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MISSION HEALTHCARE: USING ECONOMIC COMPLEXITY TO DEVISE MISSION-ORIENTED DIVERSIFICATION STRATEGIES FOR BRAZIL

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MISSION HEALTHCARE: USING ECONOMIC COMPLEXITY TO DEVISE MISSION-ORIENTED DIVERSIFICATION STRATEGIES FOR BRAZIL

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SUMÁRIO

ABSTRACT

The paper seeks to combine mission-oriented and complexity-based smart specialization policies to devise diversification strategies focused on health-related products for Brazil. The approach is largely empirical and applies the economic complexity methodology to assess the best routes for Brazil, a country facing severe economic constraints but with a considerable level of productive capabilities already established in the healthcare sector. The mission-oriented development strategy outlined in this paper seeks enhance Brazil's productive specialization while addressing also socioeconomic and environmental challenges.

RESUMO

O artigo busca combinar políticas orientadas por missões e de diversificação baseadas em complexidade econômica para formular estratégias de diversificação para o Brasil, focadas nos produtos do complexo industrial da saúde. A abordagem empírica se utiliza da metodologia de complexidade econômica para identificar as melhores rotas de diversificação para o Brasil, um país que enfrenta restrições econômicas severas, mas que apresenta considerável nível de capacidades produtivas já estabelecidas no setor da saúde. A estratégia de desenvolvimento orientada por missão proposta nesse ártico busca aprimorar a especialização produtiva brasileira ao mesmo tempo em que busca lidar com os desafios socioeconômicos e ambientais do país.

Keywords: Economic Development; Economic Complexity; Mission-Oriented; Diversification.
J.E.L.: O14; O25; O32.

1. INTRODUCTION

In the last few years, there has been growing interest in the subject of smart specialization strategies. This is partially due to influence of the economic complexity literature. Inaugurated by the work of a group of researchers from Harvard and the Massachusetts Institute of Technology, this empirical literature has developed pathbreaking tools to reveal the hidden links between productive sectors, enabling the establishment of specialization/diversification strategies to foster economic development.

The approach is based on the application of network analysis methods to highly disaggregated international trade data, aiming to uncover the capabilities shared by different productive sectors and activities. Using a set of simple indicators based on the notion of ubiquity and diversity[1], Hidalgo et al. (2007) was able to map the proximity between the productive knowledge required to produce competitively any pair of goods or activities, according to the probability of competitive co-production. The *Product Space*, as it was named, allows the visualization of the proximity or relatedness of products.

Among the most important findings of this literature is the fact that, because of differences in accumulated knowledge between economies, the process of development is heavily path dependent. In developing economies, the limited set of productive knowledge can dramatically reduce the number of routes available to accelerate growth and economic transformation. Hausmann et al. (2014) also provided evidence that increases in the economic complexity are associated to higher growth rates of income per capita. Moreover, the innovative works of Hartmann *et al.* (2017) and Romero and Gramkow (2021) also showed that economic complexity is associated with reductions in inequality and in greenhouse gas emissions per capita, strengthening the importance of increasing economic complexity for sustainable development.

Taking stock of this body of work, recent studies have been seeking to use indicators based on the economic complexity methodology to guide the formulation of development policies. Hausmann and Chauvin (2015) and Hausmann, Santos and Obach (2017) adapted the economic complexity measures to identify promising sectors for the development of Rwanda and Panama, respectively. Balland *et al.* (2018) incorporated patent data in the approach to measure local technological knowledge that can guide the formulation of regional smart specialization strategies.

In the aftermath of the Covid-19 outbreak, for the resumption of post-pandemic growth, Europe and the United States are adopting extremely ambitious development plans anchored in public spending. In the United States, the Biden Plan seeks to invest $2 trillion in infrastructure, green science and technology, housing and other areas, including transfers to affected families. Similarly, the European *Green Deal* will invest 1.8 trillion euros for the development of green technologies and support to regional and industrial development policies.

This paper seeks to combine mission-oriented and complexity-based smart specialization policies to devise diversification strategies focused on health-related products for Brazil. The approach

[1] Combining these two raw measures, the authors created the indexes of complexity of products (PCI) and economies (ECI). The former indicates the amount of productive knowledge required to produce each good competitively. The latter indicates the amount of productive knowledge available in each economy.

is largely empirical and applies the economic complexity methodology to assess the best routes for Brazil, a country facing severe economic constraints but with a considerable level of productive capabilities already established in the healthcare sector.

2. MISSION-ORIENTED DEVELOPMENT STRATEGIES

Mission-oriented development strategies have gained considerable ground in the developed world in recent years. According to Mazzucato (2018), “missions require a vision about the direction in which to drive an economy, focusing investment in particular areas”. Missions must indicate a rout (R), mobilize organizations (O), generate adequate assessment (A) mechanisms, and distribute adequately the rewards (R) of the policies.

