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Global technological transformations and asymmetries: development strategy and structural challenges for the Unified Health System

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Abstract *This paper articulates contemporary themes of the development agenda as global phenomena that affect the dissemination and direction of health technical progress, subjecting the sustainability of the Unified Health System (SUS). The evaluation of the external dependence of the Brazilian Health Economic Industrial Complex, the bibliographical review of the literature on economic complexity and its data on Latin America and Brazil and the collection and evaluation of statistical data from the World Intellectual Property Organization and the National Institute of Industrial Property enable us to build an overview of increasing economic and power asymmetries that reiteratesthis centre-periphery pattern in multiple themes and geographical scales. This perspective consolidates the endogenous link between national development patterns and structural possibilities and boundaries for the setting of a Brazilian universal health system. Confronting global technological asymmetries is part of a strategic agenda that conditionsthe advancingof the Unified Health Systemtowards its founding principles of universality, comprehensiveness and equity.*

Key words *Global health, Health and development, Health economic-industrial complex, Health innovation, Health political economy*

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Introduction

In the late 1990s, the intertwining of economic, social and global geopolitics realms emerges strongly in the field of health, involving aspects related to the struggle for economic hegemony and the global technological pattern that are highly relevant to national policies, as was evident in the 1994 negotiations on the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), its developments in the Doha Round which began in 2001 and the priority treatment given by the World Health Organization to innovation, intellectual property and access[1,2].

The articulation between health, national development patterns and international relationships and disputes has been strengthened by the process of increasing competition on a global scale. Global health and health diplomacy issues, in particular, have gained strength in the public health agenda, with increasing priority being given to national and global patterns of economic development, innovation, asymmetries and inequalities, as shown by several recent works, such as those in the publication organized by Buss and Tobar[3].

The central hypothesis of this study is that there is a global asymmetry situation that structurally excludes countries, regions and populations from access to health, evidenced in an international division of labor in which some countries become mere consumers of technology while others define the global technological pattern, exercising a geopolitical domain that unfolds towards social policies and, in particular, universal health policies.

This paper shows how dependency is manifested in the situation of trade flows between countries and regions, the specialization of the productive base in products and services with different degrees of complexity and private appropriation of innovations (revealed by the global situation in the area of intellectual property), evidencing the reproduction of global asymmetric patterns in the field of health.

Methods

In order to understand the questions underlying the national patterns of global insertion, we start with a structuralist theoretical framework anchored in the propositions of Furtado[4] and Prebisch[5], recognizing their contemporaneity and adding new perspectives and analytical tools. The international asymmetries that materialize in the centre-periphery dynamics appear as a fundamental element of the capitalist system, which are reproduced in health, structurally subjecting possibilities and boundaries for the construction of the SUS in the current context of unequal and excluding globalization.

In order to capture the situation of increasing global technological asymmetry and its reproduction in the field of health, in an unprecedented way, we tried to use three analytical and information bases. This methodological procedure enhances the robust available evidence on the unequal distribution of technologies and the national bases of innovation that lead to situations of structural dependence of national development patterns, involving health in particular.

To this end, we used information derived from Brazil's commercial relationships with other regions and countries in the Health Economic-Industrial Complex (HEIC); the indicators of economic complexity of the national productive base, seeking its articulation with health productive segments; and data on the development and global distribution of patents, to highlight the recent movement of private appropriation of knowledge, which imposes limits on social policies and, in particular, on those aimed at promoting universal access to health.

In order to verify this reality within the scope of the SUS, we proceeded with the collection and analytical systematization of Brazilian trade balance data. According to a methodology developed to capture its trend in real terms described in another paper[6], we used the longest series available on the HEIC, covering the last twenty years, based on the foreign trade database of the Ministry of Development, Industry and Foreign Trade (MDIC, currently designated as Ministry of Industry, Foreign Trade and Services).

The use of the theoretical and empirical contribution of economic complexity studies, a recently developed or, more precisely, updated framework before the structuralist approach[7,8] is added to the investigation of the trade balance. Following this perspective, it adds strong evidence to the fact that specialization of the productive base has a strong inductive power over national development patterns, dependency relationships and equity.

Finally, the collection, systematization and evaluation of statistical data of the World Intellectual Property Organization (WIPO) and the National Institute of Industrial Property (INPI)

allow to cover the concentration and appropriation of knowledge by patents. We conducted a survey of historical series, clustering countries by income level, which enabled us to capture the global trend in the HEIC and the origin of (resident and non-resident) patents' applicants. As a result, it was also possible to indicate global asymmetries and their trend not only in the generation, but also in the appropriation of knowledge.

The analyses had some limitations. The Ministry of Development, Industry and Foreign Trade (MDIC) effective comparable data is available only as of 1996. Economic complexity data are recent and do not facilitate relevant historical series, but generate evidence on the geopolitics of the productive base, showing the distribution of economic activities with different degrees of technological content. In the field of industrial property, WIPO only has records after 1985, and the classification by income group is only available from 1997 onwards. In addition, data that consider different technological categories refer to patents granted and not patents filed. At the INPI, in turn, it was only possible to construct series with specific information on health patents in Brazil (HEIC segments) until 2012, which did not prevent evidencing the situation of health dependence and vulnerability.

