Ministério da Saúde
FIOCRUZ
Fundação Oswaldo Cruz

Centro de Estudos Estratégicos da Fiocruz
Antonio Ivo de Carvalho

HEALTH IS DEVELOPMENT

The Health Economic-Industrial Complex as a National Strategic Option

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Rio de Janeiro, 2022

Health is Development: The Health Economic-Industrial Complex as a National Strategic Option / General Coordinator: Carlos A. Grabois Gadelha; Assistant coordinators: Denis Maracci Gimenez & José Eduardo Cassiolato. Rio de Janeiro: Fiocruz - CEE, 2022.

ISBN: 978-65-87063-22-5

1. Saúde pública. 2. Sistema Único de Saúde (SUS). 3. Complexo econômico-industrial da saúde (CEIS). 4. Desenvolvimento. I. Gadelha, Carlos A. Grabois. II. Gimenez, Denis Maracci. III. Cassiolato, José Eduardo. IV. Fiocruz. CEE. V. Título.

This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

EXPEDIENTE

Fiocruz Antonio Ivo de Carvalho Center for Strategic Studies (CEE)

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Carlos Augusto Grabois Gadelha

CEE Integrated Project:
Complex and Prospection in Science, Technology and innovation in health

Research project:
Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0

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This book was originally published in Portuguese. Translated to English by Paula Santos Diniz.

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Preface

Nísia Trindade Lima

President of Fiocruz

The history of the Oswaldo Cruz Foundation (Fiocruz) is intertwined with the inception of public health and the constitution of the nation and the republic in Brazil. Since its creation, at the beginning of the last century, under the leadership of Oswaldo Cruz and Carlos Chagas, among other iconic sanitarians in the Brazilian science, a collective and national vision of health has been consolidated. Science played a key role in acquiring knowledge of Brazil and the backlands that represented the symbol of the strength, diversity, and potential of the population throughout the national territory, contributing to shaping the national identity and the notion of Brazilian people and republic.

Along this path, the inclusion of health as a right for everybody and the duty of the State in the 1988 Constitution was a milestone that updated the national project for a democratic society committed to people, society, and the individual and collective dimension of life. The Sanitary Reform process, which gave rise to the new Constitution, counted on the strong leadership of Sérgio Arouca, as president of Fiocruz, once again linking the Institution to a new country project.

“Health is democracy” was a central point of the VIII National Health Conference that provided the basis for the creation of the Unified Health System (SUS) as a pioneering and innovative project, unique in the southern hemisphere, to create the largest universal system in the world in terms of population. The universal right to health included the entire population, and there could no longer be any distinction according to the conditions of insertion of people in the labor market, gender, race, sexual orientation or any other segmentation of rights of each and every one of us, which should always be equitable.

By updating its project and preserving the commitment to social welfare and democracy, Fiocruz advances the vision that links health to the national standard of development, integrating the social and environmental dimensions of health to the economic dimension. In this process, the vision of the Health Economic-Industrial Complex (HEIC) has been developed over the last two decades, emphasizing the interdependence between social rights, welfare, and the existence of an economic, technological, and innovation base in health to support universal access and the right to life.

The Covid-19 pandemic has shown the structural roots of the right to life. Without an economic and productive base to meet the needs of vaccines, tests, ventilators, primary care services or intensive therapies, we could not fulfill our Constitutional duty.

In the year of the pandemic, economic interests and unequal knowledge represented an unacceptable global inequality, in which developed countries had four times more vaccines than their population was able to consume, while many countries and most of the global population did not even have access to the first dose.

From the formulation of the vision incorporated in the HEIC concept and the dramatic experience of Covid-19, we could no longer separate the social and environmental dimensions of health from the economic and, therefore, geopolitical dimension.

Being prepared and able to anticipate the guarantee of health rights, whether in stable situations or in the midst of health, epidemic, or pandemic outbreaks, depends on the possibility of the State advancing in a health development strategy, without which it will not be able to fulfill its constitutional duty.

This book shows the results of a vigorous research program developed at the Oswaldo Cruz Foundation that seeks to rescue the relationship between the economy and the demands of society, based on the development of the Health Economic-Industrial Complex. Faced with different perspectives on the approach of a society characterized so many times by its problems and absences, by its "evils", the texts published in this book resist any deterministic or homogenizing attempt, and point out, based on a qualified diagnosis, to the strategic importance of Health for the viability of a new national development project.

Several topics of very high relevance to the country are addressed in an innovative way by recognized experts in their respective topics from the field of the Health Economic-Industrial Complex: State, Territory, and Environment, ST&I, Macroeconomics for development, Labor market, public-private relations, among others.

Alongside instigating analyses, the Chapters selected for the book and that are part of a development project led by the Oswaldo Cruz Foundation in the last two and a half years in partnership with UNICAMP and UFRJ, in addition to a dozen other partner institutions, bring structuring propositions to develop a new generation of public policies, focused on contributing to the reaffirmation of Brazil's viability as a sovereign, dynamic, sustainable nation committed to life.

It is one of the most comprehensive, profound, and qualified analytical exercises on the field of political health economics developed in recent years to subsidize a new national project that is so urgent and necessary.

A book that will certainly make an immense contribution to the public debate, prepared in an agile way as a digital publication with free access. Health, life, our future and development are in a hurry.

Enjoy your reading!

Health as a Strategic Option for the Development of Brazil

Carlos A. Grabois Gadelha

This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

The Economy at the Service of Life

Health can — and should — be a new conductor for the development of Brazil in the 21st century capable of facing economic, social, and environmental challenges. If in the past steel, oil, and automobiles were the topics, the Health Economic-Industrial Complex (HEIC) presents itself, in the current scenario, as a strategic bet for the country to grow again and overcome the situation of social regression and structural dependence.

The painful experience of the Covid-19 pandemic, with the loss of more than 680 thousand lives, made evident the limited way in which the relationship between economy and society has been treated in the national debate. The Unified Health System (SUS) and the State of Social Welfare proved to be valuable constructions of society that can consolidate themselves as a great opportunity for development in Brazil, going beyond compensatory measures. Thus, the sad dominant paradigm, which places in opposite fields economy and health, market and society, state and private initiative, must be replaced by a perspective that integrates the economic, social, and environmental fields.

Faced with a situation of profound global transformations, Brazil is immersed in an intense economic, social and environmental crisis. In the country that was among the six most important economies in the world, the hunger of 33.1 million[1], the unemployment of 10 million and the increase in precariousness and underemployment that affects an increasing number of families[2] are the most visible consequences of the low economic dynamism and the sharp reprimarization of the Brazilian economy, which are accompanied by the advance of deforestation, contamination of ecosystems, and loss of biodiversity.

In the year that the bicentennial of its independence is commemorated, the economy does not grow, the environment is increasingly being attacked, the State is unstructured, and the basic needs of the population are not met, putting back the challenge of thinking about how to build a project of a country that promotes economic growth, equity – from a

1 II Inquérito Nacional sobre Insegurança Alimentar no Contexto da Pandemia da Covid-19 no Brasil (Rede Penssan, 2022)

2 PNAD Contínua (IBGE, 2022).

social and regional point of view – and environmental sustainability.

The proposal of this work starts from the perspective that the role of the economy is to guarantee the material support to reproduce the life of people and the planet. Meeting the legitimate aspiration of the population for a better quality of life requires technical and scientific capacity of the national production system to meet the demands of society. Development and innovation are key to promoting structural change that ensures universal access to social rights and environmental sustainability.

Putting the economy at the service of life permits to overcome the false dichotomy between the social, environmental, and economic dimensions and guide the economy to generate income, investments, and qualified jobs in support of a prosperous, just and democratic society. A sustainable society, committed to well-being, will only be possible with the existence of a national economic and material basis that supports this project desired by a democratic society.

Specifically, this perspective guided the formulation of an agenda to subsidize public policies for the development of the HEIC, articulating the national economic system and the organization of the SUS and Welfare. The objective is to contribute to a national development project that simultaneously pursues economic dynamism, environmental sustainability, and social well-being, inserting itself into global processes guided by the sovereignty, solidarity, and the right to life of different peoples and regions.

Health in the Midst of Social, Economic, and Environmental Transformations

Brazil and the world have been through a set of transformations that have the potential to significantly impact health, such as demographic and epidemiological transition, the fourth industrial and technological revolution, increasing globalization and funding, the risk of economic stagnation, changes in the world of work, climate change, loss of biodiversity. In a context of crisis in the international economic system and intensification of geopolitical disputes between countries, these transformations have deepened social and territorial inequalities and economic and technological asymmetries, in addition to pro-

foundly impacting health systems, with unavoidable effects on SUS.

In the coming decades, according to IBGE (2018)[3], the country will undergo a profound demographic and epidemiological change. In twenty years, the population is expected to reach around 230 million inhabitants, and the number of people over 60 will increase from 25 million to 50 million, representing more than 21% of the population. Within this range, the population over 80 years old will reach almost 9 million people.

The increase in the longevity of the population represents important achievements of the society. At the same time, its effects generate social, technological, and economic challenges that inescapably project future commitments of the State. The demographic transition will result in an increased demand in the welfare system, especially in health systems, in a country where the population lives with serious problems of food, housing, sanitation, work, mobility and access to basic rights of citizenship.

The epidemiological complexity will deepen in the coming decades, with the growth of the participation of chronic diseases in the burden of diseases, but without a linear process of transition, since communicable diseases, external causes, and health emergencies will continue to put pressure on the SUS (Araújo, 2012; Frenk et al., 1991). This set of trends becomes a picture of increasing epidemiological complexity, transforming the demand for health care, promotion, and prevention of the 21st century (Lima, Gadelha, 2021).

The profound demographic and epidemiological change occurs in parallel with the advance of the fourth industrial and technological revolution. The use of biotechnology, artificial intelligence, big data, genetic editing, additive manufacturing, nanotechnology, and internet of things form a block of innovations that are decisively expressed in the health field, bringing enormous threats and potential.

The interconnectivity provided by technologies 4.0 implies the incorporation of new fields of knowledge and sectors of activity in the HEIC, with an intense automation

3 Population Projection (IBGE, 2018)

movement based on the use of smart machine networks. The dissemination of digital technologies has led to the erosion of the borders between sectors and fields of knowledge and cause a radicalization of the systemic character of the economic space and capital accumulation in health.[4]

The new technological possibilities for health promotion, prevention, and protection show a true transversal process of "creative destruction" in the health field, posing a huge challenge for the SUS to consolidate itself as a universal system.

In the world of work and employment in health, the activities linked to the HEIC, notably the care and attention services, will continue to be great generators of qualified jobs, but new occupations will be created, and old ones will be modified, incorporating new skills. The training of health professionals will need to be increasingly interdisciplinary, and especially able to operate new digital technologies that strengthen humanized care and attention in health services.[5]

Recent transformations also decisively affect the world of science, technology, and innovation in health (ST&I in health). The wide dissemination of technologies of revolution 4.0 opens the possibility of new forms of knowledge production, based on transdisciplinarity and oriented to the challenges of health and sustainability, reinforcing the centrality of ST&I for economy, well-being and sustainability. At the same time, there still remains the challenge of funding basic research activities, fundamental for the advancement of scientific knowledge.

The understanding of the challenges caused by this set of social and technological transformations on SUS and HEIC, in a realistic and pragmatic way, should consider the concrete space in which they occur. In the international scenario, the geopolitical context is that of climate emergency, deterioration of the global cooperation environment, deepening of funding, expansion of the power of large transnational companies and increased

4 For more information, see chapter 7 "ST&I in Health: the Gateway to the Revolution 4.0 and the Path to Universal Access."

5 For more information, see chapter13 "The HEIC 4.0 to Develop the SUS and Generate Good Jobs."

inequalities, asymmetries, and inequities.

The intensification of tensions between blocs led by the US, China and Russia points to the emergence of a multipolar international order, especially after the Covid-19 pandemic and the outbreak of the Ukrainian War (Fiori, 2022). In the international economy, there is an unprecedented deepening of the power of financial institutions in parallel with the emergence and expansion of digital monopolies. The movement is revealed by the concentration of the market in gigantic companies such as Google, Amazon, Facebook, and Microsoft and the fact that only three investment fund management institutions – BlackRock, Vanguard, and State Street – are the largest individual shareholders in approximately 90% of the five hundred largest companies in the world.[6]

This movement significantly affects health. Health-related activities, including primary care, constitute crucial expansion fronts of large global companies[7], manifesting a process of invasion of industrial logic in all productive spheres, including services, according to the perspective that guided the formulation of the HEIC since its inception.[8] [9]

In this context, the field of scientific, technological, and innovation training is intensified[10]. Approximately 88% of patents filed in the field of health come from only ten countries. The US and China account for about 53% of Health patents under the Patent Cooperation Treaty (PCT) and 44% of patent families in health 4.0.[11] The asymmetry in the production of scientific knowledge and technological innovations in health, accompanied by a weakened production base, tend to convert into inequity in access to health, as evidenced during the pandemic (Gadelha, 2022).

6 For more information, see chapter 2. " The State in the 21st Century: Reflections on Strategies, Productive and Innovative Development Policies, and Impacts on HEIC Based on International Experience".

7 The Economist. Alphabet is spending billions to become a force in health care. June 20, 2022. Available on: https://www.economist.com/business/2022/06/20/alphabet-is-spending-billions-to-become-a-force-in-health-care.

8 For more information, see chapter 6: "Limits and Economic Opportunities of the HEIC 4.0 in Brazil".

9 For more information, see chapter 8: "Opportunities and Challenges for the Medical Device Industry."

10 For more information, see chapter 5. "Financialization, global competition, and challenges for the HEIC in Brazil."

11 For more information see chapter 7: "ST&I in Health: the Gateway to the Revolution 4.0 and the Path to Universal Access".

According to the Secretary-General of the United Nations (UN), "the global political and economic system is not providing global public goods of vital importance: public health, climate action, sustainable development, peace." Although multilateral access mechanisms such as the Covax Facility were fundamental to guarantee vaccination in low-income countries, technological-industrial asymmetry was translated into an asymmetry in the right to life itself, as shown in an editorial published by the prestigious journal Lancet.[12] At the end of 2021, while countries with productive capacity such as Brazil and the European Union had totally immunized more than 70% of the population, low-income countries, without productive capacity in health, had immunized less than 5% of their population.

"Inequality defines the time in which we live" (Guterres, 2020). While the richest 1% captured 38% of global wealth growth over the past 25 years and accounted for 15% of global carbon emissions between 1990 and 2015, the poorest 50% were left with only 2% of wealth (WIR, 2022) and participated in 7% of emissions (Oxfam, 2020). Economic inequalities are closely connected with social vulnerability and climate injustice, influencing and being affected by others.

Amid the growth of inequalities, an environmental consciousness emerges and is consolidated[13]. The Paris Agreement and the launch of the Sustainable Development Goals show how global economic, social, and political actors have moved to deal with the "contradictory dynamics between capital expansion and accumulation and the immanent tendency of the system to generate asymmetries, exclusion, inequality, loss of social legitimacy and unsustainability" (Gadelha, 2022).

The changes presented, summarized in Chart 1, pose important challenges for the feasibility of universal access to health in Brazil. If these global movements are not understood and brought closer to the field of social policies and development, the consequences will be the perpetuation of a compensatory pattern of public policies, while reality escapes a structuring and efficient strategy that takes advantage of the opportunities of the new technological paradigms in progress.

12 See Usher (2021).

13 For more information, see chapter 4 "Predatory Stagnation or Sustainable Development?"

Chart 1 – Main ongoing transformations and their impacts on the health field

Transformations	Impacts on the Health Field
Demographic transition and health needs	The situation of epidemiological complexity will deepen. Longevity and aging of the population with increasing weight of chronic diseases in the burden of disease and strong presence of communicable diseases and external causes.
Revolution 4.0	Radicalization of the systemic health space and the introduction of innovations open challenges and opportunities for the organization of health systems and for universal access.
Funding	Risk of the R&D strategy moving away from welfare, dismantling the innovation of universal, equitable, and integral access. Increasing tension between the collective and individual dimensions of health.
Conglomeration	The large concentration and centralization of capital in economic conglomerates translate into little diversity and high asymmetry in the production and innovation base for health.
Science, Technology, and Innovation in Health	Centrality of ST&I to respond to health challenges. Global discussion on new forms of scientific production focused on social and sustainability challenges.
Transformations in the World of Work	Health will remain as a great front for generating quality jobs. Potential for substantial transformation in health occupations, requiring more interdisciplinary training, including that of professionals from other areas to work in health.
Increased geopolitical disputes and appreciation of the territory	Health as a factor of sovereignty. Regional, national, and local productive and innovation capacity in critical areas, such as health, gains relevance.
Climate change	Intense climate events, emergence of new pathogens and other effects of climate change should put health systems in a state of permanent health crisis.
Growth of inequalities, asymmetries and inequities	Increased hunger, precariousness, climate injustice intensify health vulnerabilities (social determinants of health). Asymmetry in knowledge, productive capacity and innovation become inequities in access to health.

Source: Prepared by the author, based on the chapters that constitute this work.

Analyzing the trends cited is essential, not only to predict the future of health, but to guide, in the present, an action of development policies. Brazil's capacity to respond to the challenges of health and the SUS requires reflection and the construction of a "new state" that puts the economy at the service of life, endowed with the capacity to

promote economic, social, and environmental development.

The National State will continue to play a key role. It is necessary to analyze the historical-structural process that conditioned the policies of the past and contextualize it to understand the degree of freedom and the ability to implement structural policies in the present. One should think of institutional arrangements and instruments to articulate measures to stimulate investment, economic subsidy designs for strategic projects, creation and equity participation in national companies, haughty and active use of purchasing power treating the domestic market as national heritage, control of foreign capital inflow, among others.

The National State must be able to formulate and implement systemic and structural policies, contextualized and coordinated at the various territorial scales, in order to contemplate the different territories and regions of the country. The socio-cultural and environmental diversity present in Brazil is a potentiality that generates diversity of knowledge and solutions to national problems[14].

Therefore, the most difficult step is to adopt a perspective that captures the interdependent character of the models of organization of production and society with the environment. The strengthening of the SUS, by becoming a national challenge, can mobilize the utopian energies necessary to support the construction of a State of Social Welfare in Brazil.[15]

The economic dimension of the productive transformation is decisive for the achievement of this objective. The reconstruction of the national technology-intensive economy and industry must be seen as a central aspect so that access to social rights is not maintained as a privilege of a minority, either to guarantee material support for universal access to health, or due to the economic dynamism that this project triggers.

The next section presents how the perspective of the HEIC, which puts the economy at the service of life, can support a process of structural change that promotes economic

14 For more information, see chapter 3 "Territory, Sustainability, and Innovation: Policies for Health and Well-Being"

15 For more information on how major social and environmental challenges can conduct development, see Gadelha (2016) and Mazzucato (2021).

dynamism, social inclusion, and environmental sustainability, amid the challenges and opportunities generated by contemporary transformations.

The Perspective of the Health Economic-Industrial Complex (HEIC)

The Federal Constitution of 1988 approved an important expansion of social rights in Brazil, and the universalization of the Unified Health System is particularly relevant, whose importance was highlighted during the Covid-19 pandemic. The successful public actions in defense of life, with emphasis on the immunization of the population, increased the perception of the social value of public institutions such as the SUS, the largest universal health system in the world. However, we still have much to advance to ensure universal, integral, and equitable access for all Brazilians.

The perspective adopted has been developed at Fiocruz over the last twenty years, and indicates the analytical and political interdependence between the economic, social, and environmental dimensions of development.[16] According to the conception of one of the greatest social theorists in Brazil, Celso Furtado, development is a process of structural change in which the introduction of innovations transforms the productive and technological base to ensure the fulfillment of the growing needs of society (Furtado, 1964). Without productive transformation and technological innovation, access to citizenship rights will remain restricted to a privileged minority of the population. The scientific and technological base and economic and productive autonomy are fundamental to guarantee access to essential rights, as evidenced in the context of the pandemic.

In HEIC's research program, health is now seen as a clear and prominent space of reproduction of capitalist dynamics in its tense articulation with life, politics, and society, overcoming the fragmented and sectorized views that sometimes treat health as an externality (or as mere human capital) or as a specific and insulated field of social policies. The Covid-19 pandemic emphasized the importance of treating health as a space for both economic and social development at the same time, overcoming false and linear dichoto-

16 For more information, see Gadelha (2003), Gadelha and Temporão (2018), and Gadelha (2022).

mies between these spheres.

Brazil has the largest universal health system in the world and has a powerful productive and innovative health system, which mobilizes about 10% of GDP, represents 1/3 of the scientific and research effort, with strong alignment with technologies 4.0, in addition to being a privileged space for the generation of investment, income, and jobs, representing approximately 10% of formal occupations[17] and 25 million direct and indirect jobs.[18]

However, the development of the HEIC does not follow the growing health needs of the Brazilian society. The commitment to guarantee universal, integral, and equitable access in a country of continental dimensions generates a demand proportional to the challenge of guaranteeing promotion, prevention, and health care on a national scale, which far exceeds the installed national productive and technological capacity. The analysis of the evolution of commercial relations in health in Brazil shows a structural movement of growing mismatch between the health needs of the population and the productive base that supports it.

This reality, however, is not a spontaneous configuration in the country. On the contrary, it is a consequence of a passive and subordinate insertion bet on international geopolitics whose dynamics leads the countries excluded from the process of knowledge generation and retention to dependence. Inequality and capitalist polarization manifest themselves in the conformation (or reaffirmation) of an essentially asymmetrical and unequal global order.

As emphasized in the tradition of Latin American social thought, and currently recognized by many schools of thought, such as Harvard's complexity and the neo-Schumpeterian, economic and social delays are related and can be understood as distinct dimensions of the same problem, underdevelopment, which is expressed internationally as asymmetries between countries and nationally as structural heterogeneities.

The reproduction of a primary-exporting and poorly diversified economic structure limits

17 For more information, see chapter 10 "Health is also employment and income: an Analysis of Job and Income Generation from the Health Economic-Industrial Complex in Brazil".

18 For more information, see chapter 12 "The Health Economic-Industrial Complex: a Strategic Basis for Generating Good Jobs"

the potential for growth and makes social policies vulnerable due to external relations. The external constraint is structural, and the balance of payments is the great expression of dependence and delays in technology.[19] On the other hand, it is simultaneously reflected in the chronic problems of the labor market and in the vulnerability of social policy, encapsulating the social area in its compensatory functions, without the ability to constitute itself as a dynamic element.

Although the economy may present cycles of growth, according to the experiences of the periods of industrialization in the twentieth century and, more recently, in the 2000s, the structural problems related to technological-productive dependence persistently manifest themselves, restoring – in an exacerbated way – the condition of economic and social vulnerability.

The pandemic crisis has made this perspective clearer in the health field. The fragility of the national productive-technological base, resulting from the deindustrialization process and the sharp reprimarization of the Brazilian economy in the last five years, was evident in the lack of basic products, demonstrating that this position of dependence is unsustainable, not only from the point of view of economic development, but also as a matter of sovereignty and health security.

The insufficiency of the technological-productive base resulting from the specialization of production in products of lower added value explains the country's difficulty in overcoming the technological asymmetry in relation to the movement of the global economy and is reflected in the inequality and segmentation of access to health goods and services, generating objective obstacles to the expansion of the SUS. In other words, the possibility of "consuming without producing" is not compatible with a democratic society, where social rights are shared by everybody.

This discussion should be expanded to consider the development of the economic, productive, and technological base in health – the HEIC – as a structural factor for the sustainability of the SUS and for the transformation of the development pattern in force in the country.

19 For more information, see chapter 9 "Health and external insertion: an Analysis of the HEIC's Balance of Payment and the Impacts of the Exchange Rate".

From the perspective of the HEIC, the intentionality of the agents, the action of society, and the State have a decisive role to transform the previous conditions, without which the productive system and the social structure can be locked in the past. It is not just about capturing the notion that economic growth and income distribution contribute to social policies or that these are functional to economic development with the notion of providing externalities. It has to do with thinking about how the capitalist dynamic is reproduced within social welfare systems, conditioning public policies.

Considering the continental dimensions of Brazil and the power of its domestic market to induce the diversification and internalization of dynamic productive sectors, the decisive question as to which economic, industrial, social, and political basis simultaneously conditions the assembly of dense structures of social welfare and technological development is raised.

A new type of development is needed, with a dynamic and strong sense of social equity and environmental sustainability. To achieve this, counter-cyclical and compensatory policies are necessary but insufficient. In the face of the crisis and current challenges, profound structural transformations are needed to make room for the expansive forces that are severely restrained, to the detriment of the vast possibilities for human improvement offered by scientific and technological advances.

Health as a Conductor for the Development of Brazil in the 21st century

Health is a universal right of citizenship, enshrined in the Brazilian Constitution, while constituting a central space of economic interests and exercise of global geopolitical power. As a universal system, SUS must have a bold project and a new set of appropriate public development policies to meet the challenges in the current historical moment.

In view of the profound transformations underway, a universal, equitable, and integral system requires an increasingly sophisticated productive and technological base, which allows working in the entire field of health care and for the entire population. The systemic nature of production and access to health requires public policies that consider the interdependence between social, industrial, environmental and ST&I policies, and the construction of

new instruments to coordinate the multiple existing interests in the health area.

It is the articulation coordinated by the State that allows us to strategically guide the development of the HEIC, regulating the private sector, acting strategically where the market competes in high technology and in the high value of products and where the market has no immediate interest, despite the public interest. It is necessary to move towards a dynamic, systemic, and strategic vision that allows us to grasp the possibilities open to national development through the articulation of social demand with the domestic market and the use of the economic power of the SUS.

Development implies a brutal transformation of the productive structure focused on universal access, which, in a country as big as Brazil, can constitute a great development front. Taking care of people, translated into the expansion and qualification of health care, can become a pole of expansion of areas of activities – industrial and services – that allow the intensification of the production and direct it to make the productive-technological structure compatible with the social demand for health. Given the dimensions of the SUS, as the new areas of activities are intensive in qualified work and following sustainable technological trajectories, they have the potential to act in the core of development policies, promoting overflows and structural changes.

It is in this dimension that the development of the HEIC is placed as a prominent space for a profound change in the national development pattern. The SUS, strengthened with production, technology, science and innovation, generating income and qualified jobs, can be a platform with scale and dynamism to sustain long-term development in Brazil. The great strategic challenge is precisely to enable an expansion and articulated transformation of the entire health production system to allow, at the same time, the expansion of universal actions and services and the development of the national productive and innovation potential.

Welfare, taking care of people and caring for the environment can be the key to sustaining structural changes in the Brazilian society. The Brazilian State and SUS' institutions must build capacity to act in a complex, systemic, and strategic way, oriented to the needs of the population.

The theoretical-political formulations supported by restricted views, which consider the State of Social Welfare as an expense, end up contributing to maintaining chronic underfunding and a compensatory vision of SUS. However, SUS is a powerful universal system that operates from primary care to high-tech procedures in programs that are an international reference, developing and producing knowledge, products, and services for the entire Brazilian population.