In *Governing Missions in the European Union,* Mazzucato (2019) stresses some important guidelines for the design of mission-oriented development policies. The author emphasizes both (i) the importance of engaging citizens in the processes of defining, implementing, and monitoring missions, and (ii) the central role played by public procurement in fostering innovation, especially by creating new markets.

Accordingly, state interventions should not aim at mending market failures, but to fostering the development of new markets and innovation. Mazzucato (2013) recommends that the State should indeed act as an entrepreneur, taking the lead in directing the innovative activity and financing higher risk activities, especially in the initial stages of research.

This approach towards state interventions in areas of greater uncertainty requires a different perspective when evaluating the results of the supported projects, with the acknowledgment of failures as a natural and inherent part of the learning process that characterizes economic and technological development. The author also draws attention to the fact that missions cannot be evaluated based on simple cost-benefit analyses, but rather in terms of the creation of public value and dynamic efficiency in connection with the mission goals. Finally, Mazzucato (2019) highlights the importance of building capacity in the public sector to increase the coordination of public policies:

> *Breaking silos means taking innovation- led growth out of a narrow field of research and innovation and putting it at the center of the economic growth strategy. The optimal impact would be achieved by structuring the mission strategy and its coordination under the direct responsibility of s most es authority 's executive branch* (Ibid, p. 12-13).

The *Horizon Europe* research and innovation program constitutes a clear example directing the state planning towards structuring ambitious development strategies. The program is underpinned on the premisses of mission-oriented development strategies, aiming at mitigating climate change while collaborating to achieve the UN Sustainable Development Goals. To achieve these goals, in the period between 2021 and 2027, 95.5 billion euros are expected to be invested in: (i) building scientific excellence; (ii) global challenges and industrial competitiveness; (iii) innovation; (iv) expansion of participation and partnerships. The program is structured around 5 missions: (1) adaptation to climate change; (2) prevention and treatment of cancer; (3) ocean cleansing; (4) smart and green cities; (5) soil quality and agriculture.

Yet, despite the project's importance, its centrality is still limited in relation to the objectives of the mission-based development approach, and there is still great room for improvement and expansion.

In the United States, the Biden Plan goes in a similar direction, directing $2 trillion to investments in the areas of: (i) infrastructure and electric vehicles; (ii) science, technology and green industry; (iii) assistance to the elderly and the disabled; (iv) broadband and training work. Even though based in a completely different innovation and planning system, the plan indicates a change in the government’s view, with a clear increase in the interest of the state in coordinating the efforts in different areas. As highlighted by Mazzucato (2013) and Wade (2014), even though the US disposes of a wide network of R&D institutions and the support from its competitive industry, this apparatus has been poorly coordinated for a long time. On the one hand, the US central government displayed a pro-market discourse and against intervention over the last decades. On the other hand, however, large investments were intended to support institutions such as NASA, the Defense Advanced Research Projects Agency (DARPA), the Sematech, the National Institute of Health (NIH), the National Nanotechnology Initiative (NNI), the Small Business Innovation Research (SBIR), among other examples. The novelty now, therefore, is the construction of a more integrated and explicit investment program aiming at productive and technological development.

2.1 Mission-oriented development strategies in developing countries

The power of the mission-oriented development approach lies in the combination of socio-economic and technological development efforts. Notwithstanding the movements in Europe and in the US, mission-oriented development strategies haven’t yet been adopted in developing economies. A number of reasons explain why this approach has not yet reached the economies where they are most needed, from the lack of resources to the lack of interest of local elites in state inverventions, and the distance of economists and policymakers in these countries in relation to the “technology frontier”.

The lack of resources inflicts these countries in many different hampering the implementation of mission-oriented development strategies. There is a shortage of resources ranging from entrepreneurial capabilities – in the sense of Hirschman (1958) – to human resources and scientific knowledge. Moreover, key institutions are not well structured or simply inexistent, a characteristic of immature National Innovation Systems (Nelson, 1993; Lundvall, 1992). This is aggravated by the tighter fiscal and external constraints of these countries. Fiscal stimulus tends to impact more rapidly on inflation, triggering restrictive monetary responses. Also, higher growth rates often lead to trade deficits that increase foreign indebtedness, causing sudden stops and exchange rate crises that reduce growth in order to reestablish balance-of-payments equilibrium (Thirlwall, 1979).

Consequently, the developing economies require a more rational approach when designing mission-oriented development strategies. At one side, the chosen mission should be capable of mobilizing efforts that entail contributions to multiple objectives. One the other, the strategy needs to have a clearer focus and, at least at first, less ambitious than the ones designed for developed economies. With the maturation of the policies, and in case of positive results, it would be possible to expand it to address more ambitious goals.