Despite limitations, collected evidence proved to be very solid, which was reinforced by the integrated analytical management of the three realms, facilitating the capture of global asymmetries of the productive base and innovation in health and showing the high relevance of this political economy approach for the design and implementation of universal health systems and the SUS, in particular.

Results and discussion

Trade balance

Following the structuralist approach, inequality in the international division of labor and in the different national patterns of development are manifested in the relationships of exchange between countries, establishing a centre-periphery system. The 1990s were marked by liberalizing economic policies initiated in the Collor government with measures that changed the exchange rate system and promoted a strong and unplanned opening of the economy. Introduced in 1994, the Real Plan contributed to inflation control by containing domestic prices by competition with similar imports, marking a long process of exchange overvaluation with a chronic impact on industrial production and, thus, on the local production and innovation base[9].

Lula and Dilma governments, especially in the 2003-2014 period, despite having strong macroeconomic policy continuity elements, were marked by the resumption of a vision and actions focused on industrial policy and productive development, prioritizing productive sectors, chains and complexes with greater technological content, with HEIC gaining significant prominence and where strengthened bilateral negotiations with countries of the South[6,10] was also an important event.

National production protection tools were again gaining momentum. However, despite efforts to protect domestic industry and increase the national content of Brazilian manufactured goods, this period was marked by a significant coefficient of import penetration in the processing industry[11], due to the preservation of the macroeconomic regime, the economic and political strength of agribusiness and the growing technological gap.

In the case of health, in the period 1996-2015, the trade balance is characterized by increasing deficits. The growth of imports was related to a higher level of domestic demand in health, whose products are knowledge-intensive, revealing the brittle endogenous production and innovation base of HEIC, resulting in the growing national difficulty of meeting a demand that increased both qualitatively and quantitatively[12].

With regard to medicines, the Brazilian pharmaceutical market held seventh place in the international ranking of global sales in 2015[13], a growth that has occurred since 2000 and which is associated with increased public spending in the sector and also the consolidation of generic drugs, which are the main production of domestic companies[14]. However, with access to higher value-added products and because of competitive practices of the pharmaceutical oligopoly, the deficit of raw materials and higher value-added products increased sharply in the period.

As for medical equipment, the deficit growth signals the loss of technological capacity in the industry. Even the production carried out by companies in the national territory still depends heavily on imported supplies with higher technological content, which reaches up to 50% of them in some segments[12]. High obsolescence of technology has been observed in the sector, due

to changes in healthcare patterns and company market practices, with an increasingly shorter life cycle (18 to 24 months). The oligopolistic nature of the industry hinders the entry of independent producers from less developed countries[15].

The import and export movements and the health trade deficit (of chemical and biotechnology, and mechanical, electronic and material-based industries) have three trends. The first one was stability until 2003. The second, increased deficit between 2004 and 2013. The third reported a slight decline in the differential between imports and exports from 2014 to 2015. During the period, deficit went from US$ 3 billion in 2003 to US$ 12 billion in 2013, and thereafter declining, there being, of course, an effect of the crisis and shrinkage of domestic demand[10].

Graphic 1 shows the global asymmetries. The health deficit derives from increased technological and innovation capacity in countries of the European Union and the U.S. More recently, BRICS have significantly increased their share of the deficit because of advances in technology and production capacities in India and China, showing new global geopolitics of innovation in health.

The structural nature of the deficit can be evidenced by the small influence of the exchange rate fluctuation in its trend (Graphic 2). In general, it is possible to infer a progressive growth of HEIC imports in the last decades, regardless of the real exchange rate swing. This shows that deficit hinges not only on prices, but on health technological dependence as well, which means that universal access policies can always be limited by the availability of resources to import products. This characteristic reveals SUS' vulnerability and dependence on the dynamics of capitalist competition in health and hegemony of developed countries and China on the global technological pattern.