Among countries with universal health systems, Brazil has the lowest proportion of public funding of health actions. While in European countries at least 70% of these actions are funded by the National States, in Brazil public spending on health is around 40%. It is possible and desirable to overcome this contradiction by promoting the expansion of public funding from actions that strengthen national production and allow for a virtuous arrangement of the development of the HEIC focused on universal access.[20]

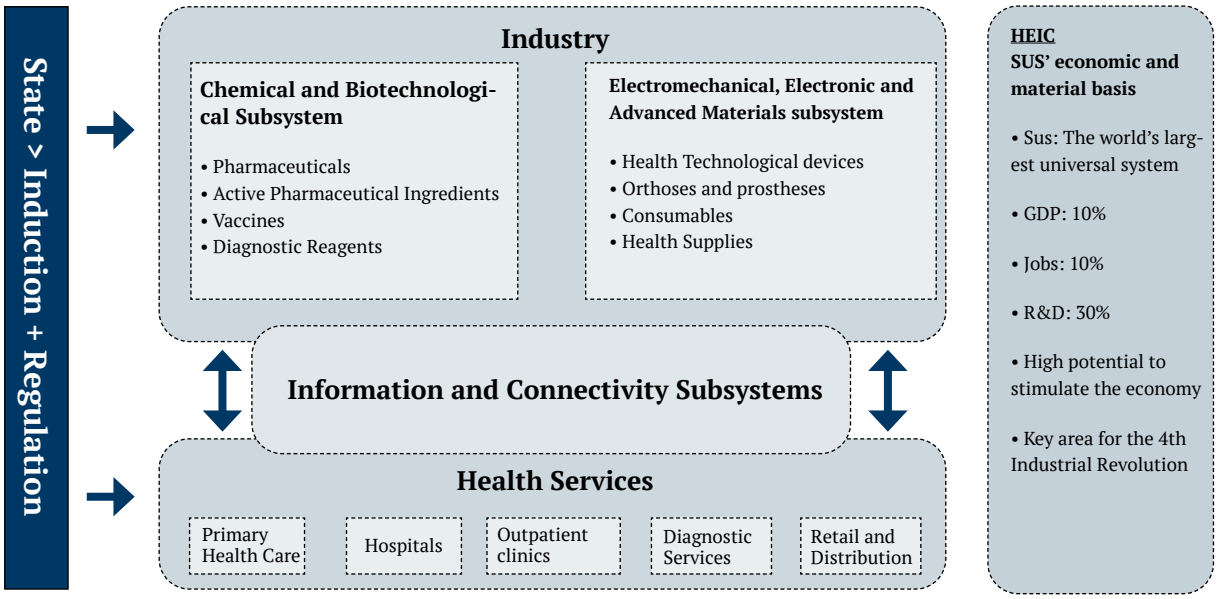
It is time to be bold to take risks of adopting new approaches and progressively and collectively seek a vision that provides the substrate for a new development project that incorporates a profound change in how the State acts. This is the primary condition for society not to be deceived by unique solutions and to be able to have utopias and transforming energy again aimed at building a dynamic, just, and democratic country.

Health can and should lead this great transformation front, which requires the expansion of paradigms to treat the health field as a strategic bet of the country to lead to structural changes. In the same way that oil, steel, and automobiles were the propellers of development in the twentieth century, health has the potential to be one of the conductors of expansion of the twenty-first century in Brazil, incorporating a model of society capable of dealing with climate change, with the needs for expansion of income and employment, with innovation and with the strengthening of national production. Therefore, breaking conceptual paradigms, daring, bringing diversity and the contradictory at all levels and integrating different areas of knowledge and public policies is essential.

20 For more information, see chapter 11 “The Fiscal Challenges to Guarantee the Right to Health and Foster the Productive Base of Health”.

The following strategic propositions, based on all chapters of this work, can contribute to a major transformation within the scope of the HEIC inserted in the transformation of the national productive and technological pattern (see Figure below, which updates the morphology of the HEIC in the context of the ongoing technological transformation):

Contemporary Morphology of the Health Economic-Industrial Complex



Source: Gadelha (2021).

Strategic propositions

- Ensure the strengthening of the HEIC as an economic and productive basis for the welfare state, universal access, and reduce the vulnerability of the Unified Health System

- Place the HEIC as a new conductor of the national development strategy, articulating the reconstruction of the national economy with social development, science, technology and innovation and environmental sustainability.

- Ensure a systemic pattern of a new generation of public policies focused on major national challenges, and the HEIC should assume a leading role for the performance of a democratic, efficient, transparent, and socially inserted State

- Consolidate the HEIC as a structuring axis for the anticipation and preparation of SUS in the face of health emergencies, allowing the country to have sovereignty in the context of the fourth technological and industrial revolution in order to guarantee universal access.

- Implement public policies for the HEIC as a decisive economic complex for the generation of decent, quality jobs and inserted in the technological changes underway in the world of work.

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The State in the 21st Century: Reflections on Strategies, Productive And Innovative Development Policies, And Impacts on HEIC Based on International Experience

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

The acute crisis caused by the pandemic in 2020 and now more explicit because of the current armed conflict in Europe overlaps with a chronic multidimensional crisis that marks the system of the world of recent decades and that began in the 1980s.

The roots of such a chronic crisis rest on a process of financialization, inseparable from contemporary capitalism, which concerns both finance and production and is combined with the current high degree of centralization/concentration of capital.

The results of financialization can be seen from at least four trends that are present in almost the entire world, but especially in the USA, Western Europe, and Japan: brutal growth in inequalities, decrease in economic growth rates, considerable increase in public, private, and household indebtedness and, of course, growth in the share of the financial sector in the economy, which translates into an increase in the share of financial profits in the total profits of the private sector (Cassiolato, Falcón, Szapiro, 2021).

Particularly after the financial crisis of 2007/2008, the capture of the national governments (and their policies) of the main Western countries mentioned above by the logic of capital accumulation of large transnational corporations (TNC) was explained.

It is in this general framework that the main transformations in global innovation and productivity dynamics in the industrial and innovative public policies adopted by the main countries were analyzed, emphasizing their connections and their impacts in the context of a global crisis. Special emphasis was given to the analysis of the role of new digital technologies popularly associated with the so-called Industry 4.0. Of course, these issues are being dynamically redefined and rediscussed, in view of the developments of the health crisis and the military conflict that hit the European continent in 2022.

The objective of this text is to think of new institutional means and formats for a "new State" capable of responding to crises, such as those we are facing, and promoting social, environmental, and economic development centered on life and, therefore, on the well-being and health of the population. We sought to find experiences that may shed some light to the definition of a new generation of public policies to guide a new national

development project, supported and sustained by a productive and technological base, the Health Economic-Industrial Complex (HEIC), aimed at universal access to health and the promotion of well-being, in the context of the political, productive, and technological transformations underway.

The main changes in the global dynamics of production and innovation in the millennium

The new millennium is characterized by the aggravation of the social and economic crisis and a brutal increase in inequality between and within countries. In this period, the emergence and expansion of digital monopolies coexist with the slow and unequal diffusion of new digital technologies, and financial institutions acquire unprecedented power, gaining, in fact, control over non-financial TNCs. The top three asset managers – BlackRock, Vanguard, and State Street – are the largest individual shareholders in approximately 90% of the world's five hundred largest companies.

The resulting changes in the strategies of Western non-financial TCNs and the rise of China have a significant impact on the overall dynamics of production and innovation in the period. In this new dynamics, the deindustrialization and the emptying of the industrial base in the USA and in the main European countries is made explicit, with negative consequences on their technological capacity. On the other hand, as a result of intense state intervention where finances are subordinated to the imperatives of production and innovation, China assumes technological leadership in the vast majority of productive activities.

The intensification of the economic and social crisis after 2007-2008, the deepening of financialization and the increase in inequality produced significant impacts on the globalization process. Since then, the global economy has been marked, among other things, by low real growth in gross domestic product (GDP) and global trade, a drop in investment in productive activities associated with a stagnation in demand and the existence of global idle capacity in important activities. This picture is linked to a significant increase in social inequalities and in the indebtedness of families, companies, and governments, in a world where financialization and investments (a great part of a speculative nature) in

financial assets continue to grow well above real production and global trade.

After transferring intensive stages of the production process in low-skilled work abroad, from the mid-2000s, the large Western TCNs also began to move to other countries, mainly to China, denser stages of production, such as product and process engineering, and design.

Advances in scientific disciplines along with specific innovations in computational capabilities and the fragmentation of the stages of the production process allow for the modularization of knowledge and segmentation of the innovation process into modular blocks of specialized tasks that can be performed by geographically dispersed Research and Development (R&D) teams. The large TNCs structure global innovation networks or circuits, setting up in practice a new international division of labor, now for innovation. Under the illusion of a false idea of "open innovation," these companies are, in fact, predators of the knowledge generated by their innovation networks in different countries.

Production Policies and Innovation

The USA, the countries of the European Union, and Japan have never abandoned the use of policy instruments aimed at productive development. Throughout the present millennium; however, the logic of industrial and innovation policies has been transformed, becoming increasingly designed to adjust to the environment of increasing liberalization and financialization.

In the European Union, since the so-called 'Lisbon Strategy' of 2000, innovation policies have acquired a significant role in the industrial policy agenda. Based on the neo-Schumpeterian concept of innovation systems, they aspired radical transformation of the European territory towards a "knowledge society" and a renewal of the productive fabric of that continent.

Its implementation and the instruments used, however, were conceived within the framework of neoliberalism. Moreover, its own conception is outsourced to the private sector (in fact, to large European transnational corporates), subverting the historical power of Nation-

al States[1]. Reaching new areas such as health and education, such policies of privatization of the State itself are not related to inefficiencies, being fundamentally based on ideology.

The financial crisis of 2007-2008 – intensified by the 2011 euro crisis – has led to significant changes in industrial and innovation policies in developed countries. Three aspects should be highlighted:

1. Significant increase in the use of instruments to protect the domestic industry, with the use of tariff and non-tariff barriers, subsidies to locally controlled companies, and increasing restrictions on foreign direct investment, by the vast majority of countries, especially by the largest and most developed ones.

Among the economic activities that have been the object of this type of government action are those of the HEIC. Between 2009 and 2020, 2,698 protection actions were implemented by various countries. Regarding pharmaceuticals, 88% of these measures were implemented by China, the USA, India, and some European countries. This distribution profile observed in pharmaceuticals is repeated in medical equipment and services. Contrary to this trend, Brazil was the country that most liberalized these activities. In fact, according to information compiled by the Global Trade Alert (Evenett and Fritz, 2022), of the world's total of 512 measures that liberalized international trade for pharmaceutical activities and 506 similar measures for medical-hospital equipment, between 2009 and 2021, Brazil implemented 82 measures (18% of the total) that facilitated imports of pharmaceutical products and 155 measures (30.6% of the total) that aimed to make the entry of medical-hospital equipment more flexible.

It is also noteworthy that the outbreak of the pandemic in 2020 led to a significant increase in the control of the inflow of foreign capital, especially to HEIC, as a result of the weakening of national companies and production chains.

1 As an example, we can mention a public-private partnership focused on research, development, and innovation established in 2008 between the European Union and the European pharmaceutical industry (Innovative Medicines Initiative Joint Undertaking - IMI), with a public budget of 2.6 billion euros, whose results were negligible (CEO, 2020).

2. Initiated by some countries in the late 2000s, national strategies aimed at technological development and stimulating the adoption of new digital technologies were introduced by a substantial number of countries, especially the USA, China, and major European countries. For example, Germany adopted the Industry 4.0 program in 2011 as part of a broad strategy to stimulate the generation and introduction of digital technologies into the German production structure. In addition, the three largest economies in the European Union (France, Germany, and Italy) have combined their main initiatives for the industry industrialization – the trilateral cooperation of the German "Industrie 4.0" program, the French government action "Alliance Industrie du Futur" and the Italian "Piano Industria 4.0" initiative. The different strategies articulate public resources with measures to protect local industry, grant subsidies, use the state purchasing power and instruments to control the inflow of foreign capital.

3. The increase of deindustrialization in the main Western countries, and the economic and social crisis, associated with the rise of China as an economic and productive power, led the main Western countries to implement, in the first half of 2010, strategies aimed at relocating productive activities previously transferred to other countries (reshoring).

Intensified after the beginning of the pandemic, all these policies have been unable to contain or reverse the deindustrialization of Western countries, as they have been carried out within the neoliberal framework. They are ineffective since they do not affect the strategies of production organization and innovation by large transnational companies based on the maximization of short-term rents and the extraction of value from the participating companies of their "global value chains."

Finally, in the absence (and misconceptions) of national policies subordinated to financialization, the territory has increasingly gained prominence in defining and implementing relatively successful strategies aimed at production and innovation.

The Pandemic and the Return of the State: Advances, Problems, and Challenges

The pandemic crisis required a quick and forceful response from the different National States, which, for the most part, defined new short and long-term strategies. The research analyzed policy and planning documents for a sample of 14 countries. In a complementary way, the actions and reactions of civil society ("social movements 4.0") to the crisis were also addressed.

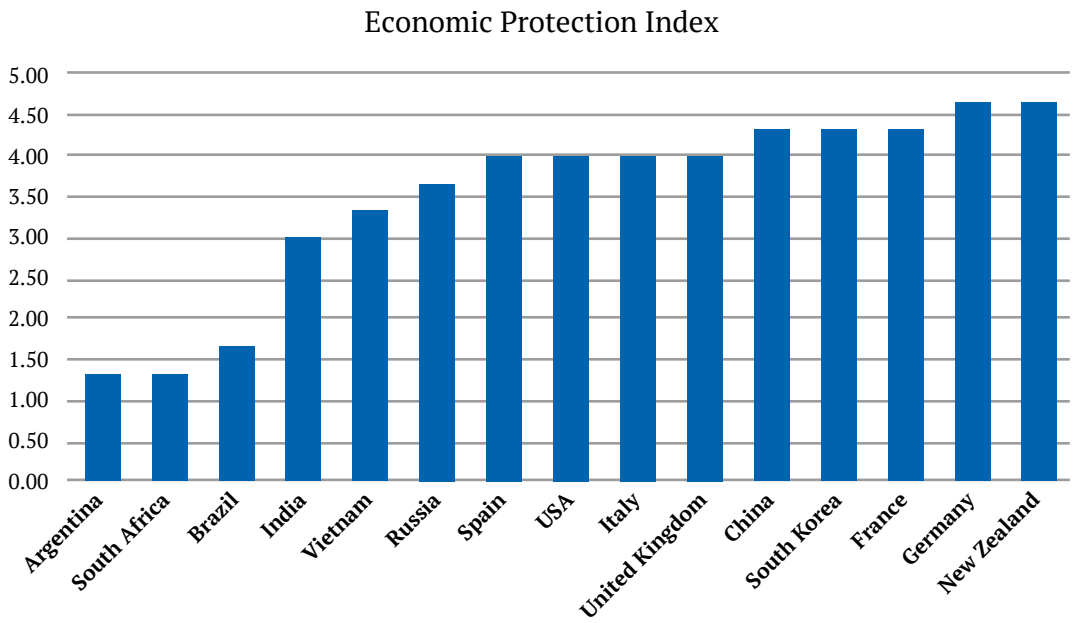
The main conclusions on the role of the State in such a scenario are: 1) The crisis unfolded in 2020 brought back the discussion on the role of the State, especially regarding health, socio-environmental sustainability, energy and digital transition, innovation and general and digital infrastructure in its different aspects, especially the need for new co-financing regimes; 2) The State in 2021 assumes as never before – except for the period after World War II – the need for social assistance and education of the new generations to ensure digital transformation and resilience in the face of climate change; 3) The orthodox myth of fiscal austerity was overcome by the imperative need for public spending, resulting in the greater indebtedness of most countries and with the support of multilateral organizations such as the International Monetary Fund (IMF) and the International Bank for Reconstruction and Development (IBRD); 4) The need for greater regulation of digital environments and an update of the means and ends of the State in the digital space, its relations with citizens and companies.

By systematizing the policy documents produced by the different governments in 2020 to face the problems brought by the pandemic, the objective was to capture, at the level of discourse and published legal measures, the breadth/duration of social protection and the direction of active industrial policy to protect strategic sectors of the economy and the Science, Technology, and Innovation (ST&I) policy. To better identify such differences in social pact, policy and ideology that are reflected in economic planning, the analysis methodology chose to build an Economic Protection Indicator composed of three indices that sought to capture: existence and breadth/duration of social protection; existence and direction of active industrial policy to protect strategic sectors of the economy; existence

and direction of active ST&I policy. The result found can be seen in Figure 1.

In summary, the analysis shows that three countries – Argentina, South Africa, and Brazil – were less able to structure policy propositions aimed at their productive and social base. An intermediate but efficient segment is represented by India, Vietnam, and Russia, followed by a slightly higher protection zone with Spain, the USA, and Italy. At the top of the list, there are China, South Korea, France, Germany, the United Kingdom, and New Zealand, which have adopted, in theory, positions of maximum protection for their scientific, social, and productive assets.

Figure 1. Economic Protection Index during the 2020 pandemic, countries in the sample



Source: Cassiolato, Fálcon, Szapiro, 2022.

What differentiates the effectiveness of the actions of the different countries is not the number of resources involved in overcoming the pandemic, but the quality of public spending, how and to it is directed. It is important to observe the trajectories of countries based on the greater or lesser degree of support to families and small and medium-sized companies, the focus on supporting productive activities considered strategic, greater or lesser control of exports of essential products, and an industrial and ST&I policy more or less focused on the supply of essential goods on an emergency basis, including converting industrial plants for the production of hospital and hygienic materials and equipment.

Other social protection measures, to avoid abuses of essential service companies such as ITC, energy, distribution, and logistics, etc., have also been implemented.

Finally, the protection measures of strategic national companies should be highlighted, especially those aimed at hindering hostile purchases. Many countries have adopted limits on the inflow of capital and even prohibitions on buying shares in certain companies, often acquiring shares and making them temporarily partners of the State.

With regard to strategies for recovery and growth, by the end of October 2021, the countries with long-term (complete or partial) plans approved by the legislative powers are: China, USA, United Kingdom, Spain, Germany (despite the recent change of government with the elections), New Zealand, France, Italy, Vietnam and South Korea. Brazil, Argentina, South Africa, and Russia (there was a plan to modernize the economy launched by President Putin before the election in 2018 that was overtaken by the pandemic) did not publish long-term plans, and India (despite the five-year plans the country has drawn up since 1951).

The following can be highlighted regarding such plans: 1) The plans are focused on resilience in the face of climate change, the energy transition, and the digitalization of the economy. It is the largest volume of public investments programmed in the world since World War II; 2) To a greater or lesser extent, they seek to prepare their societies and new generations for this new paradigm, with legal normative regulation of markets, especially financial, labor, tax system, and education; 3) HEIC has received large resources for ST&I and is, alongside education, a pillar for development, population well-being, and technological advancement; 4) There are varied models of coexistence between public and private health networks, and most high-income countries (except for the USA) intend to expand the public network and agree on the digital health service; 5) Investments in ST&I are theoretically guaranteed in most plans, as well as new energy, transport, and communications infrastructures.

Societies also react to events and respond with innovative solutions and paths. Such is the case of social movements 4.0 and new forms of financing startups and fintechs with

collaborative and profitable markets, with their own currencies and causing disorganization in the conventional financial system. Coping both is effective and often concentrates capital, but there are many successful options where entrance barriers are overcome, and innovative opportunities are created.

Despite these positive developments, particularly in the large Western capitalist countries, the actual implementation of these plans is, more than 18 months after their launch, encountering difficulties and presenting problems that become explicit in 2022. The increase in liquidity in the economies, the disruption of supply chains, the difficulties to relaunch private investments due to the subordination of business strategies to financialization, among others, have led the main Western countries to an inflationary spiral, a brutal increase in public debt and an unprecedented energy crisis, aggravated by the war in Ukraine in 2022, strongly impacting the economy and the plans of the European Union. In 2020, several analysts pointed out the problems in the implementation of such strategies, since economic policies continue to be founded on austerity, with the recent programs being extremely favorable to large speculative capital.

Health and Digital Technologies

The research pointed out that there is a risk that the development and diffusion of new digital technologies will be directed, especially in the activities of the HEIC, to processes of modernization of old technological trajectories[2] and not the creation of new potentially virtuous trajectories[3]. Thus, such technologies would be more directed to automate tasks previously performed by the work, constituting a primordial part of processes whose main

2 Acemoglu and Restrepo (2020, p. 29) highlight examples in the areas of health and education showing how in the USA automation technologies are being developed aiming only at the replacement of human beings by machines in traditional tasks, with no impact on productivity.

3 China presents numerous examples in this direction. Liu et al. (2015) analyze two cases in Suzhou and Shenzem, within the scope of the "Project to demonstrate and apply medical devices", where Industry 4.0 technologies were developed systematically and collectively by productive actors throughout the HEIC, creating new capacities, generating new jobs and meeting efficiently the needs of the population. In the case of Shenzem, a system based on new digital technologies that is appropriate for densely populated rural areas and telehealth was developed. The system basically consists of a multi-function diagnostic bed, a multi-parameter check-up instrument, a general diagnostic system and related software, allowing telehealth, a portable diagnostic bag, and a multi-function diagnostic bed.

objective is to reduce costs and downtime. They may not sufficiently focus on creating new tasks where work can be productively employed, thus mitigating their revolutionary potential. In fact, instead of improving productivity or developing new markets, new digital technologies can pose a threat by being oriented towards job insecurity, thus exacerbating one of the main obstacles to development.

In health, the greatest potential contribution of such technologies, especially Artificial Intelligence, is in the ability to process and analyze for the first time gigantic volumes of information, generating knowledge for, among others, health surveillance, diagnosis, virtual experiments, construction of formulas, and molecules. These possibilities bring, in addition to economic and technological issues, their ethical and philosophical issues, such as the bias in algorithms, ownership and use of the data of the citizens, digital rights for a digitalized society, etc. The need to legislate on the market operation in the digital economy is urgent. Large technology companies and the state have increasingly accumulated information about citizens and profited from it or have increased political and media surveillance.

With the pandemic, there was an explosion in the development and use of digital technologies. AI and robotics were intensively used to aid in the diagnosis, sterilization, and delivery of food, supplies, and medicines, disease surveillance, and monitoring, detection of infected or non-compliant individuals, etc.

Involving Big Data, Blockchain, Artificial Intelligence and cloud computing, all of these advances, in response to the crisis, occur on a global scale and more often point to more noble uses in digital technologies. The Covid-19 crisis, in addition to demonstrating the importance of these innovative technologies, has proven the feasibility of rapidly developing innovations that are relatively inexpensive, based on cooperative projects between universities, local cooperatives, and small companies.

Proposition of Public Policies

Faced with a global dynamic of production and innovation marked by profound transformations and uncertainties of a world bogged down in chronic crisis, Brazil and HEIC face significant challenges. The first one refers to the need to rethink the State itself, releasing it from the various traps deployed by neoliberalism in the last three decades that meant its capture by the diktats of the "financialized market." Brazil needs a State capable of proposing and conducting a development project that is based on the inclusion of the whole society and that addresses the main current challenges, especially the confrontation of the social issue, socio-environmental sustainability and the control – particularly through regulation – of Surveillance Capitalism (Zuboff, 2019) or Platform Capitalism (Smircek, 2017).

The discussion of a new policy of productive and innovative development in Brazil must also consider the recent experience of industrial policy and innovation, the characteristics of the national productive base and the social context. The new axes of action of policies focused on productive and innovative development should aim at solving national problems and challenges. In addition, the implicit policies (macroeconomic, commercial policy, use of public purchasing power, regulatory policy) should be designed and implemented in accordance with the objectives of the desired development standard, in addition to reinforcing the actions and instruments of the explicit policies.

Continued and large-scale investments will be needed to ensure the energy and digital transition of the HEIC subsystems. As when the Unified Health System (SUS) was implemented, planning and coordinating this transformation will require investments in workforce qualification, ICT infrastructure endowed with cyber security, new management systems, etc. Undoubtedly, current financial instruments, funding, and the public budget with the laws (LOA and PPA) will need to be modernized in the direction of what can be called State 4.0 and DeFi (Decentralized Finance). There are great possibilities for virtuous and good technological trajectories that new digital technologies present, either for the democratic and inclusive modernization of the State, of the national health system, or for the management of resources for ST&I, industrial policy, and spatial deconcentration of

HEIC. It may even require digital health reform, including telehealth instruments, applications, and algorithms such as those that the private sector already offers in healthtechs. This is where technological modernization and the model of services and management of the SUS offer the greatest opportunity in the current scenario of difficulties. However, it requires adopting a State policy, to be continued in the long term, a social pact for the future of the country.

As for the industrial subsystems of the HEIC, it seems logical to bet on the regionalization of productive activities in health, seeking commitments and articulations between the different local actors: governments, educational, and research institutions, community agents, etc.

The biggest challenge is the clear need to endogenize the infrastructure and production of goods and services of the digital economy, introduce the advances of Artificial Intelligence, Big Data, etc. in structuring projects, aimed at the most pressing needs of the Brazilian society in health, education, water and sanitation, healthy agriculture, etc. The new data infrastructure – Distributed Registry Technology – (especially the well-proven blockchain) and its decentralized health applications (Dapps) should be built with sovereignty. Blockchain can accelerate and improve the management of the budget for the HEIC and SUS.

Especially in primary health care, training investment programs for the use of Artificial Intelligence should be stimulated; in processes and remote or virtual care, especially in DATASUS.

The construction and consolidation of a universal health system stands out as a fundamental axis of the development project and a potential focus of industrial and innovation policies. In the national health system – with the public and the private sectors coexisting – one must:

(a) build a secure infrastructure to store and process data in a decentralized manner and at the same time accessible and interoperable by health network nodes, whether they are public or private;

(b) work transparently with public-private partnerships in medical history, remote care, supply of pharmaceuticals and other inputs, and the use of AI for diagnosis, prescription, monitoring, and management of health services.

(c) Regarding the right to health, in the digital environment, two principles must be agreed as an expression of people's digital rights – digital identity and data ownership.

In short, the acute global crisis explained by the pandemic and deepened by the military conflict in Europe clearly demonstrates the urgency of rethinking the role of the State, releasing it from the subordination to the diktats of financialization and directing it to exercise the role of coordination and implementation of a new development model capable of providing effective well-being of the population. Faced with the problems already identified that were brought by the new regime of accumulation – informational, surveillance, or "spectacle" capitalism – that has been consolidating in the world and the possibilities pointed out by the latest digital technologies of the so-called "Industry 4.0", this mainly means rethinking the mistaken neoliberal institutionalities introduced in the last 30 years replacing and/or substantially changing them with others that allow the country to advance towards a fairer and egalitarian society. The experience in the post-2020 period – pandemic, military conflicts, acceleration of environmental degradation, and explosion of inequality – points to a new development project focused on activities essential to human life. In such a project, the productivity and innovation systems aimed at sustaining a dignified and socially committed life play an essential role. Health, in its broadest concept, and the HEIC, in particular, should constitute the backbone of such a project.

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Territory, Sustainability, and Innovation: Policies for Health and Well-Being

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Aggravated by the Covid-19 pandemic, the multidimensional crisis, i.e., the social, economic, political, and environmental crisis, reinforced the urgency to implement a new generation of policies that place health as a vector of an innovative project of well-being for the Brazilian society. By examining the territorial dimension of health, contemplating Brazilian diversity and breadth, and focusing on agents and regions generally invisible in traditional analyses, we show knowledge of extreme relevance to the Brazilian society as a whole. In the third year of the pandemic crisis and given the urgency to think about the country's future, we reiterate:

- the urgency to radically change living and production patterns and to focus concerns on sustainability, health, and safety of life on the planet;

- the close link between health and other essential public services and the prospects for an inclusive and sustainable future;

- the advantages of placing health as a dynamic axis of the new well-being project throughout the Brazilian territory;

- the need for the different territories to preserve autonomy in technologies, inputs, goods and strategic services, with emphasis on "productive and innovative systems with a future", focused on health and other public services;

- the objective of promoting digital, territorial, and national security and sovereignty, combining productive and innovative dynamism with sustainability, social advances and territorial cohesion;

- the essential role of the State in the defense of common goods and in the implementation of new participatory policies that are appropriate to the needs of the country and its regions. (LASTRES et al., 2021)

Health, territory, Sustainability, and Innovative Initiatives

The continental dimensions of Brazil and its strength offer rich potentialities to be stimulated and that demand specific agendas. The role of the territory – understood as the real space, where the actors are and where social, cultural, and productive activities are carried out – highlights the importance of deepening knowledge about the Brazilian reality, aiming at the formulation of contextualized, systemic, and coordinated policies at the various scales and capable of contemplating the different territories and regions of the country, as exemplified by the national health policy and the constitution of the Unified Health System (SUS).

The multiple crises combined with the pandemic contributed both to expose the distortions and limits of the hegemonic economic and political model, which was deeply unfair and unsustainable, and to expand existing vulnerabilities. The speed and extent of the destruction of nature and the colossal inequality were identified as potential sources of the outbreak and repetition of epidemics. In the discussion, the depoliticization and the conclusion that resilience to climate change only makes sense if supported by a political, cultural, and ideological transformation were emphasized.

The debate on sustainability required the requalification of the concept of development, reinforcing the importance of solidarity with present and future generations, as well as multidimensional and territorial vision. This orientation was incorporated into the health-environment relationship and includes the social, economic, cultural, ecological, environmental, political, and territorial dimensions. Thus, when exploring the links between health and sustainability, the relevance of the systemic and contextualized approach was equally evident[1].