3. IMPROVING HEALTHCARE SERVICES AS A CORE MISSION FOR BRAZIL

The covid-19 pandemic created a clear rout for mission-oriented policies in the developing world. Although the organizations and assessment mechanisms might vary from country to country, the rewards of redirecting policies towards strengthening public healthcare and the related sectors are extremely clear. Public healthcare provides an important contribution to reduce income inequality in underdeveloped economies, as the provision of the service constitutes an indirect increase in the income of poor families. Furthermore, increases in the population health tends to reverberate on the overall productivity. Furthermore, health-related manufacturing industries and services usually display high R&D intensity, which, once again, tends to impact on the country's productivity.[2]

Hence, fostering the provision of healthcare related products and services can positively affect several socioeconomic and environmental goals of developing economies, in a clear association between mission oriented and smart specialization development strategies.[3]

The report *Pictures of the Brazilian Society: the country's main problems and priorities*, prepared regularly by the National Confederation of Industry (CNI, 2020; 2021), interviews each year circa two thousand people in 127 municipalities to know, among other things, what should be the government's priorities for the next year. Among the options, "Improving healthcare services" came in 1st place in 2018, 3rd in 2019 and 2nd in 2020. In those years, between 30 and 40% of respondents indicated that healthcare should be the priority. "Promoting job creation" ranked 2nd in 2018, moved to 1st in 2019 along with "Improving the quality of education", and returned to 1st in 2020.

Taking the results of the CNI surveys into account as well as the impacts of the covid-19 pandemic, a clear indication emerges for the core mission to be adopted in Brazil: to improve its healthcare services[4].

2 Indeed, high technological intensity sectors, such as pharmaceuticals and medical equipment, display strong economies of scale. Romero and Britto (2017) found that the returns to scale in high-tech sectors are considerably higher than those in other sectors, even when considering differences in research intensity.

3 Economic development is inseparable from the process of structural transformation, which involves learning and mastering new economic activities. In the classical development literature, this process is associated with increments in the participation of the manufacturing sectors in the economy (Schumpeter, 1934; Prebisch, 1962; Furtado, 1964; Hirschman, 1958; Kaldor, 1966), whereas in the contemporary literature the emphasis is on specific high-tech industries, as the latter became increasingly more heterogeneous, requiring specialized knowledge and interconnected production networks for competitive production.

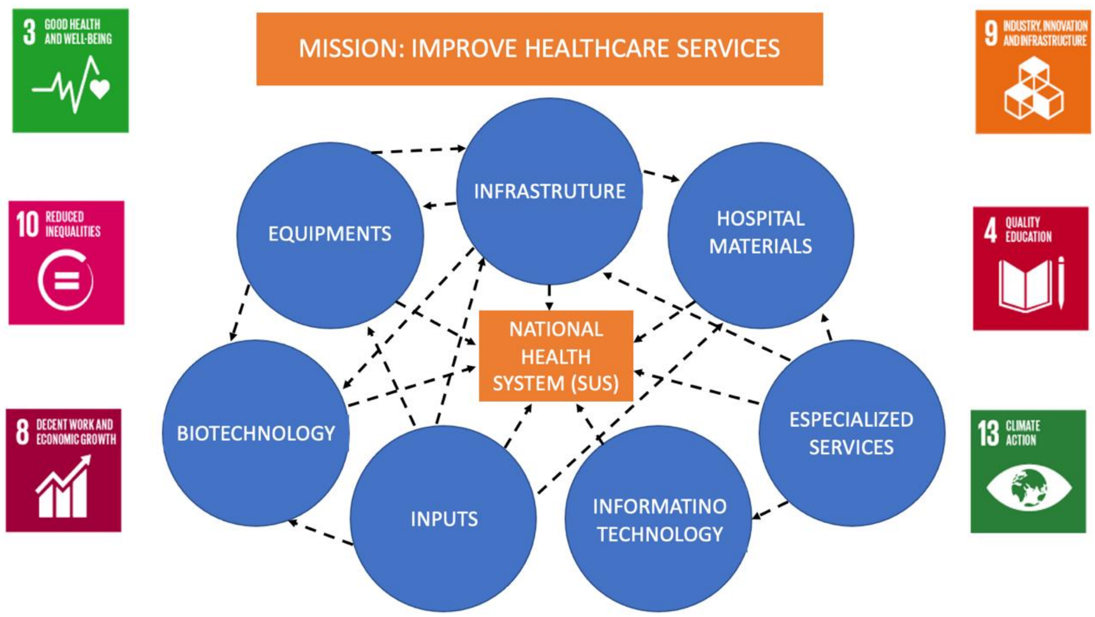
4 To better draw this mission, however, one would need to perform more specific queries and improve citizen participation in the decision on the secondary objectives to be prioritized.

