

A patent study of emerging pharmaceutical markets: the case of BRICS countries

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Abstract. Countries with emerging pharmaceutical markets are gaining evidence worldwide because these regions are considered to be responsible for sustainably increasing sales of new drugs. Therefore, the collection of innovation data from these regions is of great relevance in characterizing these pharmaceutical markets and how they are being explored. Through patent data collected on the Derwent World Patent Index and on the WIPO (Intellectual Property Statistics Data Center) platform, a technological mapping of the pharmaceutical and biopharmaceutical sector was developed. Among the results obtained, it was noted that China's (111,821 total patents) growing importance in the pharmaceutical sector is becoming increasingly close to Europe (190,690 total patents) and US (260,834 total patents). In both sectors, Russia (27,657 total patents) was seen as the second BRICS country with a larger patents number. On the other hand, the low rate of innovation in the Brazilian (831 total patents) and South African (844 total patents) industrial sector was observed for the pharmaceutical and biopharmaceutical areas, mainly due to the low investment in R&D. It was noted that there is still a long way to go for regions with emerging pharmaceutical markets in order to effectively exploit their domestic markets, gaining competitiveness and leveraging innovation indices.

Keywords: Innovation, Patent, Pharmaceutical, Biopharmaceutical.

1 Introduction

The pharmaceutical industry is considered highly oligopolistic because it has many companies from a few developed countries that dominate almost all the research and production of new drugs worldwide. In addition, considering that success in this market is highly dependent on innovation, the pioneering regions in this segment, the US and Europe, owe this hegemony, mainly to significant participation in the global market and control of the innovation process, with the capacity to invest heavily in R&D, dictating the dynamics of the sector [1].

The growing relevance of countries with emerging pharmaceutical markets (pharmerging regions), especially BRICS members, who are potentially responsible for the sustainable growth of drug sales, has now been observed [2]. China, for example, should become a leader in the development of pharmaceutical innovation by 2036 [3].

Another important market is that of biopharmaceuticals, which gained prominence in 2018, with an average growth of 15%, twice the growth of conventional medicines

[4]. In this sense, a study focused on the pharmerging regions, especially the BRICS, is of great importance for the understanding of the impact on the dynamics of the (bio)pharmaceutical sector, with new initiatives to foster innovation.

2 Theoretical Background

Pharmerging countries, especially BRICS members (Brazil, Russia, India, China and South Africa), have attracted attention in recent years by the accelerated growth of the pharmaceutical market, especially by the investments made by local companies in the generic segment, through methods such as reverse engineering. Also, the aging of the population favors growth in the sector, as it directly impacts on the economic growth of these countries, due to the change in consumption patterns [5].

Increasing investments are also being directed to the biopharmaceutical sector in order to obtain cheaper alternatives for the development of vaccines and biodrugs to be competitive in the market [6].

Innovation in the pharmaceutical and biopharmaceutical segment has peculiar characteristics when compared to other sectors of the economy. The (bio)pharmaceutical industries are guided by "technological impulse", that is, the creation of value depends directly on the scientific and technological advances. In this sense, high investments in Research and development (R&D) are necessary for the development of new drugs and biotechnological processes, generating innovation for this sector and conferring extraordinary profits for the companies [7, 8].

On the other hand, the production of new drugs is easily replicable and can be performed with much less investment than was necessary for research and testing prior to launching the drug on the market. In this sense, Intellectual Property (IP) plays a vital role in the modern economy, especially in the biotechnology and pharmaceutical segment. Therefore, IP is responsible for ensuring the maintenance of high investments in R&D, as it guarantees the protection of new products and processes in the sector, as well as making it difficult for new competitors to enter the market [6, 9].

Therefore, studies targeted at emerging pharmaceutical market are of interest in order to understand the innovation dynamics of the sector, based on patent data, and to assess whether the potential of the domestic market has been explored by pharmerging countries [7].

3 Methodology

The work presented consisted of an exploratory study, which integrates bibliographic research and collection and analysis of secondary data. The main fields of research encompassed Intellectual Property; Patents; Pharmaceutical industry; Biopharmaceutical industry; Innovation; Pharmerging countries and BRICS.