Economic complexity

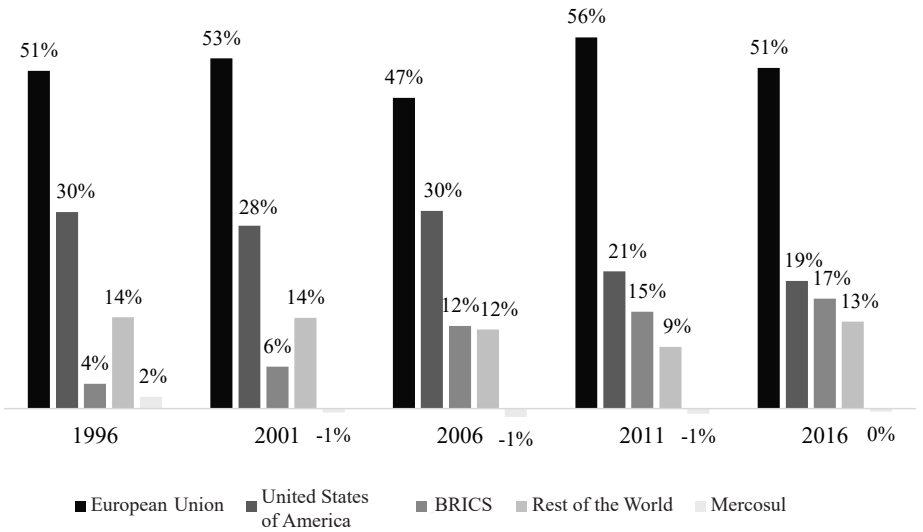
The unequal distribution of national productive bases is revealed by a concentration of the most sophisticated and technologically productive sectors in more developed countries and regions. These inequality patterns may be identified by using the Economic Complexity approach that is added to approaches and indicators available for the analysis of the geopolitics of technology and innovation, which structurally threaten sovereignty for the feasibility of universal systems in the periphery.

The adequate understanding and use of this concept requires resuming the recent contributions that follow, somewhat unclearly, the structuralist perspective. In 2007, Hidalgo et al.[16] established the foundations of the methodology in the paper on global distribution of production, according to which economies grow thanks to the development of the types of products that they produce and export. The argument is based on what has been called "Product Space", a term that refers to a concrete mapping derived from a research methodology that places products in relation to each other in a graphical representation, assessing products – and technologies – that lead the productive chains that are more dynamic and powerful to generate growing pathways in the long term.

This networked conception of global production allowed the perception of linkages *between products*, which could unfold to the structural relationship between countries and regions. Production and innovation within the HEIC – captured in "chemical" products (including biotechnology), "electronic products" and "machinery and equipment" – are found in a sort of backbone of high technological density and of knowledge, which determines the development potential of national production systems. At one extreme, countries with high participation of activities of greater knowledge content and innovation, as in the HEIC, have much more room to grow and develop than countries based on the extraction of natural products.

Technology, capital, institutions and skills required for production are more stimulated by some products than others, and more sophisticated products are located in a densely connected core, while lower-income products occupy a less connected "periphery".

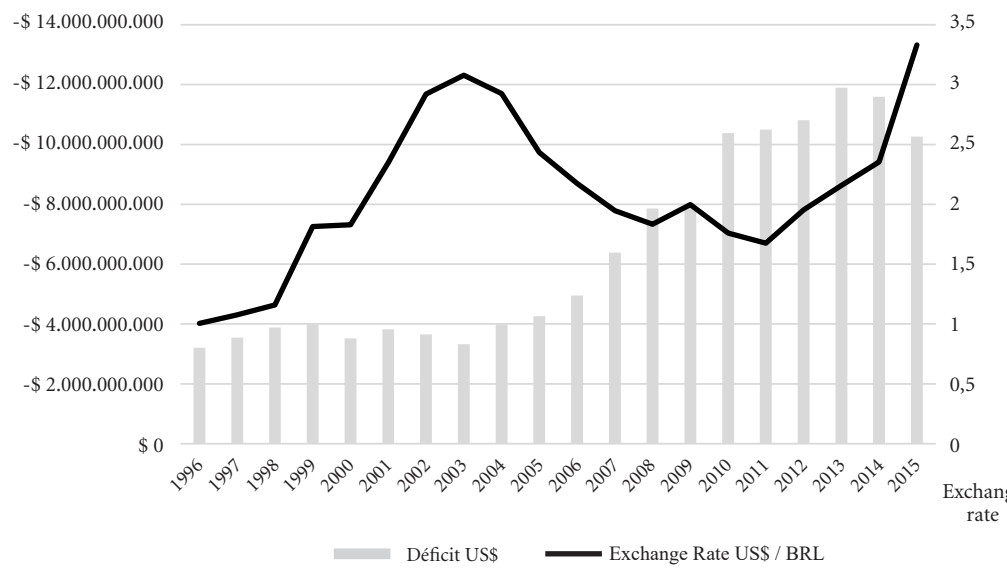
More sophisticated products are more permeable to the transformation of productive systems. The *accumulation* of the conditions necessary for the production of a greater density of knowledge gives developed economies, or those, like China, which are in a rapid process of transformation of their productive structure, advantages deriving from the greater possibility of development and technological adaptation, providing the structural basis for the establishment of dependency relationships that, as already seen, mark the Brazilian health sector. A robust economy is strongly linked to the position and ability to traverse the productive space toward mastering techno-productive cores underpinning the economic hegemony, always linked to the search for political hegemony.



* Amounts in US$ billions, updated by CPI/USA

Graph 1. Trend of the distribution of the Brazilian health trade balance deficit, according to countries or groups of countries.

Source: Prepared by authors from the information base of the Coordination of Prospecting Actions of the Presidency / Group of Studies on Development, Economic-Industrial Complex and Innovation in Health, Fiocruz, based on data from BRAZIL. Alice Web [Internet]. [Access in January 2017]. Available at: http://aliceweb.mdic.gov.br/



Graph 2. Trend of the exchange rate and the HEIC deficit (1996 - 2015).