Brazil has two important characteristics that make the development strategy anchored in the provision of public healthcare particularly interesting.

First, the productive and service capacity already accumulated by the SUS and by institutions that make up the system (such as Fiocruz, Butantan, etc.) makes the healthcare industrial complex a natural candidate for development policies in Brazil. In a seminal study, Romero and Freitas (2018) applied economic complexity indicators to identify promising sectors for enhancing the productive development of Brazil. The choice was based on determinants of three different dimensions: (i) current capabilities; (ii) market opportunities; and (iii) complexity gains. Among the 20 product categories identified, there are 4 categories directly related to the healthcare industrial complex: (1) Medicaments, packaged (4th); (2) Serums and vaccines (6th); (3) Heterocyclic compounds in nitrogen (8th); and (4) Medical instruments (13th). In addition, a number of other categories include components that can be used in the healthcare complex, such as *Air Pumps* (14th) or *Other machinery* (15th).

Secondly, Brazil has the largest universal healthcare system in the world with, virtually, all its 220 million population covered. The hybrid system requires massive public and private purchases which, if well directed, can thrust the healthcare industrial complex in the country boosting growth in the associated sectors. The healthcare sector employs circa 8 million people in the country, accounting for 9% of the Brazilian GDP (Gadelha, 2021). At the same time, as a knowledge-intensive sector, which currently accounts for 30% of the national R&D, it has an increased potential to stimulate the development of related sectors of the chemical and biotechnological industries, as well as in subsystems of the mechanic, electronic and materials industries.

FIGURE 1
Mission Healthcare: Macro-areas and Sustainable Development Goals



Source: Authors' own elaboration.

The mission of *Improving healthcare services*, in particular, fulfills the core mission role as well. As shown in Figure 1, this mission is able to contribute to the achievement of several Sustainable Development Goals:

(3) *Health & Wellness* – Directly related to the core mission;

(10) *Reducing inequalities* – The provision of public health services has a strong impact on reducing inequality;

(8) *Decent work and economic growth* – The development of the healthcare industrial complex and the sectors associated with it has enormous potential for generating high quality jobs and growth in production as well as in productivity;

(9) *Industry, innovation and infrastructure* - The development of the healthcare industrial complex and its associated sectors is likely to drive innovation in different industries and necessarily requires improvements in infrastructure;

(4) *Quality education* – Fundamental component to fulfill the proposed mission;

(3) *Action against global climate change* – Developing the healthcare industrial complex would lead to an increase in Brazil's economic complexity, which contributes to the reduction of per capita greenhouse gas emissions and in income inequality (Romero and Gramkow, 2021).

Figure 1 illustrates the capacity of the healthcare industrial complex to boost activities of different sectors and to promote the interactions between them. The improvement of health services requires the use of more and better equipment, health-personnel, hospital materials and specialized services (such as laboratory), etc. All these investments can certainly accelerate growth and foster the process of development.

4. AN ECONOMIC COMPLEXITY DIVERSIFICATION STRATEGY FOR THE BRAZILIAN HEALTHCARE INDUSTRIAL COMPLEX

4.1. Data and methodology

The empirical analysis in this paper is based on complexity measures and export data retrieved from the *Atlas of Economic Complexity*, for the pre-pandemic year of 2018. The data is classified according to the Harmonized System (2007) at the 4-digit level.

We use four complexity indicators to identify the promising sectors for smart diversification in Brazil: (i) Revealed Comparative Advantage (RCA); (ii) density; (iii) the Product Complexity Index (PCI); and (iv) the international market size. These indexes are calculated as:

$$RCA_{cp} = \frac{x_{cp}/\sum_p x_{cp}}{\sum_c x_{cp}/\sum_c \sum_p x_{cp}} \qquad (1)$$

$$Density_{cp} = \sum_{p'} M_{cp'} \emptyset_{pp'} / \sum_{p'} \emptyset_{pp'} \qquad (2)$$

$$PCI = (\vec{Q} - < \vec{Q} >)/sd(\vec{Q}) \qquad (3)$$

$$Market_p = \sum_c \sum_p x_{cp} \qquad (4)$$

where *x* denotes exports, and the subscripts *c* and *p* denote country and product, respectively. An RCA above 1 indicates that the country is competitive in the production of product in question, while the opposite holds if the index is lower than 1. *M* is a *dummy that* equals to 1 if the country *c* exports the product *p* with RCA and 0 otherwise, and $\emptyset_{pp'} = \sum_c M_{cp} M_{cp'} / max(k_{p,0} k_{p',0})$ is the proximity between products *p* and *p'*.