First, a review of the literature was carried out. This step included criteria of inclusion and exclusion of articles, definition of the information to be extracted from the articles, analysis, discussion and presentation of the results obtained.

In the collection of secondary data, the international patent bank Derwent World Patent Index (Thomson Reuters Scientific) was used. At the Derwent platform, the search was by technology and by country and the indicators were linked to the most innovative companies in the sector. Intellectual Property Statistics Data Center, promoted by the World Intellectual Property Organization (WIPO), was also used and a search by source of patents was made.

The analysis considered the period from 1996 to the last year (2016) of registration available at the patent banks.

According to the OECD's Frascati Manual [8], patent-based indicators provide insight into how a country is innovative, since R&D is the input of invention activities and patents are outputs from innovative processes. In this sense, based on this premise, with the data from these two bases, it was possible to establish a relationship between innovation indexes and patenting for the pharmaceutical and biopharmaceutical sectors

4 Results and Discussion

4.1 Pharmaceutical Industry: Derwent and WIPO

In the Derwent Index Innovation database, a search was made for patent registrations of the area of *Pharmacology*, based on the names of the depositor. Figure 1 shows the 15 companies with the highest number of patents in the pharmaceutical segment.

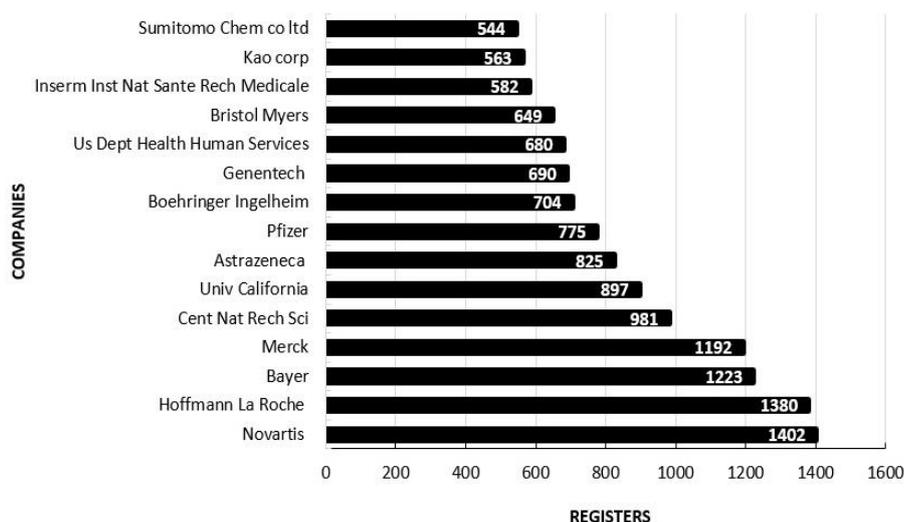


Fig. 1. Top 15 companies with the highest number of pharmaceutical patents granted. Source: Developed by the authors based on Derwent data.

It can be observed that the 15 companies with the largest number of pharmaceutical patents are of US, Europe and Japan. Based on the data, Novartis stands out first, with the highest number of protections in the pharmaceutical area (1,402 protections), followed by Hoffmann La Roche (1,380 patents) and Bayer (1,223 patents).

It may be noted that no industry or institution of pharmerging countries was identified in the ranking. This is justified by the fact that most of these countries, such as Brazil, concentrate their efforts mainly on the generic drug market, which requires a much smaller investment in R&D.

The study was also performed on the WIPO platform, using the *Pharmaceuticals* classification. For comparative analysis, beyond the Brazil, Russia, China and South Africa also were collected data from the US and Europe. It should be noted that India's patent data are not available on WIPO.

Although most pharmaceutical patents still focus on the US (158,961 patents) and Europe (189,836 patents), attention should be given of highlight of the China (75,308 patents). The Chinese growth can be explained by strong government support for the pharmaceutical sector, in the last years. In 2011, China's Health Reform and the 12th Five-Year Plan happened, culminating in significant investments in new and cutting-edge technologies, as well as several research centers.