Source: Prepared by authors from the information base of the Coordination of Prospecting Actions of the Presidency / Group of Studies on Development, Economic-Industrial Complex and Innovation in Health, Fiocruz, based on data from BRAZIL. Ipeadata and Alice Web. [Access in January 2017]. Available at: http://www.ipeadata.gov.br/ and http://aliceweb.mdic.gov.br/

The advancement of information technology facilitated the dynamic management of foreign trade databases in different countries. The notions of "ubiquity" and "diversity" are the central variables that assist in the evaluation of the "Economic Complexity" of the countries[7]. We understand that a diversified productive agenda excluding other countries reflects a more sophisticated technological structure and generates global asymmetries. The production of rare items in nature, for example, may even be exclusive, but does not draw other knowledge-intensive activities, acting as low-dynamism-generating enclaves.

Therefore, countries capable of producing a diversified production pattern (the other extreme would be monoculture) and which is difficult for others to reproduce tend to be of higher economic complexity and have a higher *Economic Complexity Index* (ECI). This information was systematized in the Atlas of Economic Complexity, in which it is possible to view the geopolitics of the productive specialization that has an overwhelming impact on health, since all HEIC activities are part of the high economic complexity products.

Figure 1 clearly shows that the Atlas of Economic Complexity reflects geopolitics that associate the economic and political dominance of hegemonic or hegemony-seeking countries – such as China – through the qualification of their productive and technological systems in more dynamic, exclusive products that leverage productive chains and, as in the case of health are essential in both substantive terms related to human needs and the commercial practices of large companies that dominate global production.

The darker the map, the greater the economic complexity of the dominant national productive systems. It is clear that there is a marked global asymmetry and that the U.S., Europe and China are the dominant forces of the global technological pattern and this is clear in the case of health, as shown in Graph 1. The centre-periphery reality reemerges with strength in the era of globalization, making some countries more independent in dominating a technological pattern that favors the autonomy for the setting of universal systems and others without much capacity to go beyond compensatory policies, since they are subordinated and dependent.

Based on these guidelines, it is possible to establish other highly relevant correlations for the social determinants of health, with emphasis on equity. Hartmann et al. further analyzed the relationship between economic complexity and

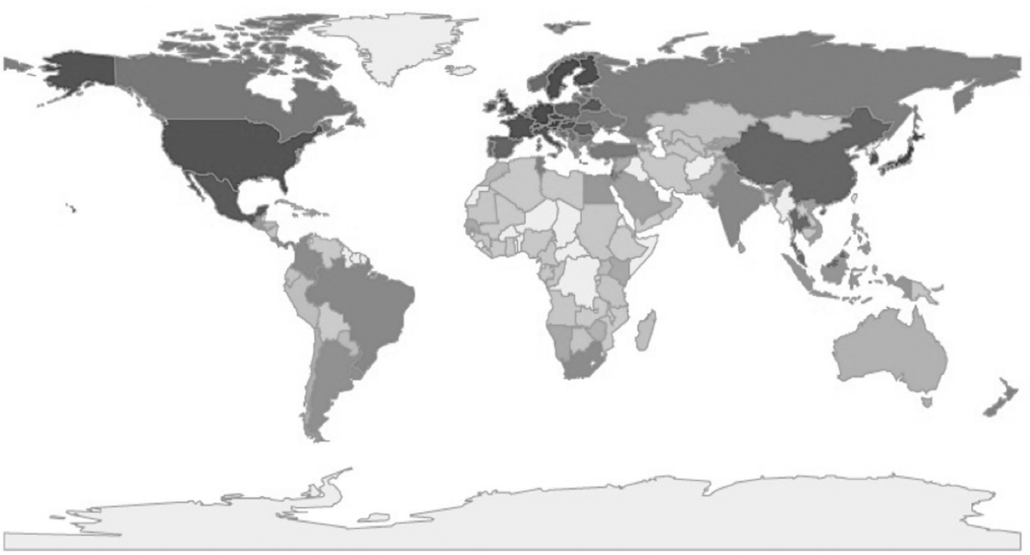


Figure 1. Global distribution of productive activities by economic complexity.

Source: Atlas of Economic Complexity[5].

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income inequality and concluded that these factors are closely linked, going so far as to propose a Gini Index associated with Products and the productive base[17]. Less unequal countries also have a productive and technological base that generates greater added value due to the sophistication of its incorporated knowledge.

Evidence of great importance emerges here that reinforces the structuralist thesis that more equitative societies must have a denser economic structure in terms of knowledge. It is no coincidence that the fact that unequal and historically slave-owning societies are primary exporters, poor in social and technological terms. There is a political economy that associates the technological base with the social structure that must be explored, avoiding any technological determinism. However, this factor points out that the social, economic, technological and political realms of development are interdependent and involve common elements related to the particular historical trend of different countries.