First and foremost, since the RCA index indicates the relative level of competitiveness of the country in the production of each good, the closer the index is to one, the closer the country is to achieving a competitive production in that industry. Hence, the index is the primary indicator of the sectors that are the closest to becoming competitive in international markets.

Second, the density index indicates how close the production of each good is in relation to the industries in which the country is competitive (RCA>1). Several studies find evidence that a diversification into closer industries, i.e., industries with no RCA but high-density, tends to be more successful. This happens because industry relatedness indicates the proximity in terms of the capabilities used in the production. Consequently, sectors with higher density use a higher proportion of capabilities already in place in the economy. Balland *et al.* (2018), for example, found that density has a positive and significant effect on the probability of the country to assess new technologies. Hence, the density indicator is an additional measure that helps identifying the sectors where the cost of entry is the lowest.

TABLE 1
Industries identified as related to the healthcare industrial complex (2018)

Description	HS4	RCA	Distance	Density	PCI	World Exports	Sector
Vulcanized rubber articles of apparel	4015	0.013	0.847	0.153	-0.385	7.5	Chemicals
Serums and vaccines	3002	0.033	0.867	0.133	1.190	180.0	Chemicals
Nucleic acids and their salts	2934	0.035	0.874	0.126	1.580	16.0	Chemicals
Medicaments, not packaged	3003	0.041	0.859	0.141	0.511	17.0	Chemicals
Diagnostic or laboratory reagents	3822	0.047	0.863	0.137	1.110	25.0	Chemicals
Carbonates	2836	0.097	0.821	0.179	-0.790	8.3	Chemicals
Heterocyclic compounds with nitrogen hetero-atom(s) only	2933	0.112	0.875	0.125	0.993	79.0	Chemicals
Other articles of plastic	3926	0.124	0.866	0.134	0.834	76.0	Chemicals
Medicaments, packaged	3004	0.222	0.853	0.147	0.738	346.0	Chemicals
Acrylic polymers	3906	0.286	0.858	0.142	1.520	16.0	Chemicals
Antibiotics	2941	0.293	0.867	0.133	0.884	11.0	Chemicals
Other inorganic acids	2811	0.383	0.850	0.150	0.253	5.0	Chemicals
Saturated acyclic monocarboxylic acids	2915	0.406	0.857	0.143	1.180	15.0	Chemicals
Wadding, gauze and bandages	3005	0.711	0.861	0.139	0.763	7.8	Chemicals
Pharmaceutical goods	3006	0.713	0.847	0.153	0.733	15.0	Chemicals
Industrial electric furnaces	8514	0.165	0.873	0.127	1.870	5.3	Electronics
Batteries	8507	0.190	0.870	0.130	0.977	52.0	Electronics
Electrical transformers	8504	0.200	0.860	0.140	0.581	88.0	Electronics
Electric motors and generators	8501	0.884	0.869	0.131	0.920	54.0	Electronics
Microscopes, other than optical	9012	0.003	0.882	0.118	1.620	3.1	Machinery
Optical microscopes	9011	0.011	0.884	0.116	0.990	2.5	Machinery
Parts and accessories for office machines	8473	0.026	0.872	0.128	1.170	250.0	Machinery
X-ray machines	9022	0.040	0.877	0.123	1.250	22.0	Machinery
Other breathing appliances and gas masks	9020	0.059	0.859	0.141	0.620	1.7	Machinery
Therapy applicances	9019	0.061	0.865	0.135	0.931	12.0	Machinery
Instruments for physical or chemical analysis	9027	0.061	0.873	0.127	1.620	44.0	Machinery
Glasses	9004	0.064	0.887	0.113	0.721	9.5	Machinery
Measuring instruments	9031	0.077	0.882	0.118	1.820	46.0	Machinery
Medical instruments	9018	0.090	0.865	0.135	0.781	121.0	Machinery
Thermometers, hydrometers etc.	9025	0.123	0.868	0.132	0.987	5.6	Machinery
Instruments for measuring properties of liquids or gases	9026	0.174	0.870	0.130	1.540	22.0	Machinery
Orthopedic appliances	9021	0.182	0.862	0.138	0.881	58.0	Machinery
Gas, liquid or electricity meters	9028	0.270	0.855	0.145	-0.051	7.9	Machinery
Equipment for temperature change of materials	8419	0.274	0.865	0.135	1.550	39.0	Machinery
Appliances for thermostatically controlled valves	8481	0.545	0.879	0.121	1.750	90.0	Machinery
Aluminum containers for compressed or liquefied gas	7613	0.024	0.866	0.134	0.869	531.0	Metals
Containers for compressed or liquified gas	7311	0.231	0.862	0.138	0.041	3.3	Metals
Sanitary ware and parts of iron or steel	7324	0.418	0.872	0.128	0.419	3.1	Metals
Laboratory, hygienic or pharmaceutical glassware	7017	0.017	0.873	0.127	1.690	1.0	Others
Spirits < 80% alcohol	2208	0.092	0.834	0.166	-0.615	32.0	Others
Gloves	6216	0.002	0.849	0.151	-1.110	1.0	Textiles
Gloves, knit	6116	0.007	0.856	0.144	-1.140	4.8	Textiles
Garments made of textile felts and nonwoven fabric	6210	0.008	0.853	0.147	-1.000	10.0	Textiles
Hats, knit	6505	0.009	0.875	0.125	-1.590	5.4	Textiles
Other made up articles	6307	0.037	0.852	0.148	-0.975	14.0	Textiles
Medical, dental or veterinary furniture	9402	0.158	0.864	0.136	0.712	3.9	Textiles
Wadding of textile materials	5601	0.205	0.841	0.159	0.030	2.3	Textiles
Nonwoven textiles	5603	0.489	0.857	0.143	1.080	15.0	Textiles
Textile articles for technical use	5911	0.718	0.859	0.141	1.290	5.2	Textiles