The historical inequality of the country is reflected in its territories, both rural and urban, and affects more severely those systematically discriminated due to income, gender, and race, and who face housing difficulties and access to other public services, such as health,

1 See section 1 “Saúde, Sustentabilidade e Território” in Lastres et al. (2022).

education, food, sanitation, energy, transportation, culture, connectivity, and security. However, the Brazilian dimensions and socio-biodiversity offer important potential to reduce dismissals, inequalities, and dependencies.

By seeking to understand the impacts of the pandemic and identify territorial initiatives to reduce its effects, the research revealed that, without living and lively territories, there is no way out. The health emergency, in addition to reaping the lives of more than 680,000 people, also repositioned the discussion on policies, especially regarding the rise of international prices and the inaccessibility to products indispensable to health, given the fragility of a national coordination and the challenges posed to subnational entities. On the other hand, it allowed us to prove the paramount importance and vitality of the SUS, which increased its capacity for care, despite underfunding, de-financing, and other difficulties, confirming that its potential grows in spaces beyond metropolitan regions, highlighting the relevance of capillarity, teams, and synergies with the territorial specificities of primary health care (PHC)[2].

The initiatives to face the pandemic revealed several potentialities:

- in the rich diversity of territorial actors, with the inclusion of new institutionalities, such as the consortia and Covid crisis committees, created by municipal, state, and regional bodies;

- in the innovative responses to the required productive conversion, which have united universities and public institutes, as well as companies and the S System and industrial representation;

- in the emblematic responses of territories, communities, and urban and rural collectives that articulated solidarity actions, sensitized society, and supported production and local purchases.

2 See section 3 “Desafios e respostas macrorregionais à Covid-19” in Lastres et al. (2021).

The immediate local responses to the pandemic of unassisted communities, favelas, and traditional people generated innovative effects, which are fundamental to protect and care for populations and generate income. This occurred when precariousness, unemployment, impoverishment, hunger, weakening of the social protection network, and discouragement worsened. As a result, significant differences were recorded in the number of cases and reduction of deaths.

Cooperation based on knowledge of the territory, relations of proximity, identity and trust was the basis for the effectiveness of actions. Popular, black, indigenous, feminist, and the favela's associations and young leaders, allied to teaching and research institutions, point to these territories as places of power, which invent solutions capable of renewing public policies. As stated by a Rio de Janeiro favela leadership, "in the pandemic, favelas were governments, while governments were absent."[3]

Productive and Innovative Arrangements at the State and Local Scales: the Importance of Cognitive Territories to Strengthen SUS and HEIC

Three studies of peripheral territories, with rich experience in public health – in Piauí and Rondônia, and Maré and Manguinhos in Rio de Janeiro[4] – show the potential for promoting local productive health arrangements (LPA) and shed light on relevant aspects:

Knowledge – a factor of empowerment and emancipation of local communities – allowed, during the pandemic, residents to become protagonists of inclusive and humane ways of living, proving to be fundamental in structuring the SUS and in the implementation of initiatives, such as in Maré and Manguinhos. The action of the communities have led to the organization of the public space and integration with the local health system, in addition to the creation of crisis offices; information and communication strategies, mobilization of donations of finan-

3 See section 2 "Iniciativas Inovadoras e sustentáveis de combate aos efeitos da pandemia" in Lastres et al. (2022).

4 For Piauí, see section 4 "Sistema Produtivo e Inovativo de Saúde do Piauí e APL de Teresina"; for Rondônia, see section 5 "Sistema Produtivo e Inovativo de Rondônia e o APL de Porto Velho: dinâmica, desafios e política"; for Maré and Manguinhos see section 3 "Saúde como eixo Promotor do Desenvolvimento nas (e a partir das) Comunidades Vulnerabilizadas do Rio de Janeiro", in Lastres et al. (2022).

cial resources, protective materials, and food, manufacturing of protective items; food production; local purchases; geolocalized epidemiological monitoring, among others.

The knowledge and commitment of health professionals who settled in Piauí and Rondônia, articulating high technical capacity with the experience and tacit regional knowledge, were decisive for the advancement of LPA in these territories. In Piauí, specialists from the sanitary movement structured and legitimized the Municipal Health Foundation (FMS), which played a key role in the success of the Teresina Health Center. In Rondônia, the great differential was the arrival of renowned scientists and young researchers, forming a critical mass of local researchers for the search for solutions to health challenges in the Amazon and the identification of their pharmacological potential.

Power relations and participation of the citizens

Decentralization, democratization, and social control are founding precepts of the SUS and presuppose effective participation. However, power relations at the local level generate difficulties, mainly in the alternations of power and due to the possibility of capturing politics by interests outside the public dimension.

In Maré and Manguinhos, in the absence of the State, organized crime plays this role of weakening social cohesion and disorganizing political agendas. However, virtuous experiences show how the protagonism of the local community is fundamental to minimize these effects. In Manguinhos, the Intersectoral Management Council deserves to be highlighted, which articulates health initiatives and other public policies, inspired by "healthy territory governance". It is an example of cohesion and participation of citizens, as opposed to the forces of disruption derived from power disputes. Thus, in addition to the current logic of management based only on public-private partnership, the need to strengthen a logic of public-community partnership in the management of PHC is advocated.

It is noteworthy the performance of FMS in Teresina – an example of institutionality built by professionals committed to the sanitary perspective for health – which controls not only the health system of this capital, but also has a strong influence on the conduct of

the policy of Piauí and neighboring states. And it acts as a shield against the traditional discontinuity in the transitions in municipal power and the illegitimate attempts of capture by the private sector.

HEIC's Territorial Potential

Despite the industrial segments of HEIC almost did not exist in the territories surveyed[5], three groups with significant potential for productive and innovative activities were identified: complementary services and equipment and materials; information and communication technologies (ICT), especially health software; pharmaceuticals and herbal medicines produced from the Brazilian socio-biodiversity.

In the first group, there is the local supply by cooperatives and associations of residents of goods and services of maintenance, cleaning, food, textiles, furniture, and equipment, which can be greatly expanded.

In the second, specific challenges were observed for the digitilization of health in urban favelas, isolated communities in the Amazon, and other parts. There is also potential for contextualized solutions in the digitilization of the SUS, guided by preventive logic and the Family Health Strategy. Public universities already contribute to this effort. Examples include computer/software programs patented by the Federal University of Piauí (UFPI) and others. Such potential should be mobilized.

In the third group, small technology-based companies and extractivist LPA from medical supplies operate in distinct parts of the country. Rondônia is part of the network to create a large production base for biopharmaceuticals. In Parnaíba (PI), there is a factory of natural Active Pharmaceutical Ingredients, which belong to the company Phytobios, one of the most active in the country in the production of new medicines from biodiversity routes. It is urgent to implement a strategic policy for the development of the regional innovation

5 As shown in Lastres et al. (2021), in addition to being dependent on imports, HEIC is strongly concentrated in the Southeast. Technological transformations can reinforce this concentration, but they also bring possibilities for innovative solutions in peripheral spaces.

system in this area, in which Bio-Manguinhos has a significant role to play, including ensuring the preservation of national interests.

The role of Fiocruz and its regional offices

Fiocruz's performance in the territories studied reveals the positive results of both its regionalization vision and policy, as well as its presence and territorial rooting. In Maré/Manguinhos, where its headquarters are located, Fiocruz plays a vital role in supporting community organizations, with a large number of programs that cover, in addition to health, socio-political, economic, and cultural issues of those communities.

In Porto Velho, although the office was established in 2009, Fiocruz coordinates a set of actors in the research and promotion program of epidemiological surveillance, control, and cure of neglected endemic Amazonian diseases and the development of new drugs and inputs from forest biodiversity. It also has a strong role in training at the master/doctorate level, in addition to supporting the SUS, with emphasis on combating Covid-19.

Created five years later, in Teresina, Fiocruz-PI also leads relevant projects: Microcephaly Reference Center; Maternal-Child Network; Popular, environmental and female surveillance; Environmental changes, urbanization; Neglected diseases, Gene sequencing and molecular surveillance of SarsCov2. It play a key role in graduate courses, as well as in supporting the Health Center of Teresina and the state-level SUS.

All studies confirm Fiocruz's high commitment and capacity in these activities, by mobilizing actors, inducing virtuous productive trajectories, and strengthening the SUS. Its presence in the territory contributes, above all, to the necessary articulation between different types of knowledge and contextualization of health actions.

Public Policy Propositions

In order to understand how health and the HEIC can drive the resumption of the development of the Brazilian territory in new bases, we learn that the degradation of ecosystems produces and intensifies diseases and pandemics, mainly affecting the most vulnerable populations, and reinforces the perverse cycle of exclusion and socio-environmental deterioration, which feeds back and makes society even more unfair and unequal.

A crucial requirement in the formulation of the new policies is, therefore, to place life – human and planet – and sustainability at its center, contemplating meeting the basic needs of the territories and their communities. To this end, the Brazilian productive structure must provide the goods and services necessary to meet the needs of the populations of the entire Brazilian territory, identified in the democratic process of policy formulation. It is noteworthy that meeting social needs – in addition to being the most effective way to provide solutions to inequalities and the basis for a dignified life – can mobilize productive and innovative capacities, generate income and formal and equitable jobs, with a lower ecological footprint.

There are two main arguments in this discussion. First, that health and other essential public services (i) rely on production and innovation systems of various goods and services and represent irradiation opportunities associated with the demands and potential of different territories and regions; and (ii) have the capacity to lead a renewing transformation of the Brazilian productive structure. SUS and HEIC are examples of this systemic potential, which should be mobilized throughout the Brazilian territory.

Secondly, it is reiterated that the centrality of the territorial scale and its context cannot be ignored, especially due to the significant Brazilian socio-biodiversity. Hence the importance of systemic policies to mobilize the capacities of each territory and promote citizenship and access to public services. Both the territory and its context should be seen as essential planning units for all public policies. And the fact that health services are unevenly distributed in the Brazilian territory reaffirms that new investments cannot intensify exclusions, dependencies and environmental problems. The regionalization of health

brings with it the opportunity to renew its productive base to reduce inequalities and radiate principles of sustainability and innovation.

The following main conclusions are worth mentioning: (i) the SUS, even in the context of dismantling, showed its crucial relevance, highlighting the importance of health reform and the universal and egalitarian system, territorialized and with popular participation, reaffirming the binomial health and democracy; (ii) the varied experiences and forms of organization of communities reflect advanced responses to health, social, ecological, economic and political crises. The lessons of these "territories of difference" are very inspiring; (iii) Fiocruz's role is greater in the new scenario, requiring systemic, contextualized, and sustainable action, both in its role of supporting planning, implementation of national and international policies and regulations and in its research, production, and innovation activities.

Among the guidelines for new public policies, the primary recommendations are:

- to promote the regional sustainable dynamism of the HEIC, aiming to ensure capillarity in the equitable provision of health goods and services, in permanent dialogue with local communities, emphasizing the role of youth, women, and social movements as producers of solutions appropriate to the contexts.

- To value and qualify health professionals and the like, restructuring the formative profile, expanding transdisciplinarity, integrating social technologies, articulating scientific and traditional knowledge, promoting networks of technological and social extension and prioritizing Family Health Strategies and the humanization of care.

- To generate conditions of access to knowledge for the generation and use of technologies, internet, tools, systems, and digital platforms.

- To create new forms of financing and payment – community banks, social, and digital currencies – and ensure the current sources for SUS' financial sustainability.

- To readapt health service networks to the new context of climate crisis and extreme events and the qualified use of modern technologies.

- To ensure environmental sustainability in all processes and actions of policies and the health system.

Proposition of Public Policies

To support the consolidation of health LPAs by,

- creating and qualifying suppliers and stimulating local purchases, linked to regional science, technology and innovation (ST&I) bases, to expand the production of sustainable and appropriate goods and services in different regions of the country;

- using instruments such as micro-credit, community currencies, and incubation of solidarity economy enterprises;

- improving the use of public procurement and legal frameworks to carry out public contracts, enabling and giving preference to Micro and Small Companies (MPEs), local and regional companies, and cooperatives with socio-environmental responsibility;

- supporting articulations with regional development agencies, enhancing SUS' purchasing power in social technological orders developed in partnership with beneficiaries; mobilizing local suppliers and service providers; stimulating productive chains; and avoiding "development leaks".

To promote the development of E-Health, mobilizing local ICT skills and providing preventive, humanized, and appropriate solutions – including for excluded communities – with the Family Health Strategy as the guiding axis.

To create a database of traditional knowledge and research and training programs for specialists in the use of genetic heritage and sharing of benefits.

To mobilize regional innovation systems, aiming to generate solutions adherent to the local cultural, social, ecological, and economic conditions of the provision of SUS and HEIC; expanding and consolidating the role of Fiocruz and its agencies as agglutinating axes of regional health networks that emphasize sustainable and endogenous innovation strategies "based on practice"; as well as research at the scientific frontier oriented to neglected diseases and with a territorialized epidemiological profile.

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Predatory Stagnation or Sustainable Development?

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

From the perspective of the Health Economic-Industrial Complex (HEIC), this chapter presents an exploratory approach to how health can contribute to overcoming the problem of environmental degradation and economic stagnation in Brazil and promoting the sustainable development of the Unified Health System (SUS).

The text is presented in a context of deep global climate and socioeconomic crisis, with the planet facing the imminent risk of increasing the temperature by two degrees by 2030 (IPCC, 2022) and hunger advancing at the same speed, particularly in developing countries (FAO, 2022).[1]

How did we reach this global environmental and social crisis? One of the primary justifications is that, since the industrial revolution, the means of production and consumption develops separately from social and environmental needs (Polanyi, 2013). The consequence of this disjointed development of social and environmental needs generated a crisis in the planet's climate due to high greenhouse gas emissions (IPCC, 2022) and the deepening of social inequalities. Therefore, the crisis reveals the interdependent nature of production organization models with society and the environment, as developed by Celso Furtado in 1974.

In fact, extreme weather events, frequently reported around the world, have caused water and housing crises, food production issues, landslides and floods, among others, affecting the lives, health and well-being of thousands of people. In addition, climate change turns the health and disease profile of populations more complex, with the potential to increase the incidence of chronic non-communicable diseases and infectious diseases, especially in vulnerable populations (PAHO, Fiocruz, 2008). Those are just part of the consequences. The truth is that climate change puts (animal, plant, and human) life on the planet at risk (IPCC, 2022).

In this scenario, the ability to deal with climate change emerges as one of the main chal-

1 According to the FAO report (2022), hunger worldwide affected 828 million people in 2021. In the case of Brazil, according to the II Inquérito Nacional sobre Insegurança Alimentar no Contexto da Pandemia da Covid-19 (REDE PENSSAN, 2022), 33.1 million people are in a situation of food insecurity.

lenges for the preservation of life on the planet. Therefore, new forms of interdependent organization between economy, society and the environment are urgent. To address the climate and social crisis, there is an urgent need to build agendas for preserving sustainable ecosystems and social productive systems that drastically reduce greenhouse gas emissions in the atmosphere.

In this sense, collective awareness about the preservation of the environment and reduction of social inequalities appears as a central movement in political and economic transformations. Multiple actors – national states, private initiative, scientists, social movements, multilateral organizations – position themselves in global geopolitics to advance sustainable agendas. The Sustainable Development Goals (SDGs) consolidated the key points of this consensus of the different political agents in the 2030 Agenda, boosting what has been called the "sustainable transition", which consists of an agenda that combines the reduction of social inequalities with the transition to a low-carbon economy, in which there is a progressive drastic reduction of CO2 and methane emissions to the atmosphere – the main global warming gases[2] (IPCC, 2022).

Although climate change affects all people, its impacts are very different among groups of the population. There is a direct association between underdevelopment and vulnerability to climate risks, with strong consequences for human health (FAO, 2021). The populations living in a situation of territorial and social vulnerability are the most affected ones. Between 2010 and 2020, deaths caused by floods, droughts, and storms in vulnerable regions, where about 3.3 billion to 3.6 billion people live, were 15 times greater compared to areas of low vulnerability (IPCC, 2022).

These global asymmetries and climate injustices reveal the configuration of a center-periphery relationship associated with an international division of labor that positions countries as exporters of primary resources and consumers of imported products, services, and technological packages, while a few others produce scientific knowledge, innovations, and define the technological pattern. The current context of Brazil is a good example.

2 The replacement of fossil fuels and petroleum products, such as gasoline and natural gas, with clean energies, such as solar energy or biofuels and bioproducts derived from plants or waste (biomass) are examples of the transition (Souza et al., 2017).

The deepening of the social crisis and the economic stagnation of the last decade occur in parallel with the substantial increase in the depredation of natural resources. The Amazon rain forest has never been as much deforested as in recent years (INPE, 2022). Agricultural exports have increased and, even so, Brazil has returned to the hunger map. The reproduction of underdevelopment, in a context of complex economic, social, cultural, and ecological heterogeneity, translates into a model of predatory stagnation that does not promote economic growth, destroys biodiversity, deepens social inequalities, expands technological dependence and amplifies global asymmetries.

In this sense, the effort to transition to a pattern of sustainable development requires the construction of an agenda that offers everyone the opportunity for a full life, with nutritious and healthy food, decent housing, quality education, good employment, access to culture, and equality, so that everyone can enjoy the same condition. To construct this project desired by a democratic society, it is necessary to develop a productive structure and sustainable innovation on national bases to meet social and environmental needs.

The first step is to promote virtuous articulations between the State and the market guided by the public interest, based on a systemic view that captures the interdependent nature of the models of organization of production and society with the environment (Gadelha, 2016; Mazzucato, 2021). With this, it is possible to think of strategies to reconcile the biophysical limits of the planet and ecology (Daly, Farley, 2004) with the need to meet social demands and promote economic dynamism, investment opportunities, and generation of employment and income.

Health can play a key role in this agenda, triggering a new pattern of sustainable development. In addition to being fundamental for welfare, it has great economic relevance and is a privileged space to introduce frontier technologies. Its activities accounted for 9.8% of global GDP in 2019, and this percentage is expected to increase over the next decades (WHO, 2021). In the case of Brazil, these factors combined with the existence of SUS, the largest universal health system in the world in terms of the population covered, allow us to enable and provide the necessary scale so that investments in sustainable technological trajectories in the HEIC become a systemic solution with important overflows for

other economic sectors. Taking care of people and caring for the environment not only fits into GDP but can also be central to an economy at the service of life.

In this sense, this chapter presents an exploratory reading of the sustainable transition from the Health Economic-Industrial Complex and is organized into three sections, in addition to this introduction. The first section presents the process of consolidating the theme of sustainable development in global geopolitics, which puts the environment at the center of the global development agenda. The second section discusses the two main technological routes developed by science for the transition to a low-carbon economy, in addition to introducing, in an exploratory way, how sustainable technologies land in the health field. The third section concludes with a critical reading on the sustainability movement in geopolitics, pointing out that, without universal access guaranteed by the Unified Health System and by strengthening the Health Economic-Industrial Complex, there will be no sustainable development in Brazil. Finally, the chapter concludes with propositions of public policies for the sustainable transition of the HEIC focused on universal, integral, and equitable access to health.

Sustainable Development in Global Geopolitics

The concept of sustainable development, formulated at the end of the 1980s and presented in the Brundtland report – "Our Common Future", originates from the debates that were established between the acceleration of economic development and the environmental crisis generated by the industrial growth model. The developments of the "Great Fog of 1952", caused by air pollution in London, opened space for movements that related environmental issues to human health, forcing the English Parliament to regulate industry for the use of cleaner energies (Davis, 2002). Although incipiently, it was the first time that awareness was raised regarding the relationship between the environment, means of production, and the impacts on human health.

The fundamental historical milestone of the debate occurred ten years later, in 1962, when Rachel Carson published "Silent Spring", bringing to light the impacts of agrochemicals on human health and natural ecosystems (Carson, 2015). Such events, in addition to the

ecosystem crises and the environmental devastation of the period, fostered, especially in the scientific struggle and social movements, an awareness of the relationship between the economy, ecology, health, and society (Kroll, 2001).

In the 1970s, the recognition of environmental protection and improvement emerged as a fundamental issue in the global geopolitical sphere. The need to adopt sustainability parameters justified the first global conference on environment and development, held in Stockholm in 1972, when the United Nations Environment Programme (UNDP) was also inaugurated (Romeiro, 2012). The conference in Stockholm[3] was marked by the debate on the limits of economic growth, based on the study published by the Club of Rome, "The limits to growth" (Meadows et al., 1972).

For the first time, the Stockholm event called into question the debate on economic development and the environment in the geopolitical arena, placing on opposite sides the interests of central and peripheral countries in the economic system. On the one hand, the European countries, influenced by the Rome report, advocated "zero growth" to address environmental problems. On the other hand, the underdeveloped countries defended the "right to grow". In the case of Brazil, the Minister of the Interior and head of the Brazilian delegation, Costa e Cavalcanti, declared during the event that "We should focus on developing first and then pay the costs of pollution".

In the 1980s, the concept of sustainable development emerged as an alternative to overcome the impasse between growth and the environment[4] posed by the Club of Rome. The Brundtland Report defines it as "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development; and institutional change are all in harmony and enhance both current and future potential to

3 The Stockholm Declaration on the Human Environment states that "The protection and improvement of the human environment is a major issue which affects the well-being of peoples and economic development throughout the world; it is the urgent desire of the peoples of the whole world and the duty of all Governments" (Sohn, 1973).

4 The term "sustainable development" was first publicly used in August 1979 at the United Nations Symposium on the Interrelationships between Resources, Environment and Development. I was considered the greatest challenge of this century when Gro Harlem Brundtland, the then president of the World Commission on Environment and Development, characterized it as a political concept before the 1987 UN General Assembly (Veiga, 2006 p.19).

meet human needs and aspirations" (Brundtland, 1987). The following year, the Intergovernmental Panel on Climate Change (IPCC) was created, which is essential to amplify the alarming evidence on climate change.

The historical Earth Summit, the so-called Rio-92 conference, held in Rio de Janeiro, reformulated the notion of sustainability and climate crisis in the face of asymmetries between central and peripheral countries. It was no coincidence that the Vienna conference (World Conference on Human Rights), held in 1993, brought economic development as the main topic, especially for the poorest countries. These two events consolidate the widespread global awareness that currently integrates the notion of sustainable (economic, environmental and social development) – and human rights.

The Earth Summit held in Rio became a milestone in contemporary global discussions on the environment, especially as part of the process that led to the formulation of the Millennium Development Goals (MDGs) and Agenda 21[5]. In addition to environmental issues and the climate crisis, there was a direct objective in dealing with development patterns that cause social damage, such as poverty and the foreign debt of countries. It was also in the Earth Summit in Rio in 1992 that two important conventions on sustainable transition were born: the biodiversity COP and the climate change COP (COP – Conference of the Parties – supreme body of the United Nations Framework Convention on Climate Change).

The Millennium Development Goals and Agenda 21 would be updated twenty years later, in June 2012, at the United Nations Conference on Sustainable Development (Rio+20). The document resulting from the Conference, entitled "The future we want", laid the foundations for the collective construction by the UN member countries of a new set of objectives and goals aimed at sustainable development. In 2015, in the Paris Agreement, heads of state and representatives of the 193 countries that are members of the UN General Assembly signed the document "Transforming our world: the 2030 Agenda for Sustainable Develop-

5 Agenda 21 was a series of resolutions adopted at the international Earth Summit conference. Organized by the United Nations (UN), it was attended by 179 countries and resulted in measures to reconcile economic growth and social development with environment conservation.

ment". In the document, the eradication of poverty in all its forms and dimensions appears as an indispensable requirement for sustainable development (Roma, 2019).

However, as awareness of the importance of environmental protection gains relevance and incorporates new dimensions into global geopolitics, such as the climate crisis and poverty reduction, the difficulty in overcoming the boundaries of political discourse resulted in the maintenance of environmental policies in isolated niches, without the ability to induce a process of effective transition to a low-carbon economy.

Pathways to the Sustainable Transition of the HEIC

In addition to acting decisively in the production and dissemination of evidence of the climate and environmental crisis, the scientific field has been developing knowledge (technological trajectories) to promote the transition from a fossil-based economy (use of oil) to another based on non-fossil renewable resources (use of biological resources, such as plants). This knowledge is based on the notion of sustainable low-carbon technologies – those that, during their use or during the production process, emit less carbon or even capture them from the atmosphere (IPCC, 2022).

The main technological trajectories of the sustainable paradigm are related to the biomass route (renewable biological resources) and the circular economy (products return to the production system).

Biomass refers to the development of processes for the use of plants and their residues for the development of bio-based products (bioproducts). The circular economy, in turn, is an integrated part of the new model based on the biomass route, defining trajectories for materials to return to the production cycle (Poz, Silveira Bueno, Ferrari, 2022). The basic assumption is that products should be reused or recycled, increasing the useful life of the resources used.

The biomass route and the circular economy guide the development of sustainable technological trajectories. For instance, the technological trajectories developed to replace

the energy model based on fossil fuels (Kehrein et al., 2020) with the biofuel model, produced from solar or wind energy plants (Romero et al., 2019), and the development of bioproducts (Souza et al., 2017). Bioproducts produced in a circular economy can replace raw materials of fossil origin, such as polymers and lubricants (Orejuela-Escobar, Landázuri, Goodell, 2021), playing a crucial role in the transition from the circular economy to economic decarbonization (Junginger et al., 2019). It is expected that more than 90% of the petroleum products will be produced from renewable raw materials worldwide, and half of the pharmaceutical market may be bio-based by 2030 (Clauser et al., 2021).

These technological trajectories for the sustainable transition have a high interface with the four subsystems of the HEIC – chemical and biotechnological base; mechanical, electronic, and new materials base; information base and connectivity; and health services base – and strong link with the technologies of Revolution 4.0.

The **chemical and biotechnological** subsystem, for example, has in the biomass and green chemistry route a front for the development of bioproducts, such as medicines and pharmaceuticals, alternative and renewable reagents, the substitution of toxic solvents; natural synthesis processes, and new substances that do not pollute the environment. In this technological route, Brazil's enormous biodiversity is a significant advantage to be explored, opening opportunities for innovation, sustainable investments, jobs, income, and health for the Brazilian population. In addition, it is possible to advance in the circular economy by developing technologies for the treatment of waste and disposal of medicines.

The **electronic mechanical and materials** subsystem, in turn, must be guided by the circular economy, considering the reuse and life cycle of the products. The incentive to Research and Development of products with technology for greater energy efficiency is fundamental to ensure the rational use of natural resources, both in the industrial processes of manufacturing the products and in their clinical use.

The **information and connectivity** subsystem, which emerges with the 4th technological revolution, is considered a critical and decisive element for policy planning and deci-

sion-making in health in the current context. Digital tools cause intense changes in the patterns of care, promoting changes in the relationships between health professionals and patients, in the consumption of inputs, products, and drugs and in the generation of waste. The use of information technologies and connectivity in health can increase the predictive and precision capacity in diagnoses and interventions, reducing the time of care, increasing safety, directing the best clinical conduct and minimizing the organizational costs of services. In addition, these technologies can improve surveillance and health care through the creation of tools that promote greater integration and data processing capacity, such as the use of software and electronic patient records. The use of emerging technologies can also accelerate the discovery of molecules and enzymes capable of treating bacteria or viruses, assist in the mapping of genetic resources of biodiversity and contribute to create alerts and promote actions to minimize the impacts of climate change on health.

With regard to the **services subsystem**, the link to which all subsystems of the HEIC converge, the incorporation of sustainable technologies must be articulated with the care model so that the transition of the HEIC does not detach from health needs and strengthen access mechanisms. Ensuring the right to health is the primary objective of the organization of care services and the incorporation of technologies should strengthen them, making them more precise and resolute. This means that the organization of health systems and their connection with the productive and innovation base plays an essential role in the incorporation of sustainable technological trajectories in the HEIC.

In the context of the 4th industrial revolution, the incorporation of sustainable technologies reaffirms the need to expand prevention, promotion, and health care actions guided by a systemic vision that seeks to avoid the disease and reduce the use of unsustainable technologies necessary to treat chronic cases, such as chemotherapy and radiotherapy. The transition from a biomedical and hospital-centered model of health care to a model in which the organization of services directs the focus to primary care favors an environment of greater rationality in the use of resources.

At the same time, it is essential to create sustainable environments for the practice of health care at all levels of care, promoting the more rational use of economic, social, and environmental resources.