It appears that economies strongly based on the primary sector tend to correspond to societies in which the gap of economic inequality is most pronounced. Economies whose production is denser in terms of knowledge and innovation, in turn, have greater structural potential and degrees of freedom to establish less stratified societies and with more equitable distributions of income, including universal protection systems that require sovereignty over the appropriate and necessary technological pattern. This potential may or may not materialize depending on the political and social forces in dispute in national development strategies. Taking this relation to hypothetical limits, on the one hand, we have a country of social welfare with a technology-intensive production and, on the other hand, a nation based on something very similar to the extractivism-exclusion binomial.

In other words, there is a strong relationship between national economic complexity and the inequality to which they are subjected. It is thus possible to directly assess which productive sectors are most likely to mitigate these discrepancies, and these fronts are central and simultaneous objects to a political agenda focused on economic, social and environmental development.

This approach can also be used in the intra-national context. Freitas and Paiva[18] applied the Productive Space methodology to the Brazilian reality, discriminating it geographically. It confirmed the technical-productive inequality between the South-Southeast and North, Northeast and Midwest axis, with a non-casual relationship with regional inequalities in health, as shown by all the literature on social determinants of health. Gala[19] has also been disseminating this methodology, using it in Brazilian, South American and global reality and connecting it to the pioneers of Development Theory and ECLAC.

From a structuralist viewpoint, it is necessary to emphasize that the Productive Space methodology and its improvement, which resulted in Economic Complexity, while being innovative in its form and approach, reaffirm theories proposed by the classical structuralist school[20], with a capacity for collecting, processing and visualizing data updated for current technological capabilities.

It is particularly relevant to highlight this aspect, since Economic Complexity theorists do not stand as antagonists of orthodox economic thought, seeking, rather, an assimilation of their approach through mainstream. We should recognize the relevance of this proposition for the construction of new theories and public policies aimed at mitigating inequalities, without, however, losing sight of the pioneering input of Latin American structuralism, which is particularly important, mainly because they are explicitly situated in a heterodox political economy, since they assume that inequality is not a natural phenomenon, requiring social mobilization and state intervention.

Intellectual property

In the late 1970s, with the leading role played by innovations in a highly competitive global market, countries with technological know-how, especially the United States and Japan, began to exert strong pressure to harden international patent protection patterns for inventions, involving the search for homogenization of the national laws of all countries. The position advocated by the least developed countries, such as India and Brazil[21], was guided by the perspective that the interest and political action of the more developed countries were linked to the search for consolidating the existing international asymmetries, especially health, with the aim of avoiding a more competitive and convergent technological development process that favored access and development of those who had "lagged behind".

In spite of these positions, the view of developed and hegemonic countries was victorious with the conclusion of the Agreement on Trade Related Aspects of Intellectual Property Rights

(TRIPS) in 1994. Its insertion in the then established World Trade Organization (WTO) set a level of rights to be recognized by the States to grant patent privileges, such as the minimum term of 20 years and the prohibition of discrimination of technological segments. With the entry into force of TRIPS in early 1995, these patterns gradually became mandatory for all WTO member countries and had repercussions on the already asymmetric global process of knowledge appropriation.

What has happened since then has been the increase in the number of annual applications and patent filings in the world. According to WIPO statistics, whereas between 1985 and 1994, i.e. in the nine years prior to the onset of TRIPS, patent filings grew at an annual average rate of approximately 0.25% over the next 10 years, between 1994 and 2004, this average increased to around 5.3%, a level sustained in the period 2004-2016[22].

The exponential growth of patent applications has also led to the escalation of global patent licensing. In the period 1985-1994, the granting of patents showed an average annual growth of approximately 0.2%. From 1994 on, considering the period up to 2004, this average growth reached the annual level of 4.5%, that is, approximately 20 times higher than the previous period. The average growth was even higher in the period 2004-2016 (6.6%)[22]. As a result, the number of patents in force in the world doubled, increasing from almost 5.9 million in 2004 to approximately 11.8 million in 2016[22,23].

These data, however, do not reflect a necessarily more innovative world – about which the economic literature itself points out ambiguities in the relationship between patent protection and innovation rate – but rather point to the enhanced appropriation of technological knowledge produced. In Health, we note the launching of an expressive set of patented products with a low degree of innovation and abundance of initiatives aimed at extending the validity of patent privileges, showing that rules established by the current system may be more closely linked to monopoly practices than incentive for innovation[24].

In addition to an exponential demand for the appropriation of technological knowledge in the world, asymmetries in this process are identified if we consider the distribution of countries by income groups – high income, which includes countries such as the United States, Japan, Germany and England; middle income countries, such as Brazil, China, Mexico, and South Africa; lower middle income, such as Egypt, India, Bolivia, Indonesia, among others; and low-income countries, such as Ethiopia, Haiti and Nepal[23].