Source: Authors' own elaboration.

Third, the Product Complexity Index (PCI) measures the economic gains from the diversification process. As already mentioned, diversifying into products with higher PCI increases the economy's economic complexity, which entails several benefits, including a higher GDP per capita growth rate (Hausmann *et al.*, 2014), a lower income inequality (Hartmann *et al.*, 2017) and lower greenhouse gas emissions per capita (Romero and Gramkow, 2021.

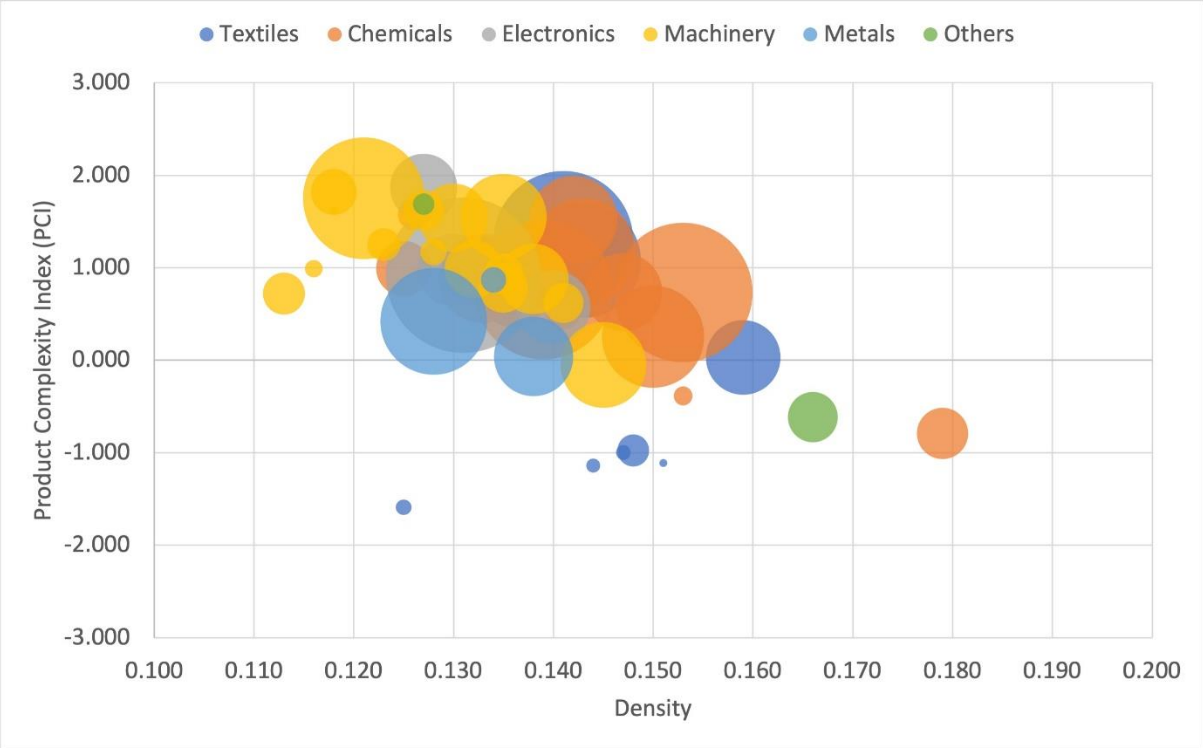
Fourth, the product *p* market size indicator shows the potential additional market return from increasing the production of this industry. Products with higher market sizes boost the production, exports and employment of a country. Although the indicator could be considered of secondary importance, this is also an information that is worth taking into account.