With the new technologies 4.0, the possibility of precise public health opens up, allowing the quick discovery, validation, and optimization of "care strategies for well-defined groups of the population, according to the needs of each population group, regardless of their economic capacity to pay" (Barral-Neto; Gadelha, 2019). With this, it would be possible to adopt more appropriate measures for specific population groups, enabling equity and universal and integral access with the adoption of efficient and better practices for people and the environment. In addition, the use of these technologies can increase predictive and preventive capacity and contribute to the advancement of policies based on surveillance models and focused on interventions aimed at reducing hospitalizations and increasing quality of life and well-being. It is, therefore, about promoting a symbiosis between taking care of people and caring for the environment, developing sustainable technologies and environments from primary care to high complexity, generating investments, jobs and welfare for the whole society.

Thus, the transformation of scientific and technological knowledge into new products and services should be directed towards meeting social and environmental needs, requiring a systemic approach that incorporates politics, society, the private sector, ICU institutions, the role of National States and their forms of organization (Gadelha, 2018; 2021). By integrating the productive and innovation base in health with the organization of health systems in a systemic way, the HEIC becomes a concrete translational space where the generation of knowledge, the development of health innovations, and the process of incorporating sustainable technologies can connect to health systems, allowing for a space of virtuous articulation between universal access, environmental protection, income, and employment generation and economic growth.

Without universal access and a strong HEIC, there is no sustainable development

Since the 1970s, when the topic of sustainability emerged, the succession of conferences held within the United Nations has expanded scientific evidence on the climate crisis, technological promises, and combat measures and environmental preservation actions. Different developed or developing countries have adopted preservation actions, but these have proved insufficient to stop the global warming movement. Especially in the last five years, entire ecosystems have reached the risk of non-return, such as the Arctic glaciers and the Amazon rain forest (Wunderling et al., 2021). In this scenario, the environmental and social crisis deepens, especially in the poorest countries.

The intensification of social drama, such as poverty, hunger, and the lack of essential products for the protection of life during the pandemic are reflections of "fractures in the fragile skeleton of the societies we build" (Guterres, 2020). Despite the record time of large-scale development and production of new vaccines for Covid-19, the asymmetries of knowledge and productive capacity of countries have dramatically translated into health inequity, if not social barbarism (Gadelha et al., 2021). By December 2021, when global production was already sufficient to fully immunize the entire global population, there was still a huge gap between the number of vaccinated in high-income and low-income countries. In addition, by the end of August 2022, less than 24% of the African population had received at least one dose (WHO Africa, 2022, 2022b).

In this sense, the analysis of the global response to the Covid-19 pandemic allows us to extract critical elements for the construction of a sustainable development model. On the one hand, the pandemic has shown that the global and national mobilization of intellectual, physical, and financial resources, either public or private, is a viable task to face major challenges of humanity. On the other hand, it was evident that only with a significant reduction in global asymmetry in productive, scientific, and technological capacity it will be possible to promote a transformation that leaves no one behind.

Strengthening the productive and innovation base in health is essential to promote great-

er diversity in the generation and exploitation of new sustainable trajectories by national companies, with overflows to the other sectors of the economy. Therefore, the role of the National States is decisive for the creation of new instruments and mechanisms that promote a virtuous interaction between the public and the private sectors in an articulated way to the territory. The strategic articulation of the internal market and the state's purchasing power is essential to ensure stability and predictability for investment in new sustainable technological trajectories that are appropriate to the social and economic needs of the population.

The global and national productive and technological system is locked in the past. Through public policies, it is necessary to put the economy at the service of life – of people and the planet. The fundamental step is to overcome narrow visions that separate the environmental, social, economic and technological dimensions into distinct fields.

An equitable, productive society committed to social rights and environmental sustainability can only be possible with the existence of an economic and material basis that supports it[6]. The structural response capacity for climate change requires systemic policies, articulated and integrated with the development process in its economic, social, and environmental dimensions.

Having good health is a fundamental part of people's lives, and Brazil has the largest universal public health system in the world, which develops universal knowledge, products, and services, from primary care to high-tech procedures. In addition, the HEIC is one of the areas with the greatest economic and technological dynamism, representing about 10% of the national GDP and more than 30% of the science, technology, and innovation effort.

The HEIC has the potential to lead a process of reindustrialization of the national economy, being the engine and symbol of a new pattern of development that promotes economic dynamism through the construction of a sustainable welfare state in Brazil. Taking

6 For more information see chapter 1, "Health as a Strategic Option for the Development of Brazil" and chapter 14, about sovereignty in health for universal access: HEIC in public policy and society.

care of people and caring for the planet can lead to overcome the picture of predatory stagnation and promote a new pattern of sustainable development.

In the comprehensive view of health enshrined in Alma-Ata Declaration and the 1988 Constitution, health is considered a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity. This comprehensive view makes the incorporation of sustainable technologies in the SUS unavoidable since health as a quality of life cannot be considered in a planet in degradation. Therefore, the vision defended for the HEIC brings out health as a strategic and structuring space to enable sustainable development in Brazil.

Public Policy Propositions

Faced with the current context of climate change and the environmental challenge, the HEIC agenda expands, and the following propositions emerge strongly to subsidize a new generation of public policies:

- Promote the sustainable transition of the HEIC through systemic and structural industrial and innovation policies, to insert its subsystems in the route of the circular economy and the profitable and sustainable use of biomass;

- Transform the SUS into a symbol of the environmental and social transition in Brazil through the creation of sustainable environments for the humanized practice of health care at all levels of care;

- Progressively promote the reduction of greenhouse gases by 2030 and zero carbon in all industrial and service sectors and subsystems of the HEIC by 2050;

- Position the National System of Science, Technology, Innovation, and Production as an essential link in industrial development and innovation policy aimed at universal access to health, the development of sustainable technologies and the promotion of the reindustrialization of the national economy.

- Structure HEIC's productive and technological base to support another model of care in the SUS, with the strengthening of sustainable prevention and promotion activities, overcoming the perverse circle that associates disease, excessive medication, and environmental unsustainability.

- Establish the HEIC as an exemplary leader of a new development standard that promotes life, articulating economic dynamism and the construction of a sustainable Welfare State in Brazil.

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Financialization, Global Competition, and Challenges for the HEIC in Brazil

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

The Covid-19 crisis, in addition to the human and health tragedy that has been provoking, on the one hand, has shown that scientific and technological knowledge are capable of responding quickly to the challenge of creating vaccines in record time. On the other hand, it made explicit how this power is distributed in an extremely unequal way among countries, a fact that also translated into a very unequal access to vaccination.

According to a report presented at the G-20 summit (WHO, World Bank, 2022) in early 2022, over 11.3 billion doses of Covid-19 vaccines had been administered worldwide, with 65% of the world's population having access to at least one dose. However, in low-income countries, the vaccination rate was only 11%, compared to 73% in high-income countries.

Not only this is the result of the absence of more active mechanisms of international cooperation, but, on the contrary, of the resurgence of nationalism that had been shown since the global crisis of 2008 and that the Covid-19 crisis accelerated and made explicit, with the widespread adoption of restrictions on the export of inputs associated with vaccines, pharmaceuticals, and medical equipment to face the pandemic.

The traumas of the crisis also made clear the importance of the articulation between the domain of scientific, technological, and industrial capacities and the ability to offer health and safety services to the population as a whole. In other words, it made explicit the importance of the concept of the Health Economic-Industrial Complex (HEIC), which highlights the need to think about issues related to productive and technological development and those linked to equitable access to health services as a right of all citizens of a country.

In addition to fighting against the pandemic, facing the challenge of ensuring access to health for the entire population in an equitable manner cannot be dissociated from the challenge of moving forward in building robust national productive and technological bases. This two-fold challenge, in turn, must consider the scenario of profound changes that the global HEIC has been going through.

We seek to highlight that this scenario reflects changes in the dynamics of accumula-

tion in contemporary financial capitalism, but from the HEIC perspective, it reveals the extent and depth of this two-fold challenge for developing countries in general and for Brazil in particular.

The Strategies of the Leading Companies in HEIC

The set of changes brought about by deregulation and financial, trade and investment flow liberalization in the 1980s provided large transnational corporations (TNCs) with an unprecedented freedom to operate in the global market and mobilize different instruments and geographical regions to leverage their accumulation.

Braga (1997) points out that the large TCNs, free from the regulatory environment observed in the golden age, have become "machines of capital accumulation in general", drawing attention to the intertwining between the commercial, technical, and productive and financial dimensions in the international scenario, as can be seen from the following excerpt:

> From the microeconomic angle, their financial potential and the liquidity they have interact positively with the expansion of their own possibilities of technical and productive investment. Thus, they have broad and privileged access to capital, information, technological networks, and global markets, by gathering companies with distinct functions within the corporation. There is the flexibilization of time and forms of profitability of 'investments' (productive, financial, and equity), the temporality of debit-credit relations, and the modalities in which they form active and passive positions. There is a simultaneous combination of mobility, liquidity, profitability, and speculation in the global circulation of these capitals. (Braga, 1997, p. 221).

Thus, there is a process of financialization of the accumulation strategies of TCNs, where the financial logic of the accumulation process has become increasingly evident. But this did not necessarily mean that the large global company has put aside its productive assets and its assets associated with innovative activity and the monopoly gains generated

by its control. On the contrary, it began to mobilize all the means at its disposal to seek maximum asset appreciation, seeking to guarantee, at the same time, sectoral and geographical breadth of accumulation and control over strategic assets. In particular, intangible assets have become important, due to their ability to guarantee high profitability, financial appreciation, and flexibility to seek new accumulation spaces, even providing high capture of value generated in global production chains, combining flexibility and minimum commitment of resources and capital immobilization.

The global HEIC can be considered one of the main examples of this process. Global leading TCNs have been increasingly financed. At the same time, they have maintained the concern to conserve high expenditure on innovative activities, as well as reinforcing strategies to increase control over intangible assets that offer at the same time the ability to maintain leadership and capture value created in the entire production and innovation ecosystem. Intense processes of merger and acquisition and capture of results created with a strong contribution of public resources are part of this strategy.

Regarding the financial logic of the leading companies, it is worth mentioning the generalization of the maximization of the shareholder value (MSV), with the aggressive distribution of dividends and use of resources in the repurchase of shares (Montalban, Sakinç, 2013; Tulum, Lazzonick 2018; Fernandez, Klinge, 2020). Based on information from the 27 largest companies in the pharmaceutical sector in 2018, Fernandez and Klinge (2020) showed that the high profitability of these companies allowed for the increase in annual dividend payment and share repurchase from US$30 billion in 2000 to US$146 billion in 2018, with a cumulative total of US$1.540 trillion over the period.

Despite the high channeling of resources to the financial market, large pharmaceutical corporations have not stopped investing in R&D and worrying about the construction and control of intangible assets. Also, according to data shown by Fernandez and Klinge (2020), the total R&D expenditures of the 27 companies analyzed increased from US$34 billion in 2000 to US$119 billion in 2018, while the accumulated value reached US$1.482 trillion. In the same period, intangible assets went from 13% (US$48 billion) of total assets to 51% (US$857 billion) in the same period.

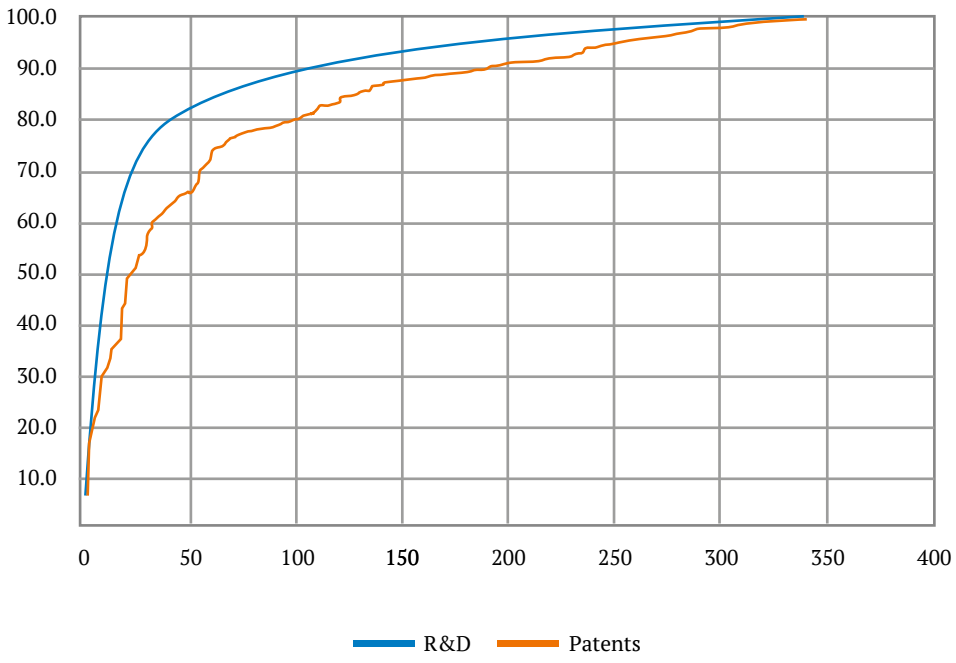
Activities related to the creation and control of intangible assets, including those related to R&D, reinforce strategic elements that can increase profits and impose new barriers against current and potential competitors (WIPO, 2017; Haskel, Westlake, 2018; Rikap, 2021). At the same time, they boost market value, to the extent that they are evaluated by investors without reference to a replacement cost as tangible assets, which explains why intangible assets have a majority and increasing participation in the market value of companies (Gagnon, 2007; Serfati, 2008; Baranes, 2017, Dosso, Vezzani, 2020).

HEIC's large companies, aware of the importance of intangible assets, start to base their accumulation by accessing them, seeking the continuous monopolization of knowledge in border sectors, defining what some authors call intellectual monopolies (Durand, Milberg, 2020; Rikap, 2021). It is also worth remembering that the protection generated by the patent system, justified by the need to protect innovative activity, has suffered distortions associated, for example, with the widespread practice of launching pharmaceuticals structurally remarkably similar to those already known (me-too drugs), with small pharmacotherapeutic differences, but capable of resulting in patent protection, higher prices, and profit margins (Mazzucato, Roy, 2019).

One way to observe the degree of concentration and control over intangible assets in the HEIC is to analyze the consolidated information on R&D expenditure and patent family of the largest companies in the sector from data organized by the Joint Research Centre Institute for Prospective Technological Studies of the European Commission, and the Directorate for Science, Technology and Innovation of the Organization for Economic Cooperation and Development [OECD] (JRC-OECD COR&DIP © database) This base considers the 2,000 largest companies in terms of R&D expenditure and consolidates information on trademarks and patents. Companies in sectors classified as belonging to the HEIC in the version released in 2019 with information for the 2014-2016 period totaled 340 companies (285 pharmaceutical and biotechnology companies and 55 medical equipment companies), or 17% of the total companies. These 340 companies spent €147 billion in 2016 and filed 23,900 IP5 patents, that is, patents deposited in at least one of the main intellectual property offices (USA, Europe, Japan, South Korea, and China) and in another second country.

Figure 1 shows the level of concentration, with the twenty largest companies accounting for 65.3% of R&D expenditure and 49% of the patents of the 340 companies. Of these twenty companies, all were from developed countries. Considering the distribution by country (Table 1), one can clearly observe the difficulty for developing countries to overcome the high barriers present in the sector, built from the strategies highlighted above. The only two developing countries on the list are India, with ten companies, and China, with 21 companies.

Figure 1. Distribution of R&D and Patent Expenditures of the 340 HEIC companies in the top 2000-2016



Source: JRC-OECD COR&DIP© Database. Prepared by the authors.

Table 1. HEIC companies present among the Top 2000 largest in R&D expenditure. Opening by country, 2016

Country	Companies	%	R&D expenditure (million Euros)	%	Patents	%
United States	177	52,1	71.506	48,6	9.529	39,8
Switzerland	7	2,1	18.648	12,7	2.364	9,9
United Kingdom	18	5,3	11.828	8,0	1.173	4,9
Japan	31	9,1	11.581	7,9	2.480	10,3
Germany	14	4,1	8.335	5,7	2.766	11,5
Ireland	9	2,6	5.961	4,1	1.579	6,6
France	5	1,5	5.573	3,8	884	3,7
Denmark	10	2,9	3.019	2,1	843	3,5
India	10	2,9	1.609	1,1	247	1,0
Israel	1	0,3	1.601	1,1	92	0,4
China	21	6,2	1.418	1,0	293	1,2
Belgium	4	1,2	1.352	0,9	790	3,3
Netherlands	4	1,2	1.225	0,8	235	1,0
Australia	3	0,9	755	0,5	114	0,5
Canada	4	1,2	557	0,4	36	0,2
South Korea	7	2,1	478	0,3	216	0,9
Italy	2	0,6	424	0,3	49	0,2
Spain	3	0,9	361	0,2	53	0,2
Sweden	3	0,9	248	0,2	67	0,3
Slovenia	1	0,3	118	0,1	0	0,0
Hungary	1	0,3	114	0,1	11	0,0
Finland	1	0,3	113	0,1	26	0,1
New Zealand	1	0,3	54	0,0	90	0,4
Greece	1	0,3	50	0,0	11	0,0
Austria	1	0,3	39	0,0	5	0,0
Singapore	1	0,3	39	0,0	13	0,1
Total	**340**	**100,0**	**147.006**	**100,0**	**23.966**	**100,0**

Source: JRC-OECD COR&DIP© Database. Prepared by the authors.

It is worth noting that the result reflects not only the efforts of HEIC's leading global corporations, but also how they seek to control and possess the knowledge generated by the HEIC productive and technological ecosystem as a whole, either via Mergers and Acquisitions (M&A) or by the organization of the value and knowledge chain.

Regarding the M&A process, data from the Institute of Merges, Acquisitions and Alliances (IMAA) showed an accumulated value of US$5.3 trillion in operations between 1985 and

2016 in all HEIC's sectors. These transactions, driven by equity appreciation and the participation of large institutional investors in the capitalization of operations, reinforce the degree of global concentration and control over patent-protected commercial assets and technological assets.

The M&A movement involves various aspects. The most obvious is the strong concentration observed from large operations, such as the purchase of Celgene by Bristol-Myers Squibb for US$79.4 billion in 2019, or the purchase of the health insurance company Aetna by CVS Health in 2018 for US$70 billion, or the acquisition of Covidien by Medtronic for US$42.7 billion in 2014. But it also involves the strategy of acquiring smaller innovative companies. As investments in the HEIC require high resources – whether in R&D or in the subsequent processes of registration and regulation of innovations –, in general, small companies, supported by government funding of scientific support and fostered by processes of capitalization of venture capital funds, even if they have the potential to develop relevant later stages of the innovative process, they end up being acquired, because they would hardly be able to keep up with the current level of expenditure to continue developing technology.

Another feature highlighted refers to the fact that an important part of the research carried out in leading companies, small technology-based companies, universities, and research institutes are financed with government fundings. Many authors point out that, especially in the most relevant discoveries in the HEIC, there is a fundamental participation of the State. Given the high risks, R&D expenditure is recurrently supported by government fundings (Gotham et al., 2017; Tulum, Lazonick, 2018; Mazzucato, Roy, 2019, Cleary et al., 2020). The analysis carried out by Cleary et al. (2020) showed that all 356 drugs approved by the Food and Drug Administration (FDA) between 2010 and 2019 were directly or indirectly related to research funded by the National Institute of Health (NIH), totaling a contribution of US$230 billion.

In other words, innovations are the result not only of business efforts, but involve significant investments by public agents, institutions, and funds and, therefore, society as a whole. At the same time, the results of innovation are captured by a small portion of

agents who, in addition to being protected by patents, use active strategies to expand protection without necessarily adding concrete benefits (Wieseler, MacGauran, Kaiser, 2019).

The combination of flexibility, cost reduction, accumulation of intangible assets, protection via intellectual property, mobilizing financial performance of non-operating returns, asset appreciation, and State support translates into the significant expansion of the accumulation process, channeled to a limited number of agents. Beneficiaries participate as shareholders or are part of senior management and obtain significant gains from shareholding appreciation, dividend distribution, and stock buyback (Lazonick, 2015; Mazzucato, 2020), while a large part of the population is in increasingly vulnerable positions in terms of income, employment, and access to social and health services.

At the other end of the HEIC, these high margins of pharmaceutical companies and medical equipment end up leading to cost pressure for hospitals, insurance operators, and public health systems. The need to raise the scales to be able to face the challenges in the health services sector, combined with the opportunities arising from consolidation gains in a market still relatively pulverized, led to a wave of M&A in the services segment from the 1990s. This movement was accompanied by the emergence of new partnerships between companies and financial funds that allowed the capitalization of growth strategies, increasing, on average, the size of the companies involved in the international dispute in the health service markets and resulting in large conglomerates in the sector (Hiratuka, Da Rocha, Sarti, 2016), such as CVS Health, which had revenues of US$292 billion in 2021, and United Health, with revenues of US$285 billion. This movement even overflowed to peripheral countries, also leading to a process of consolidation in the service sector in these countries, posing new challenges to public health policy.

For developing countries, therefore, there is a major risk that asymmetry and distance from those countries that host large global corporations dominate and control the most important stages of the production and innovation chain in the sectors at the frontier of knowledge. At the same time, there are also challenges for the provision of health services to the population, both by the subordinate position in the production chain, which is often manifested in situations of dependence on imports of strategic inputs, and by the

very process of concentration observed in private services, for example, in the segments of hospitals, exams, and health insurance companies.

Challenges for the HEIC in Brazil

The information presented on the global logic of financial accumulation that characterizes the leading global companies in the contemporary HEIC leaves no doubt that the search for the implementation of a comprehensive development strategy, aimed at maintaining a universal health system and, simultaneously, at fostering national productive and technological advancement, necessarily involves thinking of a long-term strategy, aimed at raising the degree of autonomy necessary to overcome Brazil's structural vulnerabilities.

Therefore, it is urgent to reinsert in the national long-term development agenda the expansion of knowledge and technological training in the various segments of the HEIC. Despite the issues, Brazil is one of the few countries that has a universal health system, the Unified Health System (SUS), created within the Federal Constitution of 1988. This system, governed by the principles of universal access, equity, integrality, decentralization, and popular participation, has a high capillarity in the Brazilian territory. Fagnani (2018) points out that the system contemplates 70% of Brazilians with lower income and that they would not have the resources to access private services. Per year, there are more than 2.8 billion healthcare services – from outpatient procedures to overly complex surgeries, such as organ transplantation.

Nevertheless, a comprehensive and sustainable social policy cannot be achieved unless a more advanced productive and technological base has been developed. Therefore, it is essential to integrate the demand for health goods and services with the national productive and technological development. Both because of the SUS and the private demand, with a population of more than 200 million people, Brazil potentially offers a demand for the development of the HEIC that is not negligible.

From the point of view of the structure of the production of goods, the existing base, although very fragile, has important actors in different segments, both subsidiaries of

transnational companies and national companies. In the pharmaceutical sector, for example, despite the growth of national companies because of the increase in scales related to the production of generics, the most complex innovative activities still remain relatively low. Based on a sample of the largest companies in the sector, Paranhos, Mercadante, and Hasenclever (2020) highlighted that, between 2008 and 2014, while domestic capital companies increased domestic R&D expenditure in relation to sales from 3.7% to 4.9%, foreign capital companies had the indicator reduced from 2.2% to 1.4%. That is, not only do foreign companies make less innovative efforts in Brazil in relation to domestic companies, but the difference has also become more significant over time.

Several authors (Caliari, Ruiz, 2014; Gadelha, Temporão, 2018; and Paranhos, Mercadante, Hasenclever, 2020) point out that the increased involvement of national pharmaceutical companies with more knowledge-intensive activities was supported by a return of active industrial policies in the country, combined with the financial strengthening allowed by the Law of Generic Medicine. In contrast to the excessively horizontal policies of the 1990s, policies with greater sectoral concern were observed. In addition, since 2008, there has been greater integration between different areas of the federal government, such as the Ministry of Health, the National Bank for Economic and Social Development (BNDES), the Funding Authority for Studies and Projects (FINEP), the Ministry of Science and Technology and the Ministry of Industry and Commerce to support the sector, but also to expand access to medicines and health products considered strategic for SUS, through the strengthening of the country's industrial complex. It is also worth mentioning the existence of public laboratories, research institutes and universities with strong training in the health area.

However, the sector is still very dependent on imports, especially on inputs with greater technological intensity, showing that the country is still stuck in sectors with less innovative capacity. It should also be noted that, from 2016, there is an interruption of these policies, combined with the restriction of resources for both the Health and Science and Technology areas.

The need to resume even more comprehensive and articulated policies is reinforced by the strong barriers posed by the strategies of the leading companies in the field of knowl-

edge and intangible assets mentioned above. While the indicator of technological effort (R&D expenditures in relation to net revenue) of global leaders is between 15% and 20% for large global corporations, the indicator for Brazil, according to the last Innovation Survey (Pintec) for 2017, was 3.7%. Considering only internal expenses, the indicator was 2.4%. It has already been mentioned that Brazil did not have a single company among the 340 most globally innovative in the HEIC. Another indicator that reveals the distance not only in relation to the central countries, but to other countries that advanced more than Brazil, is that all the R&D expenditure of companies in the pharmaceutical and medical equipment sector in Brazil in 2017 (621 companies) were equivalent to only 0.5% of the expenditure of the 340 companies in the OECD base, and to 50% of the expenditure carried out by the 22 Chinese companies present on the same base.

But if on the side of production of goods, the effect of global changes can be observed by the barriers to advancement in more knowledge-intensive segments, in the service segment, the effects are felt more directly by the M&A process. As in the international market, where financial and private equity funds played a key role in M&A, which resulted in the consolidation of large global groups of health services, such a process has also been observed in Brazil.

This movement began in the early 2000s but accelerated when Brazil entered the American health conglomerate called United Health in 2012, which bought Amil, one of the largest Brazilian health insurance companies. Since then, a consolidation process has begun in the sector strongly capitalized by the entry of financial funds, which has been reinforced more recently by the permission of entrance and control of foreign capital to the hospital sector in 2015 and by issuing IPOs in the Brazilian stock exchange.

Considering the main companies in the sector, the strategies, in general, follow the same direction. For example, the NotreDame Intermédica group, a private health insurance operator, was purchased in 2014 by the US private equity fund Bain Company for about R$ 2 billion. In April 2018, the company went public and raised R$ 2.6 billion. In December 2018 and June 2019, it raised another R$ 5.6 billion with primary and secondary offers. With this, it accelerated the purchase of other operators, several of them involving hospi-

tals, reinforcing the vertical model. More recently, NotreDame Intermédica announced a huge merger with the Hapvida Group, with an estimated value of R$53.4 billion, creating a company that should reach 18% of the health insurance market in Brazil (Jaggi, 2022). The Hapvida Group itself was expanding fast and issued, in 2018, an IPO in which it raised R$3.4 billion, followed by a primary offer in 2019, when it raised another R$2.6 billion. It also raised R$2 billion with the issue of debentures. Most of these resources were used to acquire the São Francisco Group for R$5 billion. The acquisition consolidated the company's expansion in the Southeast and was the second largest operation in the history of the sector, after the purchase of Amil by United Health.

In the hospital segment, the consolidation strategy has been followed by Rede D'Or, which has been adopting an extremely aggressive acquisition strategy, especially after the partnership with BTG Pactual, which subsequently sold its share to the Sovereign Wealth Fund in Singapore. The private equity fund Carlyle also has a share in the company. In the IPO held in December 2020, the volume raised reached R$11.5 billion, becoming one of the largest operations in the history of the Brazilian stock exchange. The funds raised should continue the expansion of the acquisitions that the company has been carrying out, in order to explore the gains in scale and at the same time increase the bargaining power with health operation and insurance companies.

Proposition for Public Policies

If the pharmaceutical, biotechnology, and medical equipment area has to face the growing barriers associated with the difficulty of mastering knowledge-related skills and intangible assets, on the services side, the influence of global dynamics under financialization is more directly verified by the consolidation process and the emergence of large private groups in the health area, which creates challenges for the regulation of the sector and for the country's own public health system.