The investigation of the relationship between patents of residents and nonresidents – here considered as: a) patents of residents, those whose first applicant or assignee is resident in the country where the filing was made; and b) non-resident patents, those of residents of other countries[23] – reveals much more than just the original property of technology. It also notes the national capacity of countries to generate technologies, the interest of their holders in the foreign market and shows deep asymmetries between technology-owning and non-technology-owning countries[25].

In 1997, that is, two years after TRIPS' entry into force, of the total number of applications filed worldwide, 63.4% were residents and the remainder were non-residents. This ratio has suffered favorable variations to the participation of residents, which in 2016 reached the level of 70.9%. As shown in Table 1, its distribution by country, considering the income category, indicated that, in 1997, 87.9% of the applications filed worldwide were so in high-income countries, of which 59.4% belonged to its residents. By 2016, the percentage of participation of these countries in total annual filings in relation to the world total had fallen to 49.6% and only 29.4% would be of their residents. In the upper middle-income countries, participation in total global filings increased from 9.4% in 2004 to 47.6% in 2016, with resident participation growing from 3.3% to 40.6% % of total world filings. Patent filing applications in lower- and lower-middle-income countries remained insignificant and participation of their residents in the world total was negligible as well[22].

If we compare only the participation of high-income and upper-middle-income countries in the period 1997-2016, change is mainly due to the sharp increase in China's share. For more than 20 years, this country has been showing an average annual growth rate of patent application filings of approximately 23% – increasing from 24,774 in 1997 to 1,338,503 in 2016. In addition, the explosion of filings in that country is associated with the participation of residents, which grew at an annual average of 27.7%in the period 1997-2016, while non-residents recorded only 14%, and as of 2012, Chinese residents became the main patent filers in the world[26].

Thus, if we isolate China, the reality revealed is completely different. Despite significant im-

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Table 1. Trend of the distribution of patent filings by groups of countries.

Countries by income category	Patents filed								
	World total (%)			Residents in relation to filings in the income category (%)			Residents in relation to world filings (%)		
	1997	2004	2016	1997	2004	2016	1997	2004	2016
High Income	87.9%	82.8%	49.6%	67.7%	65.3%	59.1%	59.4%	54.1%	29.4%
Upper middle-income (with China)	9.4%	14.4%	47.6%	36.5%	46.0%	85.3%	3.3%	6.6%	40.6%
Upper middle-income (without China)	7.3%	6.2%	4.8%	29.6%	40.0%	42.9%	2.2%	2.5%	2.1%
China	2.1%	8.3%	42.8%	51.2%	50.5%	90.0%	1.1%	4.2%	38.5%
Lower middle-income	2.6%	2.4%	2.4%	29.1%	29.1%	26.7%	0.8%	0.7%	0.6%
Low Income	0.1%	0.4%	0.3%	12.5%	89.6%	86.0%	0.0%	0.4%	0.3%

Source: Prepared by authors from the information base of the Coordination of Prospecting Actions of the Presidency / Group of Studies on Development, Economic-Industrial Complex and Innovation in Health, Fiocruz, with data from the World Intellectual Property Organization, 2017.

proved participation of residents of upper-middle-income countries, considering filings made in countries in this income category, which hiked from 29.6% in 1997 to 42.9% in 2016, the share of residents of these countries in world filings remained practically stable at close to only 2%.

A more specific assessment of health asymmetries can be performed by investigating data on the granting of patents in the category of medical technologies and pharmaceuticals. Considering the period 1997-2016, it is observed that the granting of patents in the areas examined grew on average 7.3% for medical technology and 5.9% for pharmaceuticals. In the first case, the proportion of patents granted in relation to the world total is increasing, on average, at negligible rates, from 3.1% in 1997 to 4.4% in 2016. The same was true for the category of pharmaceuticals, which grew from 2.4% in 1997 to 3.2% in 2014, but consecutive declining rates in this level were found in 2015 and 2016, with this percentage returning to a level lower than 3% of total grants for the year. In total, patents granted for pharmaceuticals in 2016 were almost 300% higher than in 1997, and this percentage exceeds 370% when considering grants for medical technologies[22].

Table 2 systematizes a broad set of data on granted patents, showing that the overall asymmetric process is reproduced within the industrial segments of the HEIC. It indicates, in particular, an increased concentration of knowledge appropriation by high-income countries and China, intensifying global inequalities in both general and health terms. There is also a considerable decreased participation of the residents of upper middle-income countries in the percentage of patents granted, which includes Brazil.

That is, the technological knowledge generated in the world is increasingly protected by patents in more concentrated and asymmetric fashion, now polarized between high-income countries and China. The intensification of these inequalities is also manifest, and strikingly, in the field of health, which translates into a growing risk to sustainable universal health systems and to the well-being of the most disadvantaged populations, with absolute exclusion resulting from the monopoly conferred by patents.

In the 2016 WIPO ranking, Brazil appears as the 11th largest patent office in the world in terms of volume of filings, although it accounts for less than 1% of the world total[27]. In 1997, residents' participation in filings made in Brazil corresponded to 34.9% of the total, which was above the average of the set of upper middle-income countries, once again excluding China. However, the trend of Brazilian residents' participation has declined over the years (only 18.6% in 2016), not following the growth observed in all countries in this income category, which achieved 42.9% in the same year (Table 1).