Followed by China stands out Russia, with a total of 19,386 patents. It may be noted that patent numbers in this country have been increasing in recent years (Table 1) due to Russian government measures to strengthen the national pharmaceutical sector by 2020, such as the PHARMA 2020 strategy and the Federal Targets Program (FTP) [9, 10].

The innovation index of South Africa (546 patents) stands out in relation to Brazil (483 patents). With the support of multinational investments and the government's ambitions to raise national pharmaceutical standards, South Africa has been the best-positioned region to exploit African markets. However, the country is still heavily dependent on imported products, which justifies its less expressiveness in relation to the other countries in question [11].

Regarding Brazil, its low expressiveness in comparisons with the other pharmaceutical countries can be justified by the fact of the Brazilian Pharmaceutical industry developed late and dependent on imports of medicines and pharmaceutical inputs. Therefore, was investing few resources in R&D, which made it impossible to consolidate a structured innovation system and led to the low assimilation of intensive activities in science and technology.

Table 1. Pharmaceutical patents granted to BRICS countries, US and Europe (1996-2016).

Year	Brazil	China	Russia	South Africa	US	Europe
1996	3	40	582	14	4,057	5,295
1997	16	53	766	12	4,577	5,555
1998	4	90	742	7	5,13	5,552
1999	5	178	688	17	5,806	5,686
2000	7	1,219	683	14	5,304	5,227
2001	7	1,228	523	27	6,247	6,253
2002	19	731	889	35	6,921	7,897
2003	9	1,094	966	36	7,688	9,329
2004	27	1,907	954	31	7,36	9,537
2005	9	2,161	797	29	6,218	8,272

2006	31	3,304	979	59	9,051	10,213
2007	13	3,431	899	15	6,492	9,242
2008	18	3,293	1,201	25	6,756	10,134
2009	26	3,894	1,055	24	6,777	10,332
2010	29	4,631	958	21	7,817	10,793
2011	28	7,581	957	20	8,253	10,777
2012	28	7,903	1,043	37	9,566	11,175
2013	54	7,972	915	35	10,822	12,183
2014	42	8,822	1,364	35	11,256	11,946
2015	54	8,444	1,322	31	10,561	11,175
2016	54	7,332	1,103	22	12,302	13,263
Total	483	75,308	19,386	546	158,961	189,836

Source: Developed by the authors based on WIPO data.

The WIPO data confirms the results of Derwent, showing that the US and Europe are still leaders. The WIPO already points to a growth in China's innovation, but this has not yet had significant developments in the Chinese industrial sector, since the Derwent mapping did not point among industry players, industry or Chinese institution.

4.2 Biopharmaceutical Industry: Derwent and WIPO

In the study carried out in the Derwent, the term *Biopharmaceutical* was used and as a result 916 patent records were found with respect. However other areas of knowledge are involved, because a significant amount of the titles refer to patents of biodrugs production processes and another the fewer the medicines themselves. Figure 2 shows the 15 companies that hold the most patents in the biopharmaceutical sector, only in the *Pharmacology* area.

With the data obtained, it was observed that within the *Pharmacology* area, the company that most hold patents is Merck, with 74 protections, followed by Sartorius, with 73 and in the third place appears G&E with 44 registrations. It was observed the presence of two US universities in the list, which shows the degree of novelty and interest in the area. In addition, the companies present in the list are of the pharmaceutical area, of mainly North American origin.

The study was also performed on the WIPO platform, using the *Biotechnology* classification, according to Table 2. Through the analysis of the data obtained, the prominent position of the US is visible, with 101,873 biotechnological patents. The European countries then have 85,400 protections, with highlights for countries such as Germany, France, the Netherlands, the United Kingdom and Switzerland, which are the most concentrated pharmaceutical and biopharmaceutical industries.

These results indicate, even in a purely biotechnological index, the presence of patents associated to biopharmaceutical products, including procurement processes, and points out the high degree of innovation of these regions in the sector. Within the BRICS, China is the most prominent country with 36,513 patents. These numbers

demonstrate the country's race to achieve satisfactory positions in innovation and to approach world leaders, ensuring their competitiveness in the global market and the strengthening of the national industry.