The search for scale and better cost and profitability conditions drives the industry concentration process. In addition to the increase in prices, there is also a risk that management mechanisms will be disseminated to press for higher returns, price discrimination practices, excluding lower-income customers from access to more sophisticated procedures and excessive rationalization, with negative impacts on quality. The consolidation process that increases the economic power of agents working in the sector will certainly require a greater capacity for government planning and regulation, as well as a greater need to guide private interests to generate positive consequences for the population.

The movement of concentration of the health services private sector also poses challenges for any political rearticulation for the development of the HEIC. Actors who work with a global logic tend to reinforce ties with international suppliers of products, equipment, inputs, and technological services, a fact that may go against the effort to build local productive and technological capacities.

Raising the technological capacities of the Brazilian HEIC in the long term is fundamental to guarantee a less dependent articulation and with some degree of sovereignty in relation to the global system. Of course, it is important to be aware of the training difficulties of companies and segments of the HEIC in Brazil, due to the necessary amount of long-term investments in view of the technological complexity that the health system has achieved in the recent period. But this advance is fundamental as a mechanism to create greater negotiating capacity, both from the point of view of the cost of medical solutions and treatment and from the point of view of the possibility of creating mechanisms of

international cooperation and technological development for basic research and for the development of products and services.

Finally, it is essential to curb the spurious commercialization of HEIC goods and services and the asymmetry observed between the contribution to advances in the sector and the capture of value created by restricted groups in society, as has been the case regarding the international scene.

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Limits and Economic Opportunities of the HEIC 4.0 in Brazil

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Economic and Technological Trends of the HEIC 4.0

The Health Economic-Industrial Complex (HEIC)[1] is composed of a set of economic sectors whose activities are articulated around the needs of health care services at various levels. Such economic segments come from markets with varied structures of competition and competitiveness. Technological capacities, economic scales, and/or capital structures of the firms that operate in them are also different. The ability of each sector to generate employment and income and create technological overflows for the country's economic system as a whole is also heterogeneous. For example, large industrial companies, with high technological intensity, mostly foreign capital, coexist in the HEIC with and smaller health service companies.

Although the HEIC is composed of different subsystems, which differ not only in terms of sectors but also in terms of market structure and competitive pattern, its core consists of a restricted set of large transnational companies, which have high market power, dominance over patents and other intangible assets – which allow them to control and direct technological advancement – and influence on global health expenditures.

In this sense, it is important to note that new technological trends, grouped in what is conventionally called "Industry 4.0," in reference to an alleged 4th industrial revolution, decisively permeate the entire HEIC, whose companies are great diffusers and also users of these modern technologies.

These new technological trends find their origins in the late 1970s, when the expansion of microelectronics and telecommunications allowed the strong diffusion of "digital" technologies. From the 2010s, the changes were deepened and expanded to other areas of knowledge, such as Artificial Intelligence, Big Data, Internet of Things (IoT), new materials, new energy sources, biotechnology, nanotechnology, and to other areas with a multidisciplinary[2] scientific basis. A process has been consolidated in which the phenomena of

1 See Gadelha (2003) or Gadelha and Temporão (2018) for the original formulation of the concept.

2 See OECD (2016) for an appreciation of future-bearing technologies that have been transforming the economy and society and reaffirming the leading role of the HEIC for the creation and diffusion of these technologies.

digitalization and automation become increasingly present in all economic sectors.

Most of these future-bearing technologies are to be confused with the HEIC. The companies of the complex are important diffusers and/or users of virtually all 4.0 technologies, with emphasis on **Biotechnology, Genoma Editing, Artificial Intelligence and Big Data, Internet of Things, Additive Manufacturing and Nanotechnology**.

The HEIC segments have an immediate adherence to these modern technologies due to their own economic and technological dynamics, especially because the complex is composed of companies highly intensive in science and technology, research and development, and innovation. This innovative effort, despite the perverse financialization that follows the development of contemporary capitalism, is the main source of competitive advantage and the fundamental element that allows the increasing capital accumulation of companies in the pharmaceutical and medical equipment segments, for example. Companies that, in addition to that, are extremely sensitive to the actions and public policies of developed countries (and also of some middle-income countries, such as Brazil).

In these countries, several public mechanisms of expenditure, regulation, coordination, and financing of private investment and taxation promote both a national system of innovation in its multiple aspects and players (private and public companies, research institutions) and regulate and promote health care services, either public or private. The business decisions of the HEIC segments and the activity of the State with regard to the health and life of citizens are strongly interlinked. This contributes to the diffusion of new future-bearing technologies. And such technologies are extremely promising from the point of view of life and society: they can increase the reach, scale, and efficiency of health care services, while they can intensify economic activities that generate employment and income and, potentially, the technological development of the country.

Nevertheless, it should be considered that the key technologies identified in the health sector are of interest not only to the large companies of the HEIC, but also to other business players – including those of high technological intensity, which belong to sectors related to the industry 4.0. In addition, many technologies considered “4.0” have a two-

fold use, that is, they offer applications in several sectors and are not exclusive to companies that have their core business within HEIC. In addition, there are large companies, inducing the most important modern technologies, which are part of the HEIC, but which also operate in several other sectors, being large international conglomerates (e.g., Siemens, GE). For these reasons, it is necessary to carefully analyze the transformations in the strategies of large business players inside and outside the HEIC, their effects on the production chain and the possible new business models that emerge with the progressive diffusion of modern technologies.

The HEIC and even more so the HEIC 4.0 are heavily dominated by large global scale companies. For example, in 2020, 29 of the 500 largest companies in the world were in the sector that Global Fortune 500 called "Health Care", among them the traditional pharmaceutical companies (the big pharma, whose 13 largest companies in the world earned almost US$700 billion in 2020).

The conceptualization of the HEIC emphasizes the fact that the complex is not limited to pharmaceutical companies nor to traditionally industrial sectors, also including subsystems of services – particularly relevant when discussing some of the new future-bearing technologies, such as Big Data, Data Science, and Artificial Intelligence. Therefore, to effectively indicate the main HEIC 4.0 players, it is also necessary to consider the medical equipment industry (with revenues of US$360 billion in 2020) and private health services companies (whose 8 largest global companies earned just under US$1 trillion in 2020).[3]

Therefore, it is important to note that most of the HEIC segments are composed of large companies, with global and often multi-sectoral operations. The competition pattern presupposes, as we mentioned, the permanent investment in RD&I as a means of obtaining competitive advantages and, thus, extraordinary and increasing profits.

As a consequence, in most segments, there is a predominance of concentration and centralization of capital. The market power of the leading companies in these segments

3 Data from Fortune Global 500 and Euromonitor.

is among the most prominent in all economic activities. And the same can be said regarding Big Tech companies, which increasingly break traditional sectoral barriers and advance, in the wake of new 4.0 technologies, to other segments, especially in health, both in care services and in digital control of hospital equipment and other devices for individual use ("wearable").

In this case, there is the presence of former players in the computer industry, such as IBM and Microsoft, Oracle, and SAP, but also of the newcomers that emerged after the internet boom and that have built their strategy in the commercial use of processing personal data on a large scale, such as Amazon, Alphabet, Alibaba. In common, newcomers have the same momentum for growth based on the use of digitalization and big data analytics, even if they have emerged in student dormitories, such as Facebook.

Figure 1 summarizes the main economic characteristics and the competition pattern of the HEIC 4.0 companies, including, as an example, the participation of Big Tech companies.

Figure 1. HEIC 4.0: characteristics and trends of some segments

HEIC Segments	Some Economic Characteristics	Performance in the "Revolution 4.0"
Pharmaceutical Industry	• Oligopoly concentrated worldwide • Increasingly intensive RD&I • Increasing extraordinary profits • Increasing financialization (and MSV)	• User segment of "digital" technologies • "Biotechnology" diffuser segment • New drugs: omics, biotechnology and AI • Acquisition and partnerships with MedTech startups • Partnerships with BigTech
Medical Equipment Industry	• Oligopoly concentrated worldwide, but with smaller companies operating in niche or in segments with commodities • Intensive in RD&I	• Diffuser segment of "digital" technologies, new materials, and additive manufacturing • Precision medicine: IoT and nanotechnology • Servicing mainly through AI/Big Data • Acquisition and partnerships with MedTech startups
Private Health Care Services	• Recent concentration and denationalization • Increasing financialization • Intensive in management and skilled labor	• Users of technologies: growing demand • Diagnosis: AI/Big Data and telemedicine • Prevention: precision medicine and wearables • Verticalization and partnerships with BigTech and MedTech
Big Tech	• Oligopoly concentrated worldwide • Increasing extraordinary profits • Increasingly intensive RD&I • Increasing financialization	• Leading segment for diffusion and control of technology • Focus on AI/Big Data and wearables • Verticalization: acquisition of MedTechs • Strategic partnerships with other segments

Source: Prepared by the author based on the results of the research

It is also important to consider the incorporation of a new accumulation strategy, aimed at generating maximum shareholder value (MSV), almost always obtained through decisions unrelated to the productive and technological scope, such as M&A, share buybacks or even an exaggerated distribution of dividends. This process is intensified by the fact that the technological trajectory has reached such a level that smaller companies, even if able to develop relevant phases of the innovative process, will be able to reach or even carry out the entire process, from innovation to its registration and regulation of innovation.

Productive decentralization is associated with the concentration of capital whose effect in Brazil is not only denationalization, with the potential loss of decision-making and strategic autonomy of the business units located in the country, but the greater difficulty in conducting internally RD&I practices, both in companies and in public and private re-

search institutions. For this reason, it is essential to specifically evaluate the HEIC 4.0 and its weaknesses in Brazil.

Challenges for the HEIC in Brazil

Some of the structural vulnerabilities of the Brazilian economy, in general, and of the manufacturing industry, in particular, directly affect several segments of the HEIC, constraining its ability to respond to the challenges of the pandemic.

Firstly, it is worth mentioning the long dismantling of the Brazilian productivity system. It began back in the 1980s, also known as "the lost decade", and was accelerated in the liberalization decades, with the valued stock of the 1990-2010 years, and deepened in the second decade of the 20th century. This article does not intend to discuss the causes and the extent of the deindustrialization process that has harmed the country. However, we are going to mention some of its effects:

Reduction or deactivation of the industrial park in several industrial segments, resulting in a significant increase in the trade deficit in manufactured products;

Decentralization and dismantling of the production chain, with a systematized increase in both the imported coefficient of finished goods and the import of industrial inputs, resulting in an increase in the imported content;

A generalized denationalization can be observed. This results in the loss of decision-making and strategic authority autonomy of Brazilian companies and the increase in the concentration of capital, with deleterious effects on competition and goods and services prices;

Maintenance or increase of technological dependence in several segments since the ability to conduct research, development, and innovation (R&D&I) practices, both in companies and in public and private research institutions, was strongly affected by the processes described above. Moreover, the insufficient industrial policy actions, which were virtually

abandoned in the 1990s and saw a timid return in the 2003-2014 period, also contributed to creating an insufficient national innovation system in Brazil.

That is, the Brazilian economy has been subject to even greater challenges than those it faced at the beginning of its development process. The HEIC was not immune to such fragilities and structural vulnerabilities, even though its segments had a relatively higher degree of freedom to act in the past decades.

In fact, the existence, scale, and purchasing power of the Unified Health System (SUS), albeit underfunded; the growth of the private healthcare sector, boosted by the increase in wealth in the 2003-2014 period; and the relative success of productivity and technology development policies[4] enabled sectors of the HEIC to be a little less affected by the increase of Brazil's productive and technological fragility. This occurred because the demand scale was noticeably expanded.

However, this relatively better position did not avoid processes of deindustrialization, denationalization, the concentration of capital (with impacts on prices, oftentimes associated with international patents), and increased productive and technological dependence from abroad, especially in segments of pharmaceutical, medical and hospital equipment. Likewise, the Complex's innovative capacity has been affected negatively. This took place in the entrepreneurial realm, led by big multinational companies that focus their RD&I efforts abroad, and at public research institutions, which are increasingly less funded.

In other words, the HEIC in Brazil emulates the global dynamics of the complex, including technological and competitive trends (concentration, financialization, and expansion of margins and prices), but it does so passively from a technological point of view, which reduces its contribution to the socioeconomic development of the country.

4 In fact, the HEIC was one of the few minimally relevant cases of public action in recent years (e.g., i) institution of generic drugs; ii) training of the Oswaldo Cruz Foundation – Fiocruz and Farmanguinhos for possible compulsory license; iii) specific funding from the Brazilian National Bank for Economic and Social Development – BNDES – and the Funding Authority for Studies and Projects – FINEP; iv) importance of the HEIC in the actions of the plan called Plano Brasil Maior and the Product Development Partnership – PDP, etc.)

Even if it is possible to observe the diffusion of future-bearing technologies linked to the Revolution 4.0 in the country, there is a passive and non-virtuous internalization, since it is geographically limited to the Southeast Region, marked by internationalization and restricted to high-income markets, with low diffusion in the public system and in the rest of the country.

The diffusion of modern technologies in the productive segments of the HEIC in Brazil is therefore incapable of promoting a technological catch-up, and the country remains increasingly dependent on imports, technology, or the strategies of Transnational Companies (TNC), which, in turn, are increasingly subject to the logic of financialization.

If this pattern is maintained, the incorporation of modern technologies will continue to occur inefficiently, limiting the HEIC's ability to rearticulate the socio-economic and technological development of the country. The internalization of technologies has had a private solution, but with limited effects on the ability to articulate and stimulate socio-economic development. It will continue to be a passive internalization, with limited scale, which produces soaring prices, reducing the population's access to these technologies that are revolutionizing health. But there are opportunities.

Windows of Opportunities for the HEIC in Brazil

To transform the HEIC into a major driver of economic development and to allow the greatest possible access for the population as a whole to these technological transformations applied to health, it is necessary to propose and implement public policies capable of stimulating the virtuous internalization of 4.0 technologies in the Brazilian HEIC. Without public policies designed and implemented for this purpose, the HEIC in Brazil may increasingly incorporate such technologies only in a limited and passive way, concentrating the eventual technical progress geographically and economically. In this way, a unique opportunity to reconfigure the Complex and enhance its capacity to both expand the access of the Brazilian society to health care services and leverage the economic development and technological and productive autonomy of the country would be lost.

There are three windows of opportunity that would permit overcome this passive internalization if, and only if, there is a public effort to broadly stimulate the HEIC, with regard to regulation, coordination, financing, and investment in the segments of the Complex.

First of all, there is a window of technological opportunities. Some of the 4.0 technologies, especially those associated with digital innovations, including Artificial Intelligence (AI), Big Data, or Internet of Things (IoT), have provided the opportunity to reduce barriers to their introduction into various economic segments. This can allow the development of new products, services, and business models in spaces still dominated by large oligopolies worldwide, such as in the pharmaceutical and the medical and hospital equipment industries. Although small, this window has allowed the emergence of small technology-based companies that orbit HEIC. The so-called health techs are among the most dynamic startups, both in Brazil and worldwide. Therefore, there would be room for the emergence, consolidation, and development of these companies, threatening to disrupt, to some extent, the market power of the large companies that dominate the HEIC. To actually benefit from this window of opportunity, it would be crucial to have public policies that coordinated and financed the emergence and initial development of these companies, associated with the purchasing power of the SUS, which would guarantee the demand that allows the increase in the scale of companies.

Secondly, there is a window of economic opportunity. The SARS-COV-2 pandemic and the growing geopolitical tension in the industrialized world have caused a growing fracture in the so-called global value chains. In the last forty years, the relocation of industrial production to Asia and the increase in international trade flows of industrial inputs and final products have emptied the production chains in Western countries that once concentrated industrial production, such as the USA and Europe, and, to a lesser extent, middle-income countries in the Western hemisphere, such as Brazil, Mexico, and Argentina. The pandemic and the social isolation caused by it in all countries, including Asian production centers, interrupted production and dismantled international supply chains, creating bottlenecks in the supply of inputs and industrial products in several sectors, including those associated with the HEIC. Such dismantling of the chains has refueled the debate regarding the need to promote reshoring or reindustrialization actions in the

countries that have undergone accelerated deindustrialization in recent decades as a way to reduce dependence on imported products and inputs.

Thus, the possibility of redesigning global value chains opens opportunities for the rearticulation of industrial sectors in Brazil, including those linked to the HEIC, not only as a locus of the densified production of final products, but also as a production space aimed at meeting the demand of the USA and Europe, which are regions interested in reducing the economic dependence that the East imposes on them. In this sense, policies designed to attract transnational companies, to consolidate the production chain (reducing the import of strategic industrial inputs), to leverage exports and to guarantee domestic demand, again through an intensification of public procurement policy, will be decisive for the use of this window of opportunities.

And, finally, there is a window of political opportunity. The successful public actions in defense of life during the pandemic, with emphasis on the immunization effort of the vast majority of the Brazilian population, socially and politically valued public institutions such as SUS and the Oswaldo Cruz Foundation (Fiocruz). The narrative about the inefficiency of the SUS and its inherently corrupt characteristic and spillway of badly spent taxes that has long been developed was strongly questioned by the success of the brave (and evidently efficient) actions of public institutions during the urgent response to the SARS-COV-2 pandemic. Without the ties of a narrative in favor of fiscal austerity that underfunds the public system, deregulation, and privatization, as well as the demobilization of public institutions that develop and produce knowledge, products, and services for Brazilian health, it is politically possible (and desirable) to intensify actions of regulation, coordination, the guarantee of demand, financing, and public investments that allow for a virtuous rearrangement of the HEIC in Brazil. A reorganization that permits the increase of autonomy (again a national aspiration, not just a dream of developmental economists), the scale, and capacity for technological and economic development of all segments of the complex. There is hope, but we must achieve it with political will.

Proposition for Public Policies

The formulation of public policies is crucial so that the internalization of modern technologies in defense of life is not restricted to wealthy regions and social classes. The market solution – "those who can pay for the best technologies pay for it; those who cannot, do not have access to it" – not only limits the social gains of the technological advance of health, but also destroys the potential of HEIC to command, with its wide generation of employment, income and technological diffusion, the resumption of Brazilian economic development. In the private solution of large global players, Brazil will only be a limited user of modern technologies, and not a productive center that stimulates modern technologies.

It is therefore necessary to develop policies that, first of all, are State policies, rather than government policies. This means that policies need to go beyond the electoral cycle and become perennial, allowing private and public investment decisions, which require long maturation periods and face a high degree of uncertainty regarding the expected economic return, to be effectively carried out in a virtuous way for the country.

There should be policies that resume the planning effort, expanding the scale and ensuring the stability of funds to finance the economic activity linked to HEIC. Securing and expanding a specific capital budget for the technological development of the HEIC, together with a ten-year plan for national health, is a fundamental step to guarantee horizons that reduce the uncertainties surrounding investment in technology and health.

The instruments of regulation, coordination, and purchasing power of the State must also be renewed and expanded to allow for the maintenance of the largest instrument of induction to economic development, increasingly used (again) by all countries that aim at some degree of autonomy: the economic power of the State that guarantees demand – and economic viability – for private investments. In this sense, it is important to mention that any attempt to repel adherence to international public procurement treaties is fundamental for the success of any policies that support the HEIC.

It is also crucial to improve the regulatory framework, including legal certainty for managers and suppliers, through instruments such as Product Development Partnership (PDP) or others that guarantee technology transfer, require national content or regulate prices (services, medicines, but also equipment) while ensuring economic viability for private companies and the social scope of induced activities.

Other policies that ensure the centralization of purchases at the federal level (prioritizing scale and technological development over the logic of niche and/or price) and that mobilize resources for venture capital and articulate and finance investments in health techs, are also crucial to realize the potential of the HEIC to operate as a system that expands the access of the population as a whole to cutting-edge health services, but that, at the same time, allows for a greater economic impact for the country, by generating more jobs and real technological development.

The virtuous arrangement between AstraZeneca and Fiocruz for the development of the vaccine for the SARS-COV-19 virus is an example of how the adequate mobilization of resources, the guarantee of large-scale demand, a minimally favorable regulatory framework and previous national training resulted in saving countless lives in Brazil, with the gain of technological autonomy and significant economic impacts.

This proves that it is possible to strengthen both the HEIC 4.0 and the Brazilian economic development, not only to guarantee the technological autonomy and economic growth that everyone dreams of, but, above all, to defend the lives of all Brazilians. This is a dream that needs to come true.

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ST&I in Health: the Gateway to the Revolution 4.0 and the Path to Universal Access

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Overview of Health ST&I Activities: Searching for an Inclusive Agenda

Science, technology, and innovation have always been key elements in overcoming crises. The global science, technology, and innovation system, ST&I, had a strategic role in addressing the Covid-19 pandemic, assuming a privileged space in public debate and national public policy agendas. There was also a considerable expansion of investments in research and development (R&D) in the health field, particularly in developed economies, where regional blocs and national governments reacted to the challenges posed by the health emergency by providing additional financing mechanisms, both for academic research on Covid-19-related topics and the direct promotion of public and private RD&I activities aimed at obtaining vaccines and other health products (Vargas, Alves, Mrejen, 2021).

However, despite the important actions of organizations such as the World Health Organization (WHO) and the global efforts of ST&I for the development of inclusive solutions in terms of public health, there are important asymmetries between the North and the Global South in the patterns of financing, generation, appropriation, and use of scientific and technological knowledge. Such asymmetries are reflected in the unequal distribution of benefits resulting from technological advances in the health field, the misalignment between global health needs, and the orientation of investments in research and innovation. Gaps that result from a structural and territorial concentration of global expenditure on ST&I.

The Covid-19 pandemic has shown that global asymmetries in the field of scientific skills and innovation are directly reflected in the access to the production of goods and services for health. As evidenced in the case of vaccine production and distribution, global inequality in the field of technological skills had serious implications in terms of inequity in access to vaccines by less developed countries (Gadelha et al., 2021). Although international collaboration networks have been created, such as the Covax Facility[1], to accelerate development and ensure equal access to vaccines against Covid-19, there is still a great asymmetry between rich and poor countries in the acquisition of doses of the vaccine. According to recent WHO data, more than 11.3 billion doses of vaccines

1 See: https://www.who.int/initiatives/act-accelerator/covax

have already been administered worldwide, resulting in 58% of the global population receiving primary vaccination. However, by the end of 2021, only 11% of the population in low-income countries had access to vaccination, compared to 73% of the population in high-income countries.[2]

The issue of the mismatch between the orientation of research and innovation efforts in health and the needs of public health at the global level, in turn, is not a recent theme. This issue already occupied a prominent space in the international debate on health research and innovation in the late 1980s, from the observation of the so-called "10/90 gap" (Luchetti, 2014). The term, enshrined in the Global Forum for Health Research, refers to the fact that less than 10% of the world's resources devoted to health research is spent to tackle priority health problems in developing countries, where more than 90% of all preventable deaths worldwide have occurred.[3] This finding resulted in the establishment of several initiatives by the WHO, such as the Global Strategy and Action Plan on Public Health, Innovation and Intellectual Property (GSPA-PHI)[4], established in 2008, and focused on the discussion of intellectual property in the health field (WHO, 2012). More recently, in 2016, we highlight the creation of WHO R&D Blueprint, WHO's global strategy that aims to accelerate the availability of effective tests, vaccines, and medicines in the face of the advent of major health crises on a global scale.[5] Such initiatives start from the perception that market-oriented biomedical R&D models do not meet the development of technologies for sporadic or unpredictable diseases, especially when they occur in countries with low investment in infrastructure and health care.

Despite efforts to reorient global health R&D agendas, the gap persists and widens every day. According to data from the World Health Organization's Global Observatory for

2 See: https://www.who.int/docs/default-source/coronaviruse/g20-report--accelerating-covid-19-vaccine-deployment.pdf?sfvrsn=2d432714_1&download=true

3 See: https://apps.who.int/iris/bitstream/handle/10665/66474/Global_Forum_for_Health_Research_eng.pdf?sequence=1&isAllowed=y

4 See: https://apps.who.int/iris/bitstream/handle/10665/254706/9789241503457-eng.pdf?sequence=1&isAllowed=y

5 See: https://cdn.who.int/media/docs/default-source/blue-print/an-randd-blueprint-for-action-to-prevent-epidemics-update-2017.pdf?sfvrsn=4c31073a_1&download=true

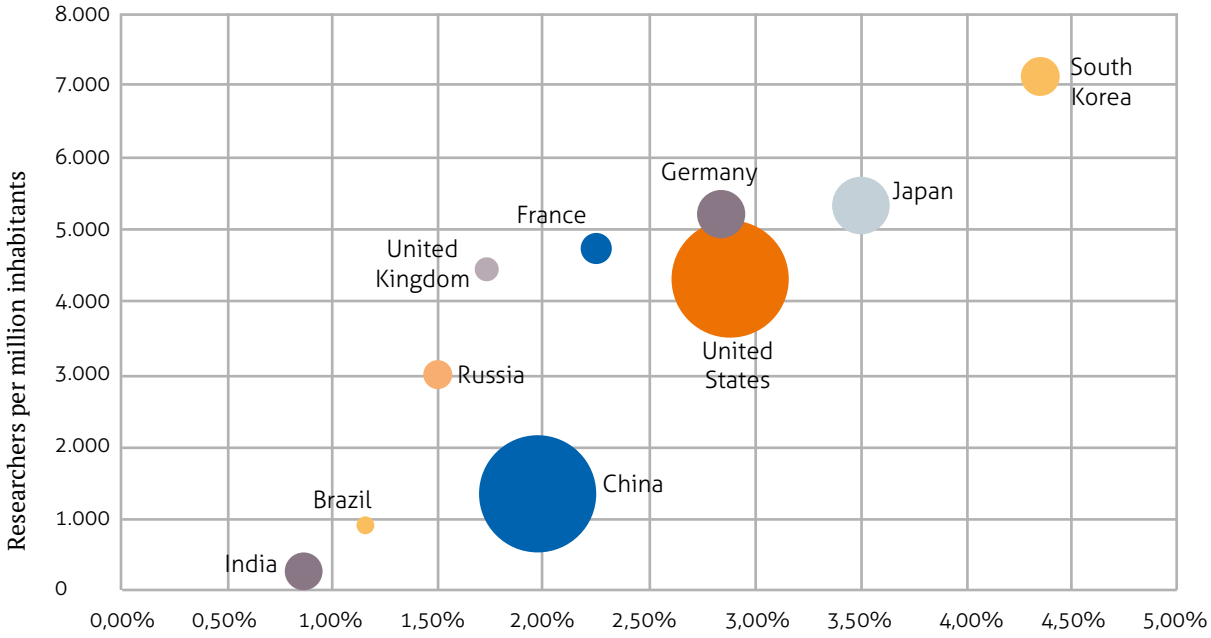
Health Research and Development, there is a direct relationship between the level of development and the resources allocated to health research and development, where low- and middle-income countries account for only 2.2% of global funds allocated to health research and have 73 times fewer researchers working in the health area in relation to high-income countries (WHO, 2022).

In summary, as highlighted by Swaminathan et al. (2022), unequal access to the benefits of global biomedical research and development activities during the Covid-19 pandemic reinforced the perception of the urgency of reorienting global ST&I efforts around the public interest.

In turn, the lack of alignment between global efforts in ST&I and demand in public health has its origin in a broader plan of high territorial asymmetries in spending on ST&I. In this context, high and middle-income countries dominate not only investments, but also scientific production and patenting in several strategic technological fields.

Figure 1 illustrates the global asymmetry in spending patterns with R&D activities based on the indicators usually used in the comparative analysis on innovative efforts of the countries. The figure shows that, for the ten countries with the highest estimated volume of R&D expenditure in 2021, the relationship between gross domestic expenditure on R&D (GERD), R&D intensity (percentage share of R&D in gross domestic product - GDP) and the number of researchers per million inhabitants. The United States and China dominate the global landscape in terms of the volume of investments and jointly account for about half of global research and development expenditure. Other Asian countries, such as South Korea and Japan, are among the leading economies in terms of R&D intensity, with shares of 4.4% and 3.5% of R&D in GDP, respectively. Brazil occupies the tenth position in this ranking with an estimated investment volume of US$38 billion and an R&D intensity equivalent to 1.16% of GDP in 2021 (R&D World, 2021).

Figure 1. Gross expenditure on research and development, share of R&D expenditure in GDP and number of researchers per million inhabitants in selected countries, 2021



Source: Prepared by the authors based on the R&D World data (2021).