In health, the poor performance is even sharper. Residents' share of patent application filings in the pharmaceuticals and medical technology segment has been on average lower than that of all other technological categories. In 2006, while average participation of residents in the

country was 20%, medical technology recorded 17.6% and pharmaceuticals only 5%[28,29]. By 2012, overall resident participation had fallen to 15.8%, residents' share of pharmaceutical patent application filings remained stable at 5%, 10 percentage points below the overall average, and in the field of medical technologies, this share had plummeted to 7.6%[30].

These data show that the production base is structurally dependent on health imports (as the trade balance data show), the country's productive activity is linked to a pattern of low technological dynamism and low value-added generation and that there is a growing and asymmetric process of private appropriation of health technologies that may evidence the exclusion of the Country in the most knowledge-intensive HEIC segments.

Final comments

This paper shows the recent context of transformations and generation of global technological asymmetries that consolidate the existence of inequality in national development patterns that add to social inequalities. It was possible to associate, in articulated and non-traditional fashion, a robust base of information and indicators involving trade balance, the structural heterogene-

Table 2. Trend and distribution of patents: total and categories related to HEIC by groups of countries.

Technology categories	All categories				Medical technology				Pharmaceuticals			
Year	1994	2004	2014	2016	1994	2004	2014	2016	1994	2004	2014	2016
Total grants	398,462	567,986	1,120,351	1,272,616	14,825	23,902	51,848	59,538	10,594	18,172	37,209	35,950
(%) in relation to total grants	100%	100%	100%	100%	3.7%	4.2%	4.6%	4.7%	2.7%	3.2%	3.3%	2.8%
(%) residents	60.5%	61.5%	63.3%	63.6%	63.6%	62.8%	55.6%	53.6%	33.8%	43.0%	50.3%	46.3%
(%) non-residents	39.5%	38.5%	36.7%	36.4%	36.4%	37.2%	44.4%	46.4%	66.2%	57.0%	49.7%	53.7%
High income	358,636	473,498	840,560	811,201	13,020	18,827	42,478	44,952	9,100	11,026	22,781	22,755
(%) in relation to total grants	90.01%	83.36%	75.03%	63.74%	3.3%	3.3%	3.8%	3.5%	2.3%	1.9%	2.0%	1.8%
(%) in the category of technology	90.01%	83.36%	75.03%	63.74%	87.8%	78.8%	81.9%	75.5%	85.9%	60.7%	61.2%	63.3%
Residents - total grants	216,516	303,178	528,167	493,935	8,218	11,449	24,160	25,155	3,138	4,458	9,284	9,003
(%) in the category of income	54.34%	53.38%	47.14%	38.81%	63.1%	60.8%	56.9%	56.0%	34.5%	40.4%	40.8%	39.6%
Non-Residents - total grants	142,120	170,320	312,393	317,266	4,802	7,378	18,318	19,797	5,962	6,568	13,497	13,752
(%) in the category of income	35.67%	29.99%	27.88%	24.93%	36.9%	39.2%	43.1%	44.0%	65.5%	59.6%	59.2%	60.4%
Upper middle-income	38,426	84,058	274,090	457,479	1,744	3,809	9,163	14,399	1,349	5,838	13,718	12,678
(%) in relation to total grants	9.64%	14.80%	24.46%	35.95%	0.4%	0.7%	0.8%	1.1%	0.3%	1.0%	1.2%	1.0%
(%) in the category of technology	9.64%	14.80%	24.46%	35.95%	11.8%	15.9%	17.7%	24.2%	12.7%	32.1%	36.9%	35.3%
Residents - total grants	24,516	38,359	178,829	313,401	1,210	2,360	4,525	6,614	438	2,755	9,328	7,532
(%) in the category of income	6.15%	6.75%	15.96%	24.63%	69.4%	62.0%	49.4%	45.9%	32.5%	47.2%	68.0%	59.4%
Non-Residents - total grants	13,910	45,699	95,261	144,078	534	1,449	4,638	7,785	911	3,083	4,390	5,146
(%) in the category of income	3.49%	8.05%	8.50%	11.32%	30.6%	38.0%	50.6%	54.1%	67.5%	52.8%	32.0%	40.6%
Upper middle-income (except China)	34,554	34,791	47,836	51,628	1,598	2,485	2,540	2,921	1,238	2,777	2,827	3,410
(%) in relation to total grants	8.67%	6.13%	4.27%	4.06%	0.4%	0.4%	0.2%	0.2%	0.3%	0.5%	0.3%	0.3%
(%) in the category of technology	8.67%	6.13%	4.27%	4.06%	10.8%	10.4%	4.9%	4.9%	11.7%	15.3%	7.6%	9.5%
Residents - total grants	22,891	20,857	25,134	22,211	1,125	1,921	1,395	1,231	419	915	918	795
(%) in the category of income	5.74%	3.67%	2.24%	1.75%	70.4%	77.3%	54.9%	42.1%	33.8%	32.9%	32.5%	23.3%
Non-Residents - total grants	11,663	13,934	22,702	29,417	473	564	1,145	1,690	819	1,862	1,909	2,615
(%) in the category of income	2.93%	2.45%	2.03%	2.31%	29.6%	22.7%	45.1%	57.9%	66.2%	67.1%	67.5%	76.7%

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ity of the productive base and the private appropriation of technologies. All these three realms have converged to reinforce the theoretical perception that current globalization is taking place by reinforcing the economic and political asymmetries between different countries and regions.