Table 1 presents the values of these four indicators for 49 industries that were identified as producing products that are either directly or indirectly related to the healthcare industrial complex. From these 49 industries, 15 are from Chemical sectors, 4 from Electronics, 16 from Machinery, 3 from Metals, 9 from Textiles and 2 from Other manufacturing sectors. Hence, a high proportion of the health-related industries can be considered high-tech sectors, especially those from Chemicals, Electronics and Machinery.

These industries are presented in Figure 2 according to their levels of PCI and Density. This figure illustrates the relatively wide range of goods taken into account, going from products with a PCI of 1.87, as the case of *Industrial electric furnaces*, to products with a PCI of -1.59, as the case of *Hats, knit*. Moreover, these products present also a considerably wide range in terms of Density, going from 0.113, as the cases of *Glasses*, to 0.179, as in the case of *Carbonates*.

Figure 2 also illustrates the expected negative relationship between PCI and Density in the sample of 49 health-related products. This indicates that most products closer to Brazil's current productive capacity (i.e. with higher Density) are products with relatively lower PCI. This was expected since Brazil still presents a relatively low Economic Complexity Index (ECI), of 0.19 in 2018.

FIGURE 2
Industries identified as related to the healthcare industrial complex



Note: The circle circumference shows the size of sector's Revealed Comparative Advantage (RCA).
Source: Authors' own elaboration.

Based on the four indexes presented in equations (1) to (4), three strategies were defined: (i) a Short-Term strategy, which emphasizes the relatively quick diversification in spite of increasing economic complexity; (ii) a Medium-Term strategy, which pays more attention to diversifying into sectors with relatively higher complexity; and (iii) a Long-Term strategy, focused on sectors of high complexity and high international markets. The rules used to define each of these strategies are summarized in Table 2.

Using the Short-Term strategy we selected 5 promising industries for Brazil's diversification based, at first, on two criteria: (i) presenting a PCI higher than 0.19, Brazil's ECI in 2018; and (ii) presenting RCA higher than 0.5, which means that the country is relatively close to becoming competitive in its production (RCA>1). The products that passed these two criteria were then ranked following their Density.

TABLE 2
Economic complexity diversification strategy

	Short-Term	Medium-Term	Long-Term
Revealed Comparative Advantage (RCA)	> 0.5	> 0.2	-
Density	Ranking	Ranking	-
Product Complexity Index (PCI)	> 0.19	> 0.6	> 1.1
Market size	-	-	Ranking

Source: Authors' own elaboration.

Using the Medium-Term strategy we selected other 5 industries for diversification based on: (i) presenting a PCI higher than 0.6, which is considerably higher than Brazil's ECI; and (ii) presenting RCA higher than 0.2, which means that the country manufacture the product, but is still distant from becoming competitive in it (RCA>1). The products that passed these two criteria were then ranked following their Density.

Finally, using the Long-Term strategy we selected 5 promising industries for diversification based on it displaying a PCI higher than 1.1. Product in this range of PCI are amongst the most complex. The products that passed this criterion were then ranked following the size of their world market size. In this strategy, Density and RCA were not considered, since in this case the strategy focuses only on promising bets for unrelated diversification in spite of on how close these products are from the country's current capabilities. It is important to stress, however, that only products that were already exported by the country were considered, which means that the country is already producing these products with some degree of competitiveness.