Health 4.0: Opportunities and Risks of New Digital Technological Frontiers in Health

The term Health 4.0, derived from the concept of Industry 4.0 (Schwab, 2016), describes the new digital frontiers and disruptive innovations that show a high potential for transformation in all production and service segments in the health field. There is a broad consensus that health represents a privileged field with enormous potential for the development and adoption of new pervasive technologies that characterize this 4th technological revolution. Chart 1 summarizes some examples of the applications of the new digital technological platforms in the field of Health 4.0.

Chart 1. Main examples of technologies in accelerated development and their potential applications in healthcare

Technology	Application examples
3D Printing	Printing of organs, tissues, medications, and implants and customized prostheses;
Artificial Intelligence/Machine Learning/ Cognitive Systems/Deep Learning	Cross-referencing for the identification of treatments such as cancer. Appeal for consultation for decision-making in the face of up-to-date studies. Analysis of a large volume of data to identify behavior and trend. Prediction of CRISPR behavior in genome editing. Maintenance of remote health equipment.
Augmented reality/Mixed reality	Boosting in the training of health professionals. Agility in the implementation of modern technologies. Possibility of implementation of assisted practice.
Autonomous Robots	Telemedicine and robotic surgery, with connectivity and integration of remote locations. Robots for elderly care
Autonomous Vehicles	Communication with local traffic systems for ambulance priority.
Big Data	Cross-referencing of data for diagnosis and development of more specific treatment for the patient's disease characteristics, as for example, Target Therapy.
Blockchain	Decreased bureaucracy involved in the health sector with increased reliability and data security
Cloud Computing	Creation of health-oriented applications with cross-database data for patient integration into the care service.
Collaborative Robots	Telemedicine Surgery, treatment, and rehabilitation assistance.
IoT Internet of Things	Development of production systems, logistics for the distribution, and use of integrated medicines and health supplies through traceability.

Source: Lopes et al., 2019.

The Covid-19 pandemic has contributed to accelerating the process of incorporating new digital technology platforms in the health field. From the intensification in the use of telemedicine to the expansion of population surveillance mechanisms to identify and track cases of Covid-19, with the use of big data and artificial intelligence, the new digital technological platforms associated with the so-called Health 4.0 were widely used to support public health strategies to combat the pandemic.

In this regard, the incorporation of innovations associated with the field of Health

4.0 is an inexorable trend for health systems globally. However, in a context where a large part of the world's population does not even have guaranteed access to basic health supplies and services or to connectivity items, there is a risk that the emergence of this new concept of health care will further increase the disparities in the access of the least developed countries in relation to the developed countries. As highlighted by Gadelha et al. (2021), the ongoing technological revolution, by bringing major transformations in the field of health, not only opens new spaces for accumulation and technological opportunities, but also brings risks of disruption of universal systems and the collective and public dimension of health in favor of a fragmented, private, individualistic and stratified organization of care, eroding inside, and also the structure of the objectives of universality, integrality, and equity.

As observed in the global panorama of ST&I activities, the generation of scientific knowledge and the adoption of innovations resulting from the so-called Health 4.0 are strongly concentrated in a limited number of countries. Chart 2 shows the number of patent families filed related to the technological fields and applications of Industry 4.0 in the health area, for a set of selected countries.

Table 2. Patent families in Health 4.0 by country

Country	Patent family (Count)		Percentage Share (%)		
	Industry 4.0	Health 4.0	Health 4.0 in Industry 4.0	Country in Industry 4.0	Country in Health 4.0
United States	2.176.846	526.762	24%	14,2%	20,6%
Brazil	22.813	4.759	21%	0,1%	0,2%
Russia	33.992	8.398	25%	0,2%	0,3%
China	5.025.658	603.228	12%	32,8%	23,6%
India	31.619	9.528	30%	0,2%	0,4%
South Africa	3.552	790	22%	0,0%	0,0%
World	15.317.628	2.560.810	17%	100,0%	100,0%

Source: Prepared by the authors based on data extracted from the Questel-Orbit competitive intelligence base for 1945-2022.

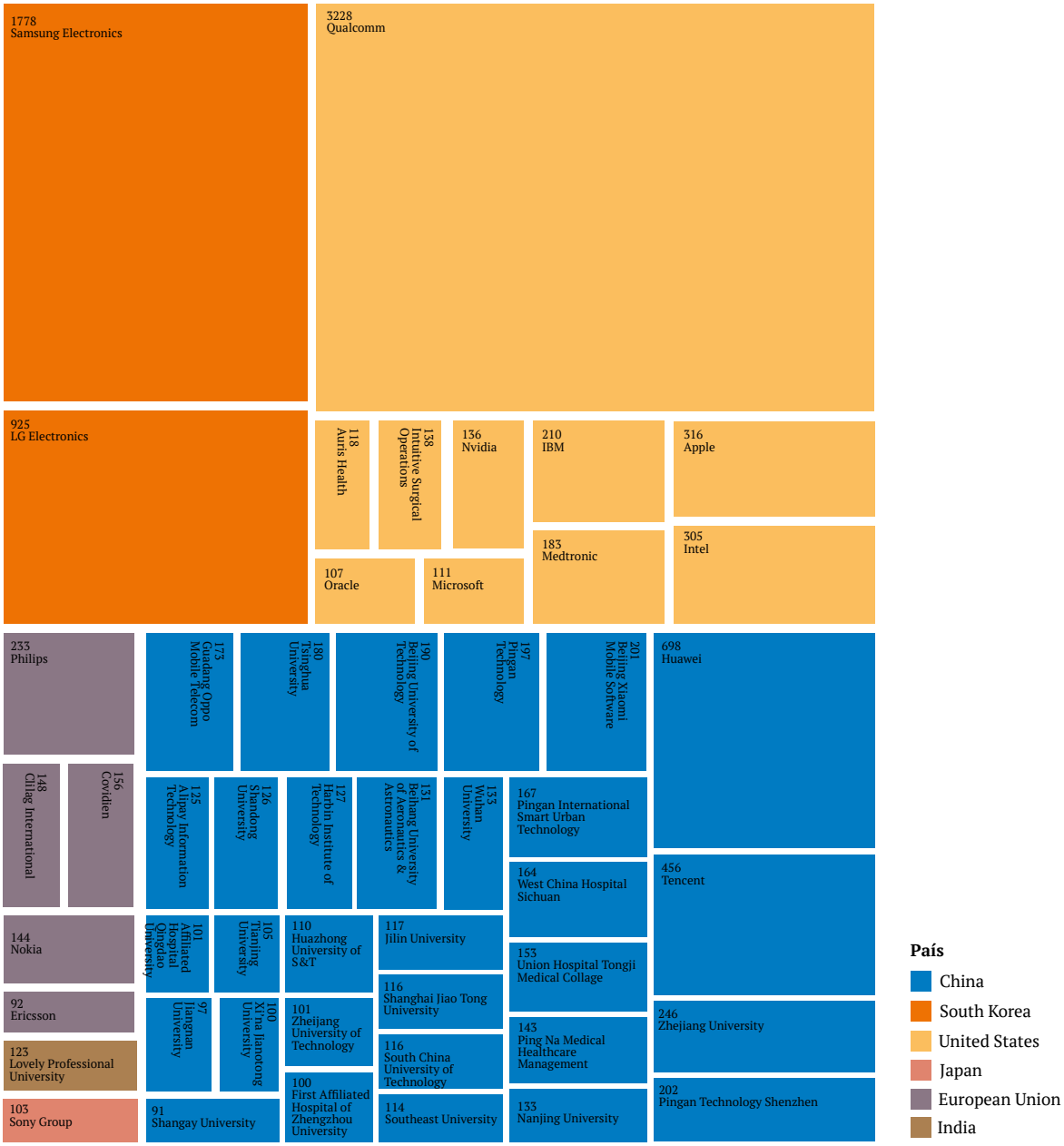
Chart 2 shows that China and the United States jointly account for 44% of patent families in Health 4.0. Such leadership reveals the strategic character of the new digital techno-

logical platforms in health in the global geopolitical context and reflects the existence of strategic advantages of the ST&I infrastructure of these countries. Such advantages combine: i) the existence of more robust national innovation systems and complex scientific, technological, and innovation collaboration networks, usually led by public research institutes, ii) the role of the State as the main promoter of first instance funding for basic and higher risk research; iii) systemic and structuring policies that articulate the ST&I networks with the main leading companies in the HEIC segments and in the sector of Information and Communication Technologies (ICTs) (Vargas, Bueno, Alves, 2022).

In addition, the analysis of the number of patent families classified by country of first priority, which constitutes a good proxy for invention, shows that the ten countries that mostly stand out as inventors in Health 4.0 are China (65,928), United States (16,415), South Korea (5,270), Japan (3,243), India (1,938), Germany (921), Australia (572), Russia (489), France (378) and the United Kingdom (233) (Vargas, Bueno, Alves, 2022).

Figure 3 illustrates the participation of the main fifty world signatories in patent families in Health 4.0, considering the main hundred territories and the main hundred signatories, in the period from 1945 to 2022. The figure shows both the territorial domain and the expressive participation of companies in the technology segment in the field of patents in Health 4.0. In addition to the American and Chinese predominance, information and communication technology companies such as Qualcomm, Apple, IBM, Intel, Huawei, Tencent, and Samsung are important, regarding the domain of patents related to Health 4.0. This trend has been reinforced by movements of intersectoral heritage interpenetration between companies that integrate the different segments of the HEIC (pharmaceutical, biotechnology, medical equipment, and medical services) and companies linked to the ICT sector (See chapters 5 and 6).

Figure 3. The main fifty world signatories in patent families in Health 4.0



Source: Prepared by the authors based on data extracted from the Questel's Orbit competitive intelligence base for 1945-2022

In addition, 49 universities and public research institutes are identified among the main one hundred signatories of patent families in Health 4.0 worldwide. This indicator points to the strongly knowledge-based nature of technologies and applications in Health 4.0 and reinforces the perception of the importance of the State as a promoter and articulator of advances in ST&I.

The challenges of Funding Science, Technology, and Innovation in Brazil

The current panorama of global ST&I activities, marked by structural asymmetries and the impact of new digital technology platforms, reveals the existence of enormous challenges for developing countries in the search for a virtuous articulation between their innovation and social welfare systems. In this context, in addition to the leading role of the State in the coordination and direction of scientific, technological, and innovation policies, the importance of financing the ST&I infrastructure stands out.

In Brazil, from the beginning of the 2000s, it was possible to observe the construction of a new financing pattern for ST&I activities, with the diversification of funding instruments and the expansion of resources for the innovation system. The country resumed an agenda of industrial and ST&I policies, implementing a series of actions aimed at stimulating the scientific and productive sector, with the Health Industrial Economic Complex (HEIC) as one of its priority focuses. In addition, a new legal framework was established to support innovation and a wide and diversified set of instruments was created to encourage ST&I activities (Brasil, 2004).

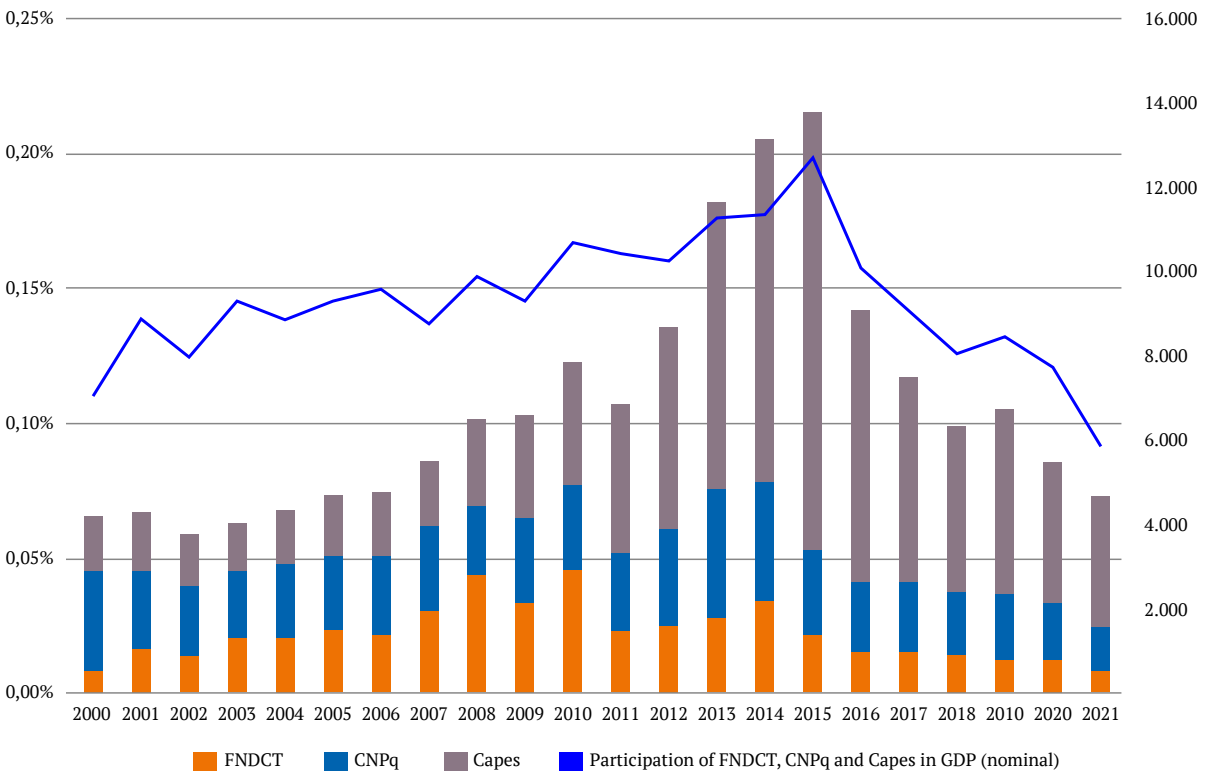
Despite these efforts, in recent years, the country has faced increasing restrictions both in terms of contingency and reduction of funding for scientific and technological infrastructure and the dismantling of the institutional coordination framework of ST&I policies.

Figure 4, below, shows the evolution of the participation of the resources of the National Fund for Scientific and Technological Development (FNDCT), the National Council for Scientific and Technological Development (CNPq), and the Coordination for the Improvement of Higher Education Personnel (Capes) as a percentage of gross domestic product (GDP) for the period 2000 to 2021 and the budgetary execution, in the same period, of these three main sources of funding for ST&I.

The creation of the Sector Funds in the 2000s brought a significant increase in the volume of resources for ST&I activities, contributing to a significant growth in the

volume of resources until 2015, with a participation of 0.2% of GDP. From that year, however, there was a sharp reduction in FNDCT, Capes, and CNPq resources, which now represent about 0.09% of the GDP in 2021.

Figure 4. History of the participation of FNDCT, CNPq, and Capes in GDP (%) and Budget execution of FNDCT, CNPq and Capes (R$ million - real values *)



Source: Prepared by the authors based on the data from the Integrated Budget and Planning System (Siop) and the National Treasury Secretariat (STN).

*IPCA (Extended National Consumer Price Index), December, 2021.

Between 2014 and 2015, the resources that were disbursed reached their maximum value, about R$13 billion on average, in real terms. However, there is a significant drop from 2015. Thus, aggravated by the political and economic crises that the country has been going through over the recent period, the budgetary execution of the FNDCT, CNPq, and Capes returned to the levels of the early 2000s in real values, evidencing a strong deterio-

ration of resources for science and institutional disarticulation for ST&I actions. Despite efforts to reverse this situation[6], the financing of ST&I activities in the country remains subordinated to a logic of fiscal austerity and leads to serious questioning of the survival capacity of science in Brazil[7].

6 An example, there is the enactment of the Complementary Law No. 177, of January 2021, which, by making the FNDCT a fund of an accounting nature, sought to establish mechanisms to avoid the contingency of resources.

7 On this issue, see R$ 9 bilhões para "impedir a morte da ciência brasileira?" – #Jornal da USP; Ministério da Economia perde poder sobre recursos para ciência e tecnologia - 06/20/2021 - Mônica Bergamo - Folha (uol.com.br)

Public Policy Propositions

The asymmetries and inequalities observed in the field of scientific, technological, and innovation training at the global level are reflected in the social condition of the world's populations, where there is a growing disarticulation between innovation and social welfare systems, especially in the least developed countries. The technological platforms in Health 4.0, despite constituting a new promise to promote inclusive innovations in health systems, also contemplate risks of widening the existing gaps in developing countries such as Brazil.

Faced with these challenges, a broad reflection on new public policy models is necessary to direct research and innovation efforts in health to public interest objectives, in terms of sustainability, inclusion, and resilience. This reflection should involve some guiding and fundamental axes:

Adequacy of the analytical and normative framework aimed at strengthening the system of science, technology, and innovation in health in Brazil, presupposing the role of the State as a central instance in the articulation and mediation between public and private interests in favor of the social interest. This implies the construction of an institutional apparatus for coordinating public policies that allows for the treatment of ST&I policy as a State policy.

Incorporation of social policies into innovation policies, to allow the transfer of knowledge to society, either through the establishment of "missions" or the creation of permanent forums that articulate the promotion of ST&I activities with the bottlenecks of health systems and social inclusion that require innovations. The challenge lies both in identifying the problems and bottlenecks relevant to society and in the ability to effectively insert these concerns into the research agendas of the academic and scientific community.

Stable and adequate funding pattern. The analysis of global investment patterns in ST&I shows that countries with greater knowledge of scientific and technological skills have a wide range of instruments and policies aimed at financing their innovation systems.

Today, Brazil faces one of its worst scenarios in terms of financing ST&I activities in the country. Therefore, it is urgent to reorganize the budget for science and technology in Brazil, particularly within the scope of the sector funds of the FNDCT, which feed the basic research process in the ST&I infrastructure.

Strengthening of the national system of ST&I in health articulated with a strategy for the development of HEIC 4.0, guided by the demand of SUS. As emphasized by Gadelha, "Without a productive, technological, national and knowledge base, SUS becomes poor."[8] However, the reconstruction of a systemic and structuring policy that promotes the strengthening of the productive and technological base of health in strategic areas for public health implies the rescue of institutional instances of coordination of industrial policy and innovation in health, such as the Executive Group of the Health Industrial Complex (Gecis), and the resumption of instruments such as the use of government purchasing power.

Improvement of the regulatory framework in order to promote universal, equitable, and accessible access to health. The adoption of new digital technological platforms associated with Health 4.0 has the potential to expand access to health in Brazil. However, if we want to adopt a digital health strategy that does is not subordinate, and dependent, as well as not dismantled from social interests and the SUS, it is crucial that the process not only involves the current discussion on the regulation of telehealth services in the country, but a broad public debate on the governance process of the Digital Health Strategy for Brazil 2020-2028 (ESD28).[9]

8 Lecture given at the Abrasco's 4th Brazilian Congress of Health Policy, Planning and Management, on 03/26/2021, available from: https://cee.fiocruz.br/?q=CEE-no-Congresso-da-Abrasco-acesse-podcasts-com-os-participantes-parte-I

9 See: http://bib≠.cofen.gov.br/wp-content/uploads/2021/11/estrategia-saude-digital-brasil-2020-2028.pdf

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Opportunities and Challenges for the Medical Device Industry

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Among the industries of the Health Economic-Industrial Complex (HEIC), it is worth mentioning the role of the medical-hospital and dental equipment and materials industry, both for its innovative potential – strongly incorporating the advances associated with the microelectronic paradigm – and for its impact on services, representing a constant source of changes in care practices, permanently bringing to the debate the tension between the industrial and sanitary logic.

This industry is one of the segments mostly associated with medical practices, often determining the technology incorporated in the procedures adopted regarding the prevention, diagnosis, and treatment of diseases. Although this activity is treated as an industry or sector, it incorporates very diverse segments, ranging from highly complex capital goods (such as diagnostic imaging) to consumables for daily use, such as instruments, surgical and outpatient materials, syringes, among many other examples. The industry is thus characterized by a great technological heterogeneity.

The medical-hospital and dental equipment and materials industry constitutes an oligopoly based on product differentiation. Its operating dynamics is based on the supply of goods, largely highly specialized, with a high number of products being launched continuously, new treatment and diagnostic options, short technological cycles (lasting less than two years), and which are marketed in association with services and other products (Gadelha et al., 2012).

It should be noted that industry-leading companies are increasingly developing strategies to offer integrated solutions to the market, that is, products associated with services: network for the provision of technical services, assistance and maintenance, software programs, and financial services. The use of this equipment, in general, is associated with the need to replace inputs, parts or chemicals, which, by increasing the costs of change, also generates a prolonged dependence between suppliers and consumers. Brand, reputation, trust, and quality of products and services are other elements that promote user loyalty.

Short life cycles, integrated solutions, and customer loyalty point to the role of complementary assets as important instruments for achieving the results of innovative efforts, to the detriment of patent filing.

The strategies of large companies have meant an increase in barriers to the entry in the segments where they operate, preventing or even excluding smaller companies that have smaller resources.

Competitive and Innovation Dynamics

The industry is highly concentrated, and competition occurs via product differentiation based on the intensity of R&D spending. Reflecting this characteristic, Table 1 presents the twenty companies that invest the most in R&D in the industry, specifying for each one the country of origin, the amount invested, and the percentage on sales.

Table 1. Companies that invest the most in R&D in the industry, 2021

Company	Country	Investment in R&D (million EUR)	% of sales
Medtronic	IE	2.031,6	8,3
Abbott Laboratories	US	1.913,5	6,8
Thermo Fisher Scientific	US	962,4	3,7
Boston Scientific	US	928,2	11,5
Becton Dickinson	US	893,2	6,4
Carl Zeiss	DE	839,0	13,3
Stryker	US	801,9	6,9
Fresenius	DE	789,0	2,1
Edwards Lifesciences	US	619,9	17,3
Essilorluxottica	FR	544,0	3,8
Olympus	JP	516,3	8,2
Intuitive Surgical	US	485,0	13,7
Baxter International	US	404,2	4,2
Terumo	JP	386,1	8,0
Zimmer Biomet	US	303,2	5,3
Dexcom	US	293,3	18,7
Dragerwerk	DE	284,7	8,4
Smith & Nephew	UK	250,2	6,7
Shenzhen Mindray Bio-Medical	CN	241,7	9,3
Varian Medical Systems	US	228,7	8,9

Source: The 2021 EU Industrial R&D Scoreboard (2021).

There is a significant percentage of resources invested in this item on sales, which clearly points to the importance of the intensity of R&D spending in the competitive dynamics of the industry. There is also a strong presence of US companies among those that invest the most in R&D, where characteristics of the US market illustrate this issue.

Table 2 shows five of the largest companies in the industry in 2019, specifying for each one the country of origin, the annual revenue, and the number of employees. It should be noted that they are included in the ranking of those who invest the most in R&D, signaling the success of this strategy for these companies.

Table 2. The largest companies in the industry, 2019

Company	Country	Revenue (US$ billion)	No. of employees
Medtronic	IE	30,55	90.000
Abbott Laboratories	US	19.95	107.000
Fresenius	DE	19.00	120.600
Becton Dickinson	US	17.29	70.000
Stryker	US	14.9	36.000

Source: GetReskilled (2020).

Note: The large and highly diversified international conglomerates, such as Philips, Siemens, Johnson & Johnson, etc., which have activities in this industry, were not considered.

It should be noted that large companies focus their competitive efforts on segments of greater technological intensity. A striking feature of the industry is its increasing absorption of technological advances from traditionally innovative industries such as microelectronics, nanotechnology, automation, precision mechanics, new materials, etc. and, more recently, associated with the emergence of the 4th industrial revolution, 3D printing, artificial intelligence (AI), big data, internet of things (IoT), among others.

Despite the strong R&D intensity that characterizes the industry, in some segments of less technological complexity, such as the market for syringes, gloves and more conventional diagnostic equipment, the competition pattern is based on prices, where production and competitiveness gains are linked to the scale and profit margins are lower (Maldonado et al., 2013).

The global market for this industry is estimated at about US$495 billion in 2022, and projections indicate that it will be US$719 billion by 2029, with an annual growth rate of 5.5% in the period (Fortune, 2022).

As for the participation by region in 2019, the Americas held 48.1% of this market, followed by the Western Europe with 24.2%, Asia with 21.1%, Eastern Europe with 4.0% and the Middle East and Africa with 2.6%. By country, for the same year, the US accounted for 42.7% of the global market share, followed by Japan with 7.2%, Germany with 7.1%, China with 6.8%, France with 3.8% and the United Kingdom with 2.5%. Together, these six countries held 70.6% of the world market. Among the so-called BRICS, the four countries with the most robust economies, China held the fourth position, Brazil, together with India, the thirteenth position with 1.3%, and Russia, the fifteenth with 1.2% share in the world market (Khidi, 2021).

The US is undoubtedly the industry's major player in terms of the size of the domestic market, its companies and even its share of world trade. The success of US companies in this industry is the result of the convergence of a set of factors: the institutional and business environment in which companies are inserted, the extension of the private health services market with a wide absorption capacity of a growing supply of new products, strong government action in opening and accessing new markets and the traditional engagement of companies in R&D. In addition to having production chains in all segments, the existence of related industries such as microelectronics, telecommunications, instrumentation, biotechnology, software development, among others, completes this perspective (Gadelha et al., 2012).

Because they do not have the same technological and industrial capacity, the other competing countries, especially in Europe and Japan, develop specialization and segmentation strategies. Germany, for example, sought to specialize in the imaging diagnostic segment, whose main company is Siemens, and in the implant segment. Japan, in turn, stands out mainly in ultrasound devices, electrodiagnostic devices, and ophthalmic instruments (Maldonado et al., 2013).

Alongside traditional companies in the industry, there has been a significant growth in startups in recent years, providing innovative and personalized products such as diagnostic systems using virtual and augmented reality (European Commission, 2018). The logic of a startup's success involves factors such as having an idea that provides superior results to all users, including patients, caregivers, and physicians, reduces costs and speeds up the decision-making process. The most successful startups are able to approach the patient by providing a better, cheaper, safer, more convenient innovation or, somehow, just a better option (Qualio, 2020). Table 3 presents some examples of startups, country of origin, and respective products.

Table 3. Examples of Startups

Company	Country	Products
ABLE Human Motion	ES	Robotic exoskeletons
AbiliTech Medical	US	Devices that aim to restore the independence of individuals with neuromuscular conditions or lesions in the upper limbs
Garwood Medical Devices	US	Minimally invasive device to avoid biofilm infections on prosthetic knee implants using electrodes to prevent the growth of microbes
Parasym Health	UK	Devices for neurostimulation for patients with inflammatory disorders and chronic pain
Signum Surgical	IE	Implant technologies to promote post-surgery healing and infection prevention in colorectal patients
X-Cor Therapeutics	US	CO_2 removal device to treat patients with acute respiratory failure
Rubi Life	CA	Device that uses nanotechnology to track fetal activity in high-risk pregnancies
Day Zero Diagnostics	US	Diagnostic systems and treatment of infections
Flatiron Health	US	Shared network in oncology
Livongo	US	Platform for chronic patients

Source: Startupguys (2021).

Information technology and electronics companies, known as bigtechs, also participate in this industry, using their skills to create innovative products, such as software and platforms that provide increasingly advanced functionality, such as personal health record applications or platforms where people can access and track their medical records. Currently, the largest bigtechs in the world are Facebook, Apple, Microsoft, Amazon,

and Google, a group known as the big five, which, in 2020, obtained together a revenue of more than US$1 trillion (Diário Popular, 2021). They are included in the bigtechs Alphabet, Meta, Tesla, IBM, Philips, Cisco, among others.

In the health field, Facebook, for example, has launched a health care tool. Developed in conjunction with the United States' Centers for Disease Control and Prevention, the American College of Cardiology, the American Cancer Society and the American Heart Association, the tool allows the registration of check-ups and other examinations, consultations, and activities of each user (IESS, 2019). In 2020, Facebook announced the launch of tools to help users receive mental health support (Tecnoblog, 2020).

Apple began its health activities in 2018 with the release of Apple Health Records. In 2019, it made the feature available to any U.S. health care provider that uses electronic medical records, and now allows patients with iPhones or iPods to download and view their medical records, including medications, immunizations, and lab results, in one place. Also in 2019, Alexa announced a smart watch that uses AI and allows patients to set medication reminders, take readings of blood sugar measurements, find nearby emergency care centers, among other features. The Apple Watch is already quite popular and, in addition to tracking heart rate, new features such as women's periods, noise exposure, and mobility are being developed. Apple's performance in health services also includes an industry electronic records business (Partners, 2020). For 2022, the new operating system, ioS 16 (for iPhone) and watchOS 9 (for watches), is scheduled to be released, which adds up to 150 different types of health data that are collected or measured between the Apple Watch, iPhone and third-party applications and devices connected to the "Health" application, which comes in the company's products (Yahoo Notícias, 2022).