It is no coincidence that one lives a period in which the neoliberal agenda simultaneously attacks the welfare state, the national productive base and the activities of science, technology and innovation. It is in fact the search for developed countries or those that, like China, have projects of global hegemony, to reaffirm and consolidate their power to define the global technological pattern and the passive introduction of peripheral countries such as Brazil. Response to this global reality necessarily involves a development strategy that articulates, at the same time, health as a universal right, the reconstruction of the national productive base in the HEIC and STI activities in health as part of a national strategy in which health is a strategic axis. This articulation proves to be essential for overcoming blockages arising from structural dependence restricting the consolidation of the SUS as a universal, equitable and comprehensive system.

Table 2. Trend and distribution of patents: total and categories related to HEIC by groups of countries.

Technology categories	All categories				Medical technology				Pharmaceuticals			
Year	1994	2004	2014	2016	1994	2004	2014	2016	1994	2004	2014	2016
CHINA	3,872	49,267	226,254	405,851	146	1,324	6,623	11,478	111	3,061	10,891	9,268
(%) in relation to total grants	0.97%	8.67%	20.19%	31.89%	0.0%	0.2%	0.6%	0.9%	0.0%	0.5%	1.0%	0.7%
(%) in the category of technology	0.97%	8.67%	20.19%	31.89%	1.0%	5.5%	12.8%	19.3%	1.0%	16.8%	29.3%	25.8%
Residents - total grants	1,625	17,502	153,695	291,190	85	439	3,130	5,383	19	1,840	8,410	6,737
(%) in the category of income	0.41%	3.08%	13.72%	22.88%	58.2%	33.2%	47.3%	46.9%	17.1%	60.1%	77.2%	72.7%
Non-Residents - total grants	2,247	31,765	72,559	114,661	61	885	3,493	6,095	92	1,221	2,481	2,531
(%) in the category of income	0.56%	5.59%	6.48%	9.01%	41.8%	66.8%	52.7%	53.1%	82.9%	39.9%	22.8%	27.3%
Lower middle-income	973	9,953	5,422	3,441	47	1,256	202	178	70	1,179	660	443
(%) in relation to total grants	0.24%	1.75%	0.48%	0.27%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%
(%) in the category of technology	0.24%	1.75%	0.48%	0.27%	0.3%	5.3%	0.4%	0.3%	0.7%	6.5%	1.8%	1.2%
Residents - total grants	151	7,769	2,148	1,539	6	1,206	137	127	4	590	120	121
(%) in the category of income	0.04%	1.37%	0.19%	0.12%	12.8%	96.0%	67.8%	71.3%	5.7%	50.0%	18.2%	27.3%
Non-Residents - total grants	822	2,184	3,274	1,902	41	50	65	51	66	589	540	322
(%) in the category of income	0.21%	0.38%	0.29%	0.15%	87.2%	4.0%	32.2%	28.7%	94.3%	50.0%	81.8%	72.7%
Low income	427	477	279	495	14	10	5	9	75	129	50	74
(%) in relation to total grants	0.11%	0.08%	0.02%	0.04%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
(%) in the category of technology	0.11%	0.08%	0.02%	0.04%	0.1%	0.0%	0.0%	0.0%	0.7%	0.7%	0.1%	0.2%
Residents - total grants	23	12	0	6	2	1	0	0	3	4	0	1
(%) in the category of income	0.01%	0.00%	0.00%	0.00%	14.3%	10.0%	0.0%	0.0%	4.0%	3.1%	0.0%	1.4%
Non-Residents - total grants	404	465	279	489	12	9	5	9	72	125	50	73
(%) in the category of income	0.10%	0.08%	0.02%	0.04%	85.7%	90.0%	100.0%	100.0%	96.0%	96.9%	100.0%	98.6%

Source: Prepared by authors from the information base of the Coordination of Prospecting Actions of the Presidency / Group of Studies on Development, Economic-Industrial Complex and Innovation in Health, Fiocruz, with data from the World Intellectual Property Organization, 2017.

Collaborations

CAG Gadelha participated in coordination of design, outline and analysis; MAC Nascimento participated in support for design, research and methodology with emphasis on economic complexity; PSC Braga participated in research and methodology with emphasis on intellectual property; and BB Cesário participated in research and methodology with emphasis on foreign trade.

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