established between universities and companies also represent a way of making knowledge more open and collaborative, in line with the assumptions of Open Science.

Therefore, the debate on Open Science and proprietary science cuts across various social strata and perspectives that need to be considered, and it is not possible to opt for one or the other without first considering the consequences in multiple spheres. In this sense, a balance between the two practices is proposed as a path that may prove to be the most appropriate.

Future studies suggest analyzing the forms of academic reward from registering patents. It would also be helpful to look at alternatives for making patented inventions available to the most vulnerable sectors of society in developing countries.

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