Microsoft, in turn, provides different products for health services. Among them, Azure, a platform for running applications and services, based on the concepts of cloud computing. Azure IoT is a platform used to develop technology and applications with the Internet of Things (IoT), providing functionality and intelligent use of resources, and can be directed to the Internet of Medical Things (IoMT), a technology that offers a

number of potentialities for the health ecosystem (Lattine, 2022). Microsoft Dynamics 365 is a suite of intelligent business applications (CRM and ERP) for management administration, delivering results through predictive and AI-driven insights. HoloLens is a device embedded in glasses that create high-definition virtual environments, allowing interactions between augmented reality and the user. The Power Platform, which is the union of three tools, Power Apps, Power BI and Power Automate, facilitates the analysis, decision-making, and automation of processes (Microsoft, 2022).

Amazon acquired the pharmaceutical delivery service PillPack in 2018 for about US$750 million (Business, 2022). The company also has its own medical operation called Amazon Care, which offers virtual consultations and home visits from doctors. In 2019, it acquired the startup Health Navigator, a company that has a digital platform that integrates online health services with support solutions for clinical documentation, care, screening, and other processes (Startse, 2019). In 2022, it acquired One Medical, a healthcare network of clinics and health offices focused on primary care for US$3.9 billion (Olhar Digital, 2022).

Google's investments consist of collecting an immense amount of patient data and using advanced AI and machine learning systems to gain meaningful insights and market them. It has several investments, such as 23andMe, which is a personal genetics company dedicated to helping individuals understand genetic information through DNA analysis technologies and interactive web-based tools. The company's Personal Genome Service allows people to gain deeper insights into ancestry and inherited traits; Flatiron Health allows cancer care providers and life science companies to gain business and clinical intelligence through its web-based platform; Freenome is a genomics AI biotechnology company that, through blood testing, can help detect and treat cancer quickly and efficiently; and Oscar Health, in turn, is a health plan based on telemedicine (Academia, 2022).

In March 2022, Google announced plans to invest in health monitoring with the use of smartphones. The idea is that users can identify health problems at home, through microphones embedded in mobile phones. The devices should detect the heart rate and

scan the eyeball. The bigtech is also testing artificial intelligence software that can certify ultrasound scans (Poder 360, 2022).

In the process of creating/reinforcing essential skills necessary to operate in this industry, companies have been developing cooperative strategies, with a convergence between health and technology companies. They take shape in agreements between IBM and Siemens in health management, between IBM and Meditronic in a digital health incubator program in Israel, between Meditronic and Qualcomm in glucose monitors, and between Philips and Amazon, linking devices and sensors from the former with web services from the latter (European Commission, 2018). Also, the partnership combining American Well's virtual care resources with Philips' digital health solutions (Philips, 2018).

Trends

The Covid-19 pandemic had an impact on the industry, which experienced a relative decrease in demand compared to pre-pandemic years, and the global market experienced a decrease of -1.4% in 2020 compared to 2019 (Fortune, 2022). If, on the one hand, companies that provide equipment and devices for interventions that are considered elective such as dental and orthopedic suffered the greatest effects, on the other hand, the growth of in-vitro diagnostic tests and equipment and devices for diagnosis and treatment of Covid-19 promoted opportunities for the producing companies. However, as of 2021, with the pandemic under greater control, elective interventions in the US, Canada, and Germany, for example, recovered, which stimulated industry growth (Fortune, 2022)

If the early stages of the pandemic affected the industry, the process of mergers and acquisitions returned strongly in 2021. This movement, which has been constant in the industry concentration process, is led by the main global companies and aims to expand production scales and concomitant cost reduction, especially intangible fixed costs, such as sales promotion costs, and the costs of developing new products. In the case of acquisitions, acquirers gain instant access to new products, new customers and a sales and technical assistance infrastructure, and expand their bargaining power with buyers (Maldonado et al., 2013).

Involving US$31.5 billion only in the first six months of 2021, we highlight, for example, the acquisitions of PPD by Thermo Fisher-PPD in the amount of US$17.4 billion, Varian Medical Systems by Siemens in the amount of US$16.4 billion, Hillrom by Baxter in the amount of US$12.5 billion, Aldevron by Danaher in the amount of US$9.6 billion and Grail by Illumina in the amount of US$8 billion (Fierce, 2022).

In March 2022, the total global amount of US$320.6 million was announced in the scope of these transactions, in which, by region, North America occupied the first position with a total business in the period in the amount of US$240 million. The five largest transactions involved the acquisition of Ivenix by Fresenius for $240 million, LDPath by SourceBio International for $240 million, BioClue and BioStrand BioKey by ImmunoPrecise Netherlands for $21.9 million, Sinusafe Medical by Bold Capital Enterprises for $21 billion, and Bestbion by SD Biosensor for $13.2 million (Medical Device Network, 2022).

However, in a "post-pandemic" scenario with a risk of recession associated with the consequences of Ukraine's war, inflationary pressure around the world, increases in energy and transportation costs, among other factors, US bigtechs suffered significant losses of about 16.5% of their market value in the first four months of 2022, equivalent to US$1.8 trillion. Analysts question which of these companies, which have experienced widespread growth since 2008, have good or bad fundamentals and which will survive this turbulence. The same questioning is made for startups (Infomoney, 2022).

Business opportunities in the industry are closely related to the ageing of the population. Much of the equipment, such as electric and manual wheelchairs, dialysis equipment, endoscopy equipment, anesthesia equipment, medical furniture, etc. are mature products and should not experience significant growth. Meanwhile, the production of imaging diagnostic equipment and other state-of-the-art medical equipment is expected to continue to grow. The production of auxiliary equipment, orthopedic products, and dental implants and products has been increasing, indicating that the demand driven by the aging of the population has been increasing; in addition, by pressuring the demand for medical care, companies are encouraged to seek more efficient solutions, promoting, for example, the development of technologies associated with precision and digital medicine (Market Prospects, 2022).

Population ageing has also induced a preference for home-care services, and companies have been launching wearable devices and portable medical equipment that are easy to handle, for monitoring and treatment, especially chronic patients. In addition, both the pandemic and growing health concerns have stimulated demand for these devices, and companies have rushed to launch new and more advanced models with new functions and at competitive prices. This market niche opens perspectives for both new entrants and established companies (Fortune, 2022).

Important business opportunities in the future will be found in the areas of intelligent healthcare and in the production of diagnostic equipment and minimally invasive products. Personal devices of ophthalmology, otology, dentistry, and respiratory therapy, which improve medical efficiency and prevention strategies, will have an increasing demand. Similarly, service models that combine medical equipment and cloud software platforms will become driving forces for the industry growth. Economic products with high added value will become commonplace in the markets of the future (Market Prospects, 2022).

As the industry adjusts to the post-Covid "new normal," the expectation is for growing personalized medicine. Big data, combined with digital manufacturing, has the potential to drive this approach by creating more effective medical equipment and devices that create new treatment possibilities and improve patient outcomes (Fast Radius, 2022).

AI also has the potential to play a significant role in industry. The new AI and machine learning capabilities provide healthcare professionals with important information stemming from the growing amount of medical record data. These tools lead to better diagnostic decision-making, providing high levels of accuracy. And medical device companies have been implementing AI technologies to rethink the development of their products. It involves the use of software as a medical device for chronic disease management and medical care administration. Currently, AI is mainly applied to detect and treat diseases in oncology, cardiology, gerontology, and endocrinology (Med Device Online, 2022; Healthcare and Life Sciences, 2022).

It should also be noted that cloud computing, by providing a shared platform with workflow automation, unified data, and a lean and personalized product development process, can mean greater efficiency and possibilities of scale operation for companies in the industry (Today's Medical Developments, 2022).

3D printing technology can be applied in the manufacture of dental, orthopedic, surgical instruments, hearing aids, tissues, and organs. With the development and innovation of these materials associated with increasing demand, a rapid growth of the market is expected. Due to the increase in the number of patients during the pandemic and the shortage of medical supplies and equipment, the 3D printing industry was able to take advantage of its rapid prototyping, shared online design, and decentralized production to produce respirator components, personal protective equipment, screening, and diagnostic tools, etc., demonstrating the flexibility of production and the diversified possibilities of manufacturing from this technology. The expectation is that the area will grow significantly in the coming years (Market Prospects, 2022).

Companies have begun to develop robots to help healthcare workers accomplish their tasks. The introduction of robots in a health unit frees health professionals from routine tasks, such as performing venipuncture, monitoring the patient's vital signs, lifting the elderly from their beds, tidying and disinfecting rooms, etc. In 2022, the Worcester Polytechnic Institute, for example, developed a remotely controlled robot. These remote assistants protect healthcare workers from the risk of contamination of infected patients. And robotic technologies are already widespread in the physiotherapy sector (Med Device Online, 2022).

Another promising area presents itself in robotic surgery. For many manufacturers, it will be necessary to expand partnerships to obtain external resources that can strengthen their own capabilities in the field of manufacturing, design, supply chain management, among other aspects. Many manufacturers plan to expand their innovative capabilities, and as new product development activity increases, outsourcing in the field of engineering, test development, prototyping, and other product development services may become necessary (Plexus, 2022).

Telemedicine experienced strong growth with the outbreak of the pandemic. As more people adopt it, new devices will emerge to keep up with the trend. Technologies such as telemonitoring devices, home messaging services, voice monitoring, and recognition centers will be used to make remote healthcare more agile and efficient. IoT solutions and integrated wearable devices are two of the most prominent trends. Technology providers will invest in software that connects patients and healthcare professionals through physical devices. Smart beds, inhalers, electrocardiogram (ECG) monitors can exchange information with telemedicine applications via an Internet connection, which will increase patient comfort and reduce hospitalizations (Acuity, 2022).

Big data and AI will further boost the global telemedicine market. Large amounts of data can be stored in AI-based software and programs. Healthcare professionals can store not only a patient's personal information, but also demographic and geographical data, providing better care. Likewise, the combination of telemedicine with virtual reality will enable quality care and make it possible to perform procedures with greater precision. Telemedicine solutions with robotic process automation (RPA) will generate efficiencies and reduce costs. Currently, RPA is already used by health organizations in scheduling consultations, hospital administration, and data management protocols (Acuity, 2022).

The emergence of the 4th Industrial Revolution will promote in health the transition to fully automated digital environments and cyber physical systems. IoT, big data, blockchain, cloud computing and AI will find growing applications in this area. The new technologies will promote the improvement of medical image analysis services (diagnosis, segmentation or classification), data collection and analysis, remote monitoring and data transfer systems. 4th Industrial Revolution technologies will have high implementation accuracy with reduced associated costs and time (Frontiers, 2022).

Proposition for Public Policies

This study presented a diagnosis of the competitive and innovation dynamics of the global medical, hospital, and dental equipment and materials industry and main trends. This investigation establishes a guideline for understanding the paths to be followed by its national counterpart. It has been presenting a growing technological gap that, associated with several institutional factors, points, in fact, to its low productive and innovative capacity.

In this scenario, and in view of the challenges and potential imposed by the new technologies associated with the 4th Industrial Revolution, the following guidelines are proposed to identify the strengthening of the production base of medical devices in Brazil, with a focus on strengthening the Unified Health System:

- Identify convergences between SUS actions and programs and the national industrial capacity to enable the centralization of public procurement to scale local production, in conjunction with the funding and other industrial policy instruments.

- Prioritize the stimulation of local production of medical devices, with attention to the most advanced critical technological components, giving this industry a strategic role in qualification and innovation in health services.

- Improve investment lines in ICTs to articulate with the productive sector, enabling more agile innovation cycles that allow the monitoring of sanitary demands.

- Adapt the regulatory framework to the new paradigm of the 4th Industrial Revolution, incorporating products and services with strong use of artificial intelligence, big data, and 3D printing and their ramifications on all levels of health care.

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Health and External insertion: An analysis of the HEIC's Balance of Payments and Impacts of Exchange Rate

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

"Viva o SUS" was a daily expression repeated by Brazilians during the pandemic, revealing the popular approval of our public health system and its importance to society as a whole. The expansion of the Unified Health System (SUS), its improvement, and the increase in its funding are fundamental and can contribute to a new development project in Brazil.

Thus, it is necessary to pay attention to the set of economic relations that make up the Health Economic-Industrial Complex (HEIC) in Brazil and to how they articulate with the rest of the world through commercial and financial relations.

Health and External Insertion

The external insertion of the HEIC reveals several important dimensions for the Brazilian economy, such as (i) the vulnerability of the system in the face of health emergencies such as the current one; (ii) the dependence on foreign currencies resulting from the external deficit of the sector[1]; (iii) the volatility of the prices of production inputs due to variations in the exchange rate; (iv) the variation in the purchasing power of the SUS according to the variation in the exchange rate; (v) the dynamic effect of health spending. The more imported content, the less is expenditure; and, finally, (vi) the role of the HEIC itself in sustaining a pattern of development that does not collide with the restriction of currencies.

The productive chains of health and their effects on income and employment are impacted by the use of imported products in the activities of the area. Imports are common and necessary in any health system, but the high number of imported inputs and final goods reduces the dynamic potential of the HEIC and impacts the vulnerability of the sector – external dependence – and its purchasing capacity in times of devaluation of the Brazilian currency against the dollar.

In this context, public and private health services do not have foreign competition be-

1 "Here there is already a first source of economic vulnerability of the health industrial complex: its strong dependence on external conditions and macroeconomic policy" (Gadelha, 2006).

cause they are non-marketable products but suffer important cost impacts with exchange rate fluctuations. An exchange rate devaluation directly impacts the cost of inputs used in health products, especially pharmaceuticals and products from various industries. The private sector tends to include this cost increase to the final product; however, the case of the public sector is peculiar, as the devaluation of the exchange rate is an element of the vulnerability of the SUS, since the budget established in reais has its purchasing power reduced at these times. According to Gadelha (2006):

> Any change in the exchange rate can lead to an explosion in health expenditure on imports. Under particular conjunctures, the devaluation of the exchange rate, at least at first, before generating its effects on the reduction of external acquisitions and the increase of exports, can lead to pressure on health expenditures (more Brazilian reais spent on imports) incompatible with budgetary availability (GADELHA, 2006, p. 18).

Therefore, moments of exchange rate devaluation can generate increased costs for the HEIC and reduce the purchasing power of the public health expenditure itself, whose budget is impacted, in particular, by the import of medicines and medical equipment, which is extremely sensitive to the exchange rate, as shown by Cesário et al. (2017). In addition, exchange rates interfere with the calculation of the profitability of international companies that use the dollar as a reference. Exchange rate volatility is, in this sense, an additional risk component for the investment decision.

The level of the exchange rate determines the conditions of competition in the productive sectors that suffer foreign competition. In general, devalued exchange rates tend to favor domestic production and import substitution. However, the effect of the exchange rate on the productive structure depends on the temporality of the analysis.

In the short term, the effects are ambiguous, since there is an enormous rigidity in the productive structure. This does not automatically respond to price stimuli, and the replacement of imported products depends on the flexibility of contracts and supplier networks. Not always can a Brazilian company replace an imported input with a domestic

product. This may happen because of contractual obligations or because the domestic supplier simply does not exist. In other words, the exchange rate devaluation may represent cost to companies.

In the long term, the contractual problem is solved, but the emergence of networks of domestic suppliers depends on new companies, entrepreneurs, expertise, and technology, which are not always available. In this context, if a long period of exchange rate appreciation can break production chains and deindustrialize them, exchange rate devaluation does not necessarily reassemble these chains and rebuild the path toward industrialization. At this point, it is necessary to be clear that a strategy of diversification of the production structure depends on the articulation of exchange rate policy with other macro, credit, and industrial policies.

The HEIC's Balance of Payments

The HEIC's Balance of Payment[2] study is the result of the methodology used to analyze commercial relations in health developed since 2003 at Fiocruz (Gadelha, 2003; 2021). The data indicate that HEIC's account for current transactions is insufficient, and deficit tends to increase. In 2006, there was a deficit of US$5.8 billion and increased to US$17.4 billion in 2020. This trend is temporarily mitigated in years of economic crisis as in 2009, 2015, and 2016, showing a reduction in the deficit.

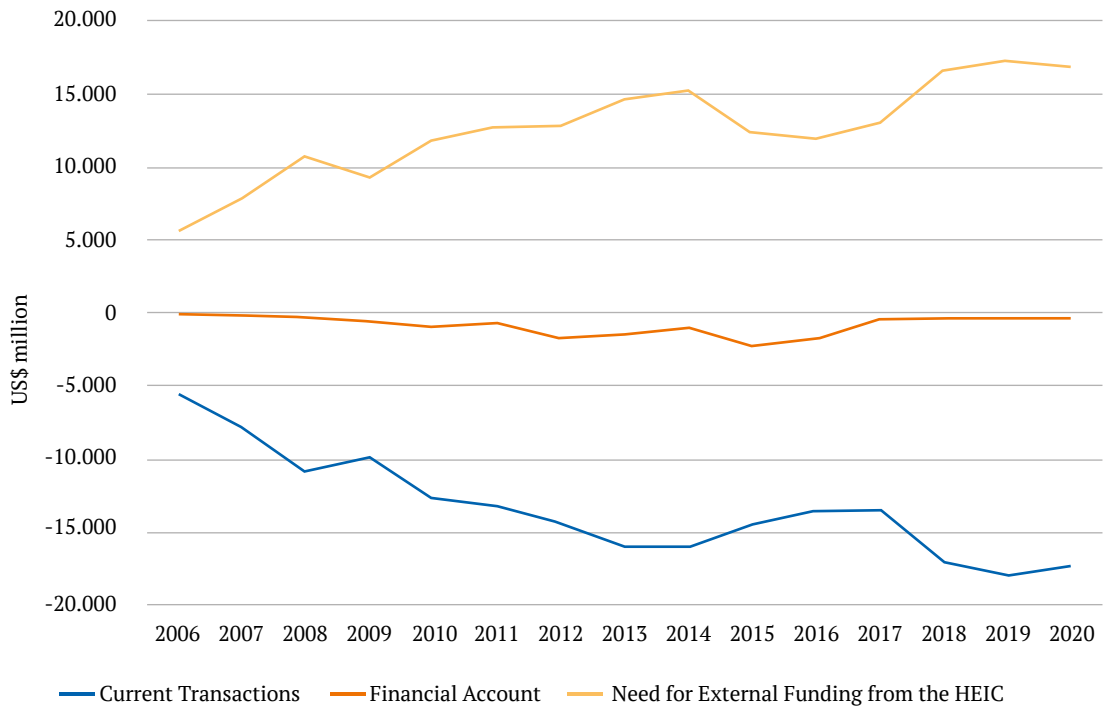
The HEIC financial account is also structurally insufficient in the period under review, which represents the attraction of foreign capital and the formation of external liabilities. The greatest formation of external liabilities by the HEIC were in the years 2012, 2015, and 2016, respectively, US$1.7, US$2.2, and US$1.7 billion.

The attraction of external capital by the HEIC is insufficient to cover the deficit in current transactions, which implies a high and growing need for funding from the HEIC that

2 Balance of Payment (BOP) is an accounting record of all transactions between residents in Brazil and residents in other countries. Transactions may include the purchase and sale of goods, services, and products, in addition to financial ones such as loans, investments, among others.

reaches the level of US$17.3 billion in 2019, as shown in Figure 1.

Figure 1: The HEIC balance of payments

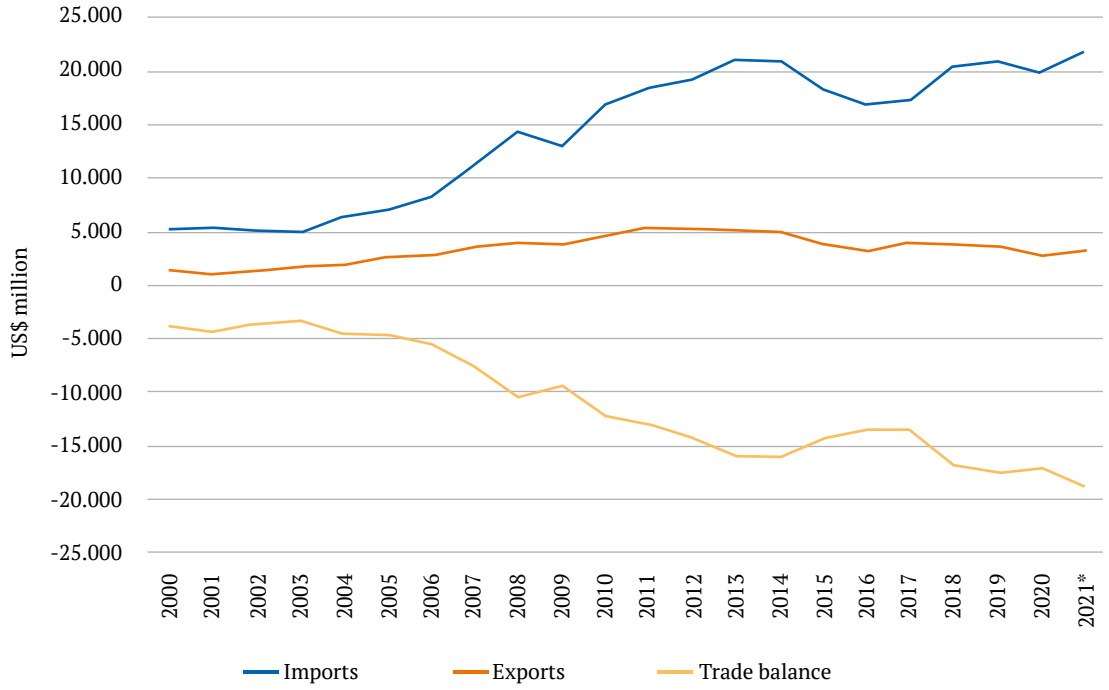


Source: BCB. Prepared by the authors

It is worth highlighting the limitations of the data available, especially in relation to the financial account, which implies an underestimation of the inflow of external resources to the HEIC.

The evaluation of the trade balance, whose elaboration has as methodological reference the work of Gadelha (2003) and Gadelha et al. (2021), shows that in the period from 2000 to 2021, as shown in Figure 2, there was HEIC's trade balance worsened, mainly due to the increase in imports. In five years, between 2009 and 2014, the trade deficit went from US$13 to US$21 billion.

Figure 2: Evolution of the trade balance of the health complex, from 2000 to 2021, in Brazil*



Source: Siscomex. Prepared by the authors

*Values from 2021 until the month of October

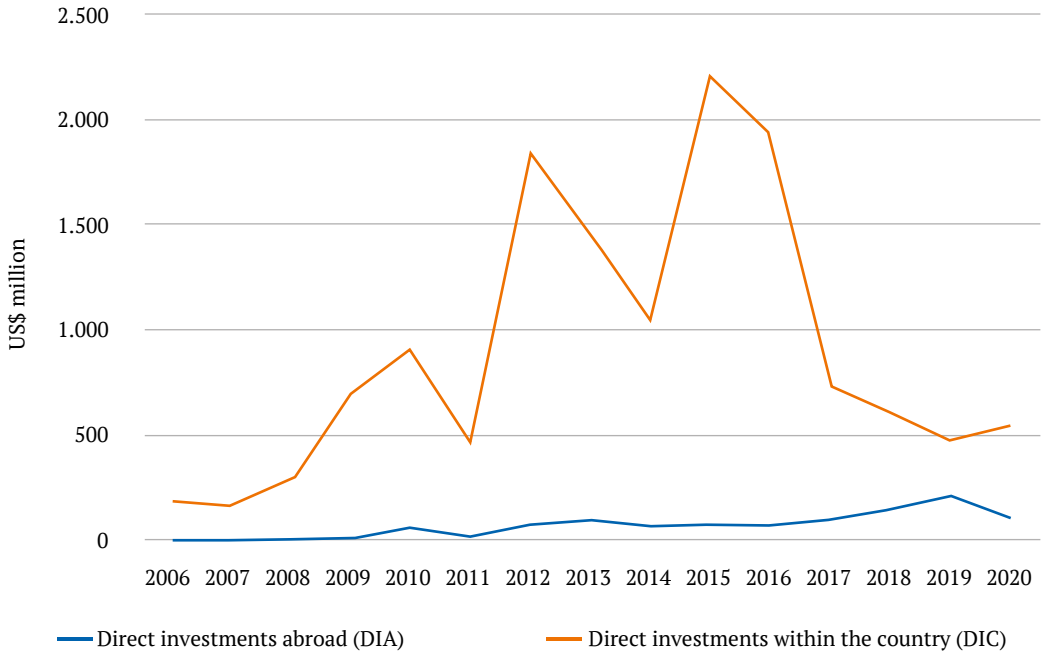
In the same period, exports remained practically constant, with a slight downward trend from 2014 onwards. The result of the different trajectories of the export and import series shows a graph with a shape like an "alligator mouth" that leads to an increase in the trade deficit from US$9 billion in 2009 to US$18 billion in 2018 (Figure 2).

It can be seen in the graph that, in 2009 and 2015, years of economic crisis and exchange rate devaluation, there was a slight improvement in the trade balance. This is not due to the expansion of exports, but to the reduction of imports, which points to the importance of studying the exchange rate and domestic demand as determinants of the performance of the HEIC's balance of trade.

On the financial account side, direct investments are the most significant sub-accounts. Direct investments in the country reached a maximum of US$2.2 billion in

2015, the year in which there was an inflow of US$1.3 billion in the participation in the capital of the health sector (Figure 3). Brazilian direct investment abroad reached a maximum of US$203 million in 2019, considering both sectors analyzed.

Figure 3. Direct investment of the pharmaceuticals and pharmochemicals and health service sectors



Source: BCB. Prepared by the authors

Exchange Rate Impacts on the HEIC

As shown, the exchange rate can significantly impact the HEIC production costs by increasing the cost of imported inputs. In view of this, our research evaluated the impact on the costs and prices of the HEIC and its productive segments, an increase in imported inputs caused by an exchange rate devaluation, using the input-output matrices (IOM) made available by the Brazilian Institute of Geography and Statistics (IBGE). To this end, a price formation model was built to verify how the intersectoral transmission of cost shocks occurs.

The results of the research showed the impact of a 10% exchange rate devaluation on the

prices of the different activities, considering the prices of each sector equal to 100 before the exchange rate change, according to Chart 1. This increase in the cost of imported inputs leads to a 0.76% increase in the price of HEIC as a whole. Its most impacted activity is the manufacture of pharmochemicals and pharmaceuticals. Its price increases by 1.8%.

Chart 1. Simulation of the 10% exchange rate devaluation on HEIC

Activities	Price	Prices after Shock **	Sector Ranking
HEIC	100,00	100,76	52
Manufacture of pharmaceuticals and pharmochemicals	100,00	101,80	21
Public Health	100,00	100,62	57
Private Health	100,00	100,62	56
Brazilian Economy	100,00	101,06	-

Source: SCN/IBGE, calculations by the authors.

To get a better idea of the size of this impact, this exchange rate devaluation would lead to an increase in the Brazilian inflation by 1.06%, measured by the GDP deflator. This activity is one of the most impacted by exchange rate changes when analyzing all sectors of the Brazilian economy, being the 21st with the highest price increase of the 67 that appear in the input-output matrices.[3]

Public and private health activities are relatively less impacted, due to their cost structure and their production chain. Exchange rate devaluation increases the price of both activities by 0.62%. Just over half of this increase is due to the inputs directly imported by these activities, the rest being related to imports that occur in its production chain.

3 It is important to highlight that one of the hypotheses of the model is that there is a reduction in the sector's profit margin. If this hypothesis were modified to maintain the profit margin, the price increase would be even greater.

Proposition for Public Policies

The study sought to advance the evaluation of the external, commercial, and financial insertion of the HEIC. It is hoped that the results found here can stimulate further studies and shed some light to the understanding of the HEIC and its dependency and vulnerability relationships associated with foreign trade and external funding. This understanding is fundamental to think about public policies that increase the dynamic potential of the HEIC and contribute to the construction of a development project in which health is fundamental.