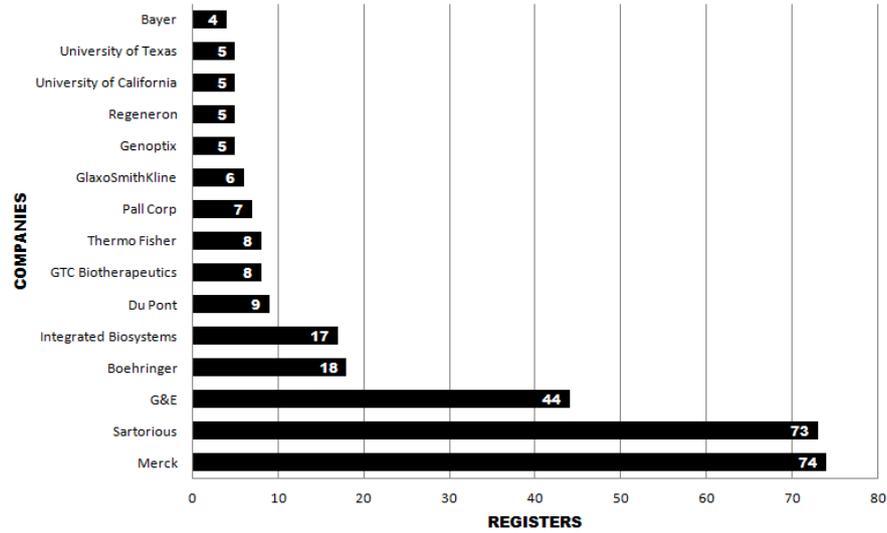


Fig. 2. Top 15 companies with the highest number of biopharmaceutical patents granted between 1996-2018. Source: Developed by the authors based on Derwent data.

Brazil, on the other hand, presents some stagnant numbers over the years, with fluctuations, reflecting the low level of exploitation of biotechnology-related markets in the country, which includes the field of biopharmaceuticals.

South Africa has the lowest number of patents in the countries listed, with 298 protections, indicating the country's low level of innovation in the biotechnology segment.

Table 2. Patents on biotechnology awarded to Europe, US and the BRICS countries (1996-2016)

Year	Brazil	China	Russia	South Africa	US	Europe
1996		18	268	7	2,916	2,383
1997	1	26	328	7	3,556	2,674
1998		37	248	6	4,646	2,770
1999	4	31	168	10	4,718	2,811
2000	1	121	174	9	4,216	2,497
2001	8	153	142	8	4,480	2,756
2002	20	85	177	5	4,458	2,972
2003	6	292	840	9	4,346	3,496
2004	27	575	642	17	4,168	3,742
2005	7	657	921	14	3,656	3,333
2006	24	924	760	10	4,145	4,072
2007	8	1,014	263	8	4,092	3,801

2008	7	1,047	382	12	4,221	4,014
2009	10	1,191	308	29	4,369	4,273
2010	21	1,849	390	23	4,906	4,673
2011	16	2,813	366	11	5,162	4,855
2012	21	4,515	352	27	5,731	5,215
2013	35	5,712	349	22	6,270	5,658
2014	41	5,339	405	15	6,830	5,769
2015	41	5,016	417	31	7,068	6,361
2016	50	5,098	371	18	7,919	7,275
Total	348	36,513	8,271	298	101,873	85,400

Source: Developed by the authors based on WIPO data.

5 Conclusion

The data obtained through Derwent corroborate the patent indexes obtained in WIPO, noting the importance of European and US countries in the pharmaceutical and biopharmaceutical segments.

China's growing importance in the pharmaceutical sector is becoming increasingly close to Europe and US, putting market leadership at risk. In both sectors, Russia was seen as the second BRICS country with a larger patents number, demonstrating the importance of government policies for the generation of innovation in industry.

On the other hand, the low rate of innovation in the Brazilian and South African industrial sector was observed for the pharmaceutical and biopharmaceutical areas, mainly due to the low investment in R&D.

It was noted that there is still a long way to go for regions with emerging pharmaceutical markets in order to effectively exploit their domestic markets, gaining competitiveness and leveraging innovation indices.

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