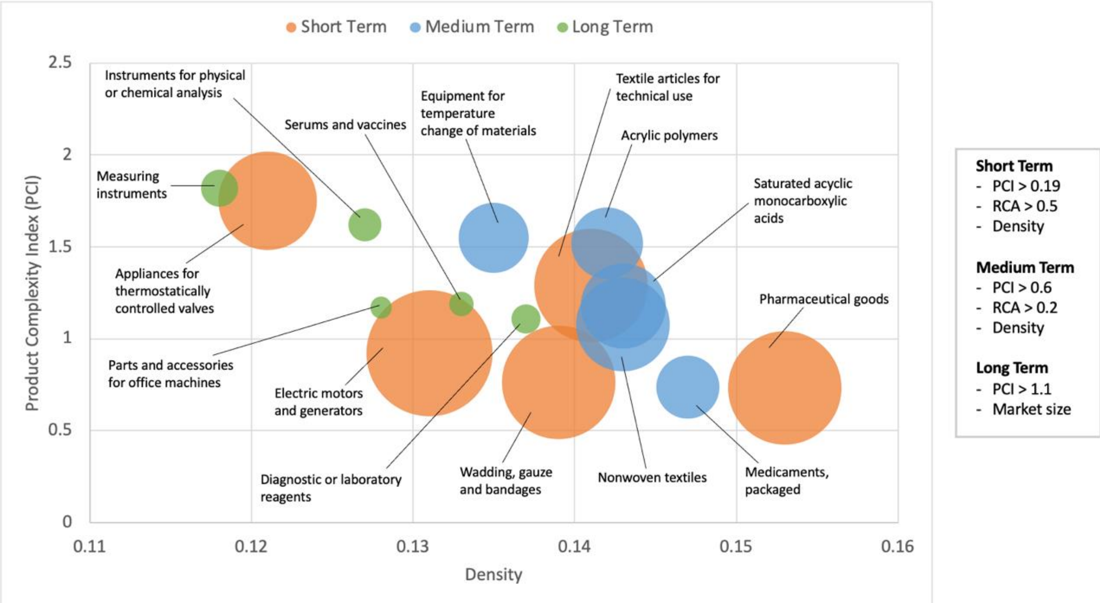
4.2. Results

Figure 3 presents the 15 industries selected to enhance Brazil's diversification into the healthcare industrial complex. First and foremost, it is important to stress that all the industries selected present a relatively high PCI, above 0.5.

The industries in the Short-Term strategy are the ones for which Brazil is closest to becoming competitive (RCA>1), as indicated by the size of the circles. Among the 5 industries in the strategy, 3 are amid the ones with lowest PCI, and 3 amid the ones with highest Density. This indicates lower learning costs involved in expanding the activities to encompass these industries. The results also show one outlier amidst the industries in the Short-Term strategy: *Appliances for thermostatically controlled valves*, which presents a high PCI (1.75) and high RCA (0.545). In the case of this industry – apart from the fact that it is relatively distant from the country's current capacities, as indicated by its low Density (0.121) – Brazil has oddly managed to achieve a considerably high level of competitiveness, which puts the product in the group of the Short-Term strategy.

The industries in the Medium-Term strategy are the ones in the middle ground both in terms of how close Brazil is to becoming competitive in their production (RCA>1) – indicated by the size of the circles – as well as in terms of their Density. Among the 5 industries in the strategy, one is amid the ones with lowest PCI, while 4 are amid the ones with highest Density. Yet, 2 of the industries are amongst those with the highest PCI. In general, therefore, the industries in this group are located more towards the center of Figure 3, in the PCI-Density representation.

FIGURE 3
Industries identified as promising for the development of the Brazilian healthcare industrial complex



Note: Circle sizes indicate the size of sector's Revealed Comparative Advantage (RCA).
Source: Authors' own elaboration.

Finally, the Long-Term industries are the ones with highest PCI, on average, and for which Brazil is still far away from becoming competitive in their production (RCA>1). Among the 5 industries in the Long-Term strategy, 2 are amid the ones with highest PCI but they are also amid the ones with lowest Density, while 3 present intermediate PCI, 2 of which with intermediate Density. Thus, the industries in this group tend to be more distant from the current capacities internalized by the country (which puts them in the left side of the PCI-Density representation). This indicates higher requirements of time and investment to becoming competitive in these industries, but also higher gains from assessing these activities, as indicated by their higher complexity.

5. CONCLUDING REMARKS

Putting Brazil back on a development path in the aftermath of Covid-19 outbreak will require massive investments and concerted efforts from the State and the private sector in several areas of the economy. Consistent with the constraints and challenges faced by the country, the mission-oriented development strategy outlined in this paper can enhance Brazil’s productive specialization while addressing also socioeconomic and environmental challenges.

To put this plan (or any other development plan) in motion, it is essential to reconstitute the country's planning apparatus and promote the modernization of practices and instruments used in promotion of economic and technological development.

First, it is crucial to recreate the Ministry of Planning and elevate it to the position of prestige and prominence it once held. As recommended by Mazzucato (2019), it is crucial that the Ministry of Finance and the Ministry of Planning engage in the formulation and execution of the mission-oriented development strategy, enhancing the coordination of the various government policies and combining planning efforts aimed at innovation, regional development, provision of public services, job creation, climate change mitigation, etc. The key word here is *coordination*.

Second, it is also essential to recover BNDES’ capacity. As highlighted by Mazzucato and Pena (2016), development banks play a central role in financing innovative activities, assuming the role of patient risk takers. As pointed out by Machado (2019), BNDES disbursements from the second half of the 2000s onwards were only partly focused on high-complexity sectors. This indicates a relatively conservative strategy on the part of the bank’s direction, with a high proportion of disbursements channeled to established sectors. In this sense, it is essential to adopt clearer guidelines for the bank’s financing strategies, aligning its actions with the objectives designed by the Ministries of Planning and Finance.

Third, it is also crucial to strengthen other relevant R&D institutions. In the case of the mission of *Improving healthcare services*, it is essential to direct resources to institutions such as Fiocruz, Butantan and the National Institute of Technology and Health (INTS). Furthermore, it is also crucial to strengthen institutions such as the Brazilian Company for Industrial Research and Innovation (EMBRAPII) and the Brazilian public universities so that they can support the productive development associated to the mission.

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