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Health is also Employment and Income: an Analysis of Job and Income Generation from the Health Economic-Industrial Complex in Brazil

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Every Brazilian citizen benefits directly or indirectly from the Unified Health System (SUS). If in the recent past this statement could raise doubt, this is no longer possible after the Covid-19 Pandemic. The importance of SUS in providing medical care and vaccinating millions of Brazilians, as well as the technical capacity of public institutions such as the Oswaldo Cruz Foundation (Fiocruz) and the Butantan Institute in the production of vaccines, for example, became noticeable to everyone.

Health services and the manufacture of medicines and vaccines are part of the so-called Health Economic-Industrial Complex [HEIC] (Gadelha, 2003, 2021). This concept promotes the merge of the sanitary and production dimensions. Thus, the HEIC can be seen as one of the vectors of an economic and social development project, associated with the guarantee of rights and the provision of public services of quality.

The purpose of this chapter is to discuss the HEIC from a macroeconomic perspective, based on the results of extensive research on the subject. Thus, we will discuss the macroeconomic dimension of health from a general perspective, and then discuss the employment, income and production multipliers of the HEIC, relating the consequences of these results for public health and development policies.

Macroeconomics and Health

Development is usually understood as a process that combines economic growth and structural changes, which expand the economic and social possibilities of a country. From a purposeful point of view, development planning should have as its starting point the idea that one of its objectives is the improvement of people's quality of life and the guarantee of human rights, reflecting improvements in the labor market, the distribution of income and wealth, the social and environmental indicators, and the productive structure.

Aligned with this, Rossi et al. (2020) advocate a development project guided by socio-environmental missions, having as growth engines the distribution of income and the provision of social infrastructure. In this project, social demand acts as a dynamic element of

the domestic productive structure, in order to generate income, employment, technology, and the support of this process.

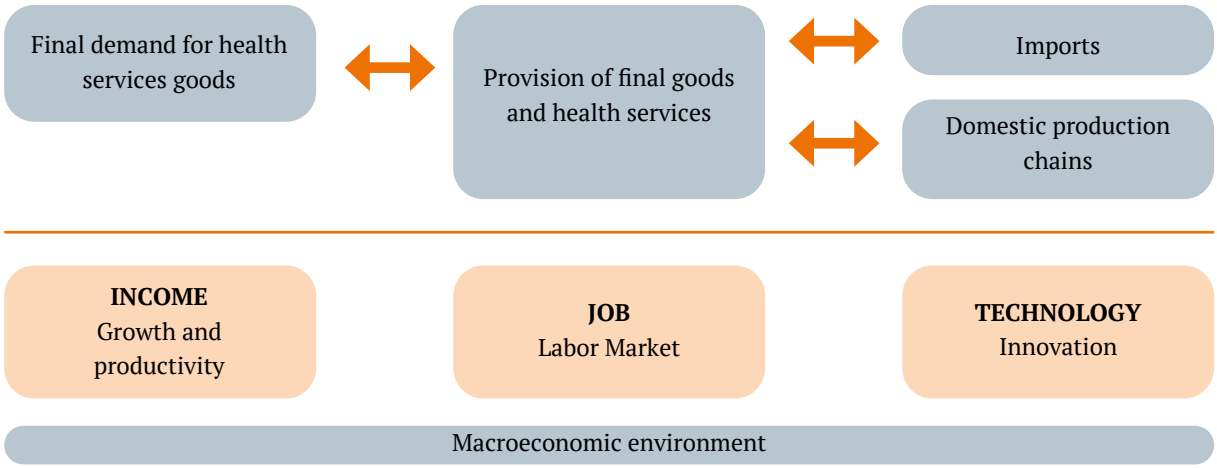
When considering the purposes of this process, health appears as a central element of economic development. In this perspective, the expansion of access to quality health is one of its central objectives, and its search assists in the generation of economic growth of quality.

Furthermore, we can consider that health is deeply interconnected with economic development. In this process, instead of the economic growth being an end in itself, it becomes a means to meet historical social demands, associated with the modernization of the productive structure and the generation of qualified employment. Thus, one of the missions of a development project is to guarantee minimum health conditions for the entire population – health in a broad sense, such as aspiration to well-being.

The HEIC approach helps us to think of an economic development in which health plays a key role. First of all, this occurs because it is interdisciplinary literature with several dimensions, such as the social dimension of the right to health, the productive and technological dimension, in addition to the external dimension of the dependency and vulnerability relations associated with foreign trade and external funding. Moreover, when dealing with the productive and technological dimension, the HEIC approach shows the potential that health brings to development, given the centrality of public health and its power of production chains capable of generating income, jobs, and technology.

One of the central aspects of the articulation of the HEIC in a development process is to understand its macroeconomic role, as illustrated in Figure 1. Our starting point is the basic economic relationship that establishes equality between supply and demand. The final demand for health goods and services represents the dimension of the right to health, social needs and other needs, but also the need for private health, in the form of services and products, such as medicines. This demand will be met by a supply of final health goods and services.

Figure 1. Analytical scheme to analyze macroeconomic aspects of the HEIC



Source: Rossi and David (in press).

Part of this supply of health services is served by imported production, representing a leakage of domestic demand out of the country. This leakage constitutes a reduction in its dynamic potential and indicates an inability of domestic production to meet the final demand, either because of the lack of competitiveness of the national economy, insufficient domestic production for the size of the market or even because of the lack of the productive segment in the Brazilian economy, referring to the technological dimension of health provision.

Most of the health supply, however, is from the domestic production. This occurs because health services are, in general, non-marketable, that is, they cannot be imported from other countries – and an important part of this supply is public provision. Meeting the demand for health in the form of domestic production to the national economy boosts the labor market, generating quality jobs and income.

Such production also leads to domestic production chains in the form of demand for inputs, generating income and employment indirectly along its supply chain. Here, again, importation plays an important role. The more imported inputs are used along the health production chain, the less its potential to boost the economy in creating jobs and expanding income.

Employment and income generated directly in the production of health goods and services, or indirectly along their production chain, also play an important role in boosting the domestic economy. This expansion of jobs and income will also materialize as the largest consumption of families, representing an additional demand for a wide variety of goods and services of the Brazilian economy and thus also leveraging production, employment, and income.

Health Multipliers in Brazil

One way to measure the dynamic potential of the HEIC is through multipliers. The multipliers tell us how much the health supply generates regarding production, employment, and income in Brazil. These are calculated based on data from the System of National Accounts (SCN) of the Brazilian Institute of Geography and Statistics (IBGE). In particular, we use the input-output matrices (MIP) information contained in this information base.

IBGE discloses the MIP only every five years, with a significant delay, because it is expensive and time-consuming[1]. For this reason, we only have official data for 2010 and 2015, limiting our analysis to these years. The multipliers were calculated for the HEIC as a whole as well as for its separate activities[2], which are the following: production of pharmaceuticals and pharmochemicals, public health, and private health. In our analysis, we will always assume a demand for health (HEIC or its segments) in the amount of R$1 million that will be entirely supplied by national production.

Our research indicates that, in 2010, for every R$1 million of HEIC production, 10.3 jobs were created directly in the HEIC[3]. However, this does not exhaust job creation. As mentioned, there is a demand for inputs associated with this production of HEIC. Thus,

1 It should be noted that such periodicity is aligned with the best international practices of the institutes of economic statistics.

2 Rossi and David (in press) point out that the HEIC is underestimated in this database, compared to the Health Satellite Accounts also provided by IBGE. However, it is not possible to calculate the multipliers from the satellite accounts.

3 In order to be able to compare the two years, the 2010 monetary data were transformed into 2015 reais by inflation measured by the implicit GDP deflator of the period in question.

the supply of final health goods and services in the amount of R$1 million generated 6.1 jobs indirectly along the production chain. These workers, in turn, used income for consumption, and production to meet this consumption was responsible for generating 12.2 jobs. In other words, for every R$1 million of HEIC production, 28.5 jobs were generated in Brazil in 2010. Compared to the other 64 productive activities of the Brazilian economy, HEIC was the 21st sector with the highest employment multiplier. All these data are shown in Table 1. The first effect mentioned here is the "direct" one, the second effect is "indirect" and the last effect is the "income".

Table 1. The HEIC job multiplier

Year	Direct	Indirect	Income	Total	Order
2010	10,3	6,1	12,2	28,5	21
2015	10,7	5,6	11,4	27,7	18

Source: SCN/IBGE. Prepared by the authors.

In 2015, for every R$1 million of the HEIC production, 27.7 jobs were generated in total. Although the multiplier was reduced, HEIC continued to be one of the sectors with the greatest potential for job creation, improving its position in relation to the other sectors of the economy – it rose to the 18th position in this ranking.

We can analyze the generation of jobs separately for the productive activities of the HEIC. As can be seen in Table 2, public health has a great prominence, generating a total of 32.26 jobs in 2010 and 30.94 jobs in 2015 for every R$1 million produced. In both years, this activity was the 17th with the highest multiplier of jobs. Private health also has great potential in job creation, with a total of 27.6 jobs for every R$1 million produced for 2015.

Table 2: Job multipliers per HEIC activity

Activity	Year	Direct	Indirect	Income	Total	Order
Manufacture of pharmaceuticals and pharmochemicals	2010	1,66	5,78	6,31	13,75	59
	2015	1,77	6,44	7,08	15,28	56
Public Health	2010	10,39	5,82	16,16	32,36	17
	2015	10,62	5,26	15,05	30,94	17
Private Health	2010	13,20	6,43	9,94	29,57	21
	2015	13,06	5,58	8,96	27,60	19

Source: SCN/IBGE. Prepared by the authors.

Regarding income generation, the HEIC has an even greater prominence. In 2010, each R$1 million spent on HEIC production to meet an equivalent demand generated R$1.4 million in income in Brazil. That is, it had a multiplier of 1.4, as shown in Table 3, being the 6th activity to generate more income in the Brazilian economy. In 2015, the HEIC did not show a major change in its ability to generate income.

Table 3. The HEIC Income multiplier

Year	Direct	Indirect	Income	Total	Order
2010	0,58	0,29	0,53	1,40	6
2015	0,60	0,27	0,54	1,41	7

Source: SCN/IBGE. Prepared by the authors.

Moving on to the analysis of each productive segment, again public health has great prominence. For each R$1 million of production, R$1.61 million of income is generated, being the 4th activity with the highest income multiplier for 2010 and 2015 (Table 4). Private health is also an activity with the capacity to generate income. In 2015, for each R$1 million of production, it generated a total of R$1.29 million, being the 12th activity with the highest capacity to generate income. This is due to two factors. These activities are intensive in work, more specifically, in qualified work, resulting in good salaries paid to workers.

Table 4: Income multipliers per HEIC activity

Activity	Year	Direct	Indirect	Income	Total	Order
Manufacture of pharmaceuticals and pharmochemicals	2010	0,48	0,34	0,27	1,09	43
	2015	0,40	0,36	0,33	1,10	42
Public Health	2010	0,65	0,26	0,70	1,61	4
	2015	0,67	0,23	0,71	1,61	4
Private Health	2010	0,54	0,31	0,43	1,28	12
	2015	0,60	0,27	0,42	1,29	12

Source: SCN/IBGE. Prepared by the authors.

As we discussed, one of the economic dimensions of health is the domestic productive chain. For HEIC to be able to increase its production, a number of other sectors are mobilized in the production of inputs, with job generation and income along the supply chain. Thus, each R$1 million of HEIC production generated a total production of R$2.59 million in 2010 in the economy, of which R$0.58 million were in the production of inputs and R$1.01 million were in the production of consumer goods to meet the demand of workers employed directly in HEIC and indirectly in its production chain. In 2015, the HEIC production multiplier decreased, with R$2.56 million of total production in the Brazilian economy (Table 5).

Table 5. The HEIC Production Multiplier

Year	Direct	Indirect	Income	Total	Order
2010	1,00	0,58	1,01	2,59	30
2015	1,00	0,53	1,03	2,56	34

Source: SCN/IBGE. Prepared by the authors.

In Table 6, we have the production multipliers per HEIC's productive activity. Once again, public health stands out, having a multiplier greater than private health and the manufacture of pharmaceuticals and pharmochemicals. In 2010, each R$1 million of public health provision generated R$2.86 million of total production in the Brazilian economy, being the 8th activity with the highest production multiplier. In 2015, its

multiplier dropped to 2.83, as did its relative position (11th position).

Table 6. Production multipliers per HEIC activity

Activity	Year	Direct	Indirect	Income	Total	Order
Manufacture of pharmaceuticals and pharmochemicals	2010	1,00	0,69	0,53	2,22	54
	2015	1,00	0,77	0,64	2,41	49
Public Health	2010	1,00	0,51	1,35	2,86	8
	2015	1,00	0,46	1,37	2,83	11
Private Health	2010	1,00	0,60	0,83	2,43	44
	2015	1,00	0,53	0,81	2,34	53

Source: SCN/IBGE. Prepared by the authors.

In all tables, we can see that the manufacture of pharmaceuticals pharmochemicals has low multipliers of employment, income, and production, compared to the other activities of the HEIC, but also compared to the rest of the economy. This occurs because of some factors. First, unlike public health, for example, this activity is not very intensive in work, generating less jobs in its production. Secondly, these low multipliers can also represent leakages along its production chain: greater demand for its production turns out to be an increase in imports. Thus, this segment and its production chain can and should be the target of industrial policy, aiming at the internalization of important productive relations.

Proposition for Public Policies

One of the main lessons of our study is that a development project that focuses on expanding the population's access to health care is capable of generating quality jobs with good wages, income, technology, and economic growth. This means that putting the economy at the service of life, far from being an obstacle to economic growth, is a fundamental means in the search for the economic and social development of our country.

The multiplier analysis indicates the dynamic potential of the HEIC. In addition, it shows paths and possibilities for public policies aimed at the challenges of increasing the well-being of the population, seeking to advance in the technological standard, change the productive structure, generate investments, employment, and income.

In particular, public policies of this type benefit from the high purchasing power of the SUS and its ability to influence the structure of the entire HEIC – manifested, for example, in the significant multipliers of public health. A public procurement policy could act as a vector of coordination in technological and productive development and in the generation of qualified jobs – fundamental aspects in the search for a developed economy, a sovereign nation, and a just society.

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The Fiscal Challenges to Guarantee the Right to Health and Foster the Productive Base of Health

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

With the 2008 financial crisis and the Covid-19 pandemic, there has been more structuring debate on flexible fiscal rules, capable of combining greater discretion with fiscal sustainability in greater time horizons. International experiences and recommendations from multilateral organizations point to the need for fiscal frameworks that preserve strategic expenditures not only for economic recovery but also to promote structural changes – social, economic, and environmental – with emphasis on public investments and expenditures in health, education, science, technology, and innovation.

We seek to problematize and mention the institutional changes necessary to foster the Health Economic-Industrial Complex (HEIC), articulated with the adequate funding of the Unified Health System (SUS), such as the adoption of flexible and modern fiscal rules, capable of, together with a new budgetary management, combining economic growth without increasing public debt, stimulating expenses with strong economic and social returns, as well as defining its funding strategy.

The Challenges of Tax and Fiscal Frameworks

Building a Welfare State with universal access is rare among developing countries. The Brazilian case, in addition to fiscal restrictions, is marked by an imbalance between taxes and the transfers and the provision of public services. As Silveira et al. (2022) point out, the tax system has a strong income concentration effect, since the low progressivity of direct collection is more than offset by the strong regressive effect of indirect collection, which represents almost 50% of the tax burden. In a previous study, Silveira and Passos (2017) demonstrate that, in Brazil, the entire distributive effect of the State's performance occurs on the side of public expenditure, in particular, by social security income transfers and free public services such as health and education.

Despite the incomplete implementation of constitutional determinations regarding the social protection system, since the promulgation of the Brazilian Constitution in 1988, there have been advances in terms of coverage, with the expansion of social expenditures and resources in areas such as education and health. These advances were completely threatened with the approval of the Constitutional Amendment 95 (CA 95), which impos-

es a reduction in the size of the State, as presented in Dweck, Moretti and Melo (2021), and prevents the expansion of public provision of services.

The CA 95 reinforced the overlapping of tax rules in Brazil by adding to two other main tax rules. The so-called "Golden Rule", approved in the original constitutional text, defines that the State can only issue debt up to the limit of capital expenditures. This rule, often associated with a partial interpretation of John M. Keynes' ideas of separation between regular and capital budgeting, has the premise that only the capital budgeting could be deficient and could compromise, especially in periods of recession, regular expenditures such as health and education.

During the second half of the 1990s, after the monetary stabilization of the Brazilian Real Plan, a new wave of changes in the institutional framework of public finances began. The Fiscal Responsibility Law – LRF (Lcp 101/2000) was prepared simultaneously with the administrative reform of Fernando Henrique Cardoso's government and one of its main purposes was the focus on structural fiscal adjustment (Barcelos; Calmon, 2014). There was the incorporation of instruments such as strict regulation on personnel expenditure, debt limit, fiscal result targets, and privatization of funding institutions, such as state banks.

As pointed out by Dweck (2020), the LRF, even with its procyclical balance rule of primary surplus results, never determined the size of the Brazilian State. From a macroeconomic point of view, what the LRF imposed was a "balanced budget" rule. However, at the end of 2016, the CA (constitutional amendment) 95, the so-called "spending cap", was enacted, which limits the correction of federal primary expenditures to past inflation. Therefore, the State's capacity to act does not follow the evolution of economic activity or population growth. In addition, there are few exceptions to the rule and only for very atypical situations, such as the authorization for extraordinary funds.[1]

To decrease expenses at the federal level, the CA 95 changed, during its term, the minimum federal obligations for the areas of health and education. As of 2018, the minimum

1 Such expenses are not subject to the limit imposed by the spending cap. However, they are only admitted meeting unpredictable, urgent, and relevant expenses.

mandatory federal expenditures in health were frozen at 15% of the Net Current Revenue (RCL) of 2017, updated by the inflation after twelve months. In practice, the actual increase in revenue does not need to be passed on to SUS. The result was a loss of R$37 billion of funding for SUS between 2018 and 2022[2], when the extraordinary funds were discounted to face the pandemic.

In relation to 2022, even after the recent fiscal maneuvers that added R$113 billion to the budget, CA 95 withdrew R$12.7 billion from SUS, making it impossible to meet structural and cyclical pressures on the system. The picture is even more acute in view of the growing transfer of the health budget to constitutional amendments, especially those of rapporteur.

After contributing to smoothen economic fluctuations in 2020 (with the suspension of tax rules), in 2021, the fiscal policy started to operate again procyclically, which was another factor that prevented the recovery of the economy, even in the face of recent changes. The current moment demonstrated the inadequacy of the fiscal framework. Given the growth in revenue, it would be possible to increase expenditure while maintaining the goal of primary surplus. However, this potential is "blocked" by the spending ceiling or cap, in a situation in which the per capita gross domestic product (GDP) is still at a level below that verified in 2013. Moreover, there is a resurgence of the social crisis, with an increase in inflation. To circumvent the tax restrictions, a new amendment to the spending cap was approved, restricted to 2022, enabling the expansion of benefits. The resumption of the spending cap in 2023, added to the end of exemptions from federal taxes on fuels, will produce a new fiscal contraction, which, together with the delayed effects of the monetary tightening cycle with the increase in the Selic, will have a negative impact on the economy.

Regarding the tax system, the evaluation is similar to that carried out for the fiscal framework, with strong structural disorganization and adoption of specific measures that may aggravate the situation. An example is PLP 18/2022, which aims to mitigate high domestic fuel prices, and should imply a strong drop in state revenue with ICMS, with impacts on the financing of public services, including health.

2 According to the value provided for in the LOA 2022.

Regarding indirect taxation, the direction of the proposal under discussion in the Senate is correct, providing for simplification of taxation on consumption by creating the Dual Value Added Tax (VAT) with a broad basis of incidence, destination taxation, and non-cumulativeness. However, the reform of indirect taxation should be complemented by an increase in the weight of direct taxes on income and equity.

The Income Tax (IR) proposal approved by the Chamber of Deputies provides for provisions that increase the progressiveness of the tax system and others that make it more regressive. Among the measures related to higher income taxation, it is worth mentioning: a) the end of the income tax exemption on the distribution of profits and dividends to individuals; b) the end of the deductibility of interest on equity.

Still, the proposal brings measures that point to greater regressivity of the system, such as: a) excessive reduction of taxation on companies from 35% to 26% (IRPJ + CSLL); b) maintenance of the rates of the Individual Income Tax (IRPF) chart; c) preservation of the exemption from income tax on profits and dividends distributed in several cases.

In addition to the issues of progressiveness, the text approved in the Chamber may impact the SUS, either due to the exemption of taxes levied on the HEIC (which would compensate for the drop in direct taxation) or due to tax losses for subnational entities.

Another relevant point is that, in the various legislative proposals on the tax issue, there is no measure related to the modification of tax expenditure on health. This expenditure is extremely regressive and has shown significant growth over the last few years, from R$21 billion in 2008 to R$56 billion in 2022, an increase of 167.1%, while the health budget showed growth of 32.1% in the same period. The Brazilian tax model imposes a cap (CA 95) on expenditure that has a distributive effect, but there is no limit to the expenses of the tax waiver, strongly concentrated on the higher income levels.

The Brazilian fiscal rigidity also generates substantive impasses to sanitary federalism, subtracting the State's capacity to promote the federal government balance in the provision of public health services. According to data from the Integrated Planning and Bud-

geting System (Siop) and the Public Health Budgeting Information System (Siops), the Union's share of public health expenditure fell from 58% in 2000 to 42% in 2019, which signals the incompatibility of the fiscal framework model with the sustainability of SUS.

The federal government has fiscal capacities much higher than those of subnational entities, which are dependent on tax collection to spend, especially indirect tax revenues (ICMS and ISS) and transfers of resources linked to social contributions, which also constitutes an obstacle to progressive tax reform. Therefore, the sustainability of the SUS requires a greater balance in funding the system, reversing the tendency to reduce the participation of the Union.

Currently, states and municipalities, respectively, are required to apply 12% and 15% of their tax revenues in public health actions and services, with a procyclical effect. The 2004-2013 period was marked by the real growth of health expenditures in states and municipalities, the opposite occurring between 2014 and 2016, a period in which there was a decrease in GDP. In addition, there is a strong correlation between health expenditures and revenue, in the face of a brutal disparity in the financial capacity of the entities.

The articulation between the expansion of the supply of services and the strengthening of its productive base, including from a local point of view, is also threatened by fiscal rules, which affect the State's purchasing power as a mechanism for productive induction and innovation, impacting industrial policy (Edquist et al., 2000; Elder; Georghiou, 2007). The context of technological delay and wide trade deficit reinforces the importance of using public instruments, establishing partnerships between the State and the private sector, focusing on structuring the productive base of health and reducing external dependence.

There is another potential threat to industrial induction capacity via public procurement across Brazil. In January 2020, the Brazilian government formalized its application to join the Government Procurement Agreement (GPA), which was implemented in October 2020. The first Brazilian offer was presented in February 2021 to the World Trade Organization (WTO), with a new offer in November of that year.

According to the newspaper Valor Econômico, which had access to restricted documents, it is noteworthy that: "Brazil faces demands to expand the access of foreign companies to the public procurement market in more states and sectors such as health (...)" (Moreira, 2021). When the adhesion to the GPA is confirmed, foreign companies may participate in bids on equal terms with domestic suppliers, affecting the capacity of technological induction and productive development.

The article aimed at pointing to the dismantling of the structure of state action instruments, related to the tax regime, tax system, and public acquisitions. The reconstruction of such instruments is central to a development strategy that combines productive and technological changes within the HEIC and the guarantee of the right to health.

Public Policy Propositions

It is urgent to resume the development project focused on social demands, which has the expansion of public provision of social services as one of its purposes. Therefore, it is essential to strengthen the productive base for the provision of services. Thus, we will discuss proposals to expand the fiscal capacities of the Brazilian State, so that it can respond to the structural challenges of guaranteeing the right to health and the consolidation of the HEIC.

Our proposal refers to changes in the fiscal framework, giving fiscal policy the role of stabilizing the economy and enabling structuring expenses, but also in the tax system, in the sense of greater progressiveness, and in budgetary management.

After the 2008 financial crisis, the so-called second-generation tax rules (Eyraud et al., 2018) began to be adopted and defended, which are based on some **fundamental principles**, among which it is worth mentioning:

a) **the reduction of the procyclical character**, with the government acting in the opposite direction to that of families and companies, especially when there is a retraction of the private sector and the need for more effective action by the public sector to avoid a worsening of the economic situation;

b) **greater flexibility**, with the provision of escape clauses for atypical situations, such as low growth and high unemployment, never leaving fiscal policy inflexible for long periods;

c) guarantee of transparency mechanisms, so that the society can know the tax situation.

To these guidelines, the use of fiscal policy should be added to:

d) respond to structural challenges, especially those capable of guaranteeing the right to health and the productive densification of the HEIC, so that the expansion of the supply of health services is accompanied by the reduction of external dependence on the sector;

e) induce expenses with strong multiplier and redistributive effects, so that the budgetary classifications express not only the accounting effect of the expenses, but their potential impacts in economic, social, and environmental terms, in order to apply tax restrictions in a differentiated way.

The adoption of the principles and guidelines mentioned above would reverse the current process, in which top-down fiscal anchors (Orszag; Rubin; Stiglitz, 2021) predetermine limits, affecting expenses almost indiscriminately. Instead, the process of preparing the public budget would start from the goals related to agendas such as the HEIC for the definition of fiscal limits. Such limits must be compatible with scenarios of non-explosive trajectories of the mid-term debt-to-GDP ratio, to which the emphasis on expenses with strong multiplier effects contributes.

The changes in fiscal rules towards the principles already outlined should be combined with new rules for the minimum application in public health, aiming at expanding access and equalizing the supply of services in the territory. Instead of a declining floor as a proportion of the RCL (CA 95), a mandatory minimum formula that points to the achievement of a federal per capita value compatible with the universality and comprehensiveness of the SUS is proposed.

The values applied in health would be updated by inflation, by the growth of the elderly population (proxy for the demographic transition) and by a factor of correction of inequities created from structural elements that imply other pressures on the SUS, such as: epidemiological transition; incorporation of technologies; coverage of care gaps; advancement of coverage in primary care; reduction of supply bottlenecks in medium and high complexity specialties; greater balance between public and private spending on health and between the supply of public and private ICU beds, considering the territorial variable, and the reduction of the productive and technological vulnerability of the SUS. The formula would allow for the construction of a floor with the growth of resources and greater stability in the face of economic crises.

In the simulations carried out by Dweck, Moretti, and Melo (2022), we highlight two

initial possibilities for the inequality correction factor in order to compare their fiscal impacts between 2023 and 2032. In a first simulation, we considered that the values applied in health[3] would be updated, in addition to the inflation of the previous year (IPCA) and the growth of the elderly population, by a factor of correction of inequities between the supply of services in the public and private networks corresponding to half of the average annual real growth of tax expenditures on medical expenses in the IRPF between 2004 and 2019, that is, 2.25%. In this case, federal public spending on health would increase from 1.6% of GDP (or 14.2% of the RCL) in 2022 to 2.1% of GDP in 2032[4], or 19% of the RCL. If the current percentages of health spending of subnational and private entities[5] are maintained, public spending on health would represent 4.4% of GDP, reducing the difference in relation to private spending on health to 5.4% of GDP, according to data from Conta SHA.[6]

Alternatively, we estimate the effect of another inequality correction factor corresponding to half of the average annual real growth rate of federal tax expenditures on health plans in the IRPF, between 2004 and 2018, that is, 3.4%. In this case, federal health expenditure would reach 2.4% of GDP in 2032, or 21.3% of the RCL. As a proportion of GDP, health expenditure would evolve 0.8 p.p. compared to 2022. Total public spending in relation to GDP with health, assuming the maintenance of the participation of sub-national entities, would reach 5% of GDP, almost equaling private spending. A greater acceleration in the growth of federal expenditures, possibly combined with an increase in the percentage of GDP spent by sub-national entities, would allow for a higher level of public spending than private spending, as observed in other countries with universal systems.

To demonstrate the importance of a rule such as the one we proposed, Graph 1 shows a counterfactual exercise of estimating the real evolution of federal expenditures per capita

3 For the year 2022, the value applied in health was considered as stated in the LOA 2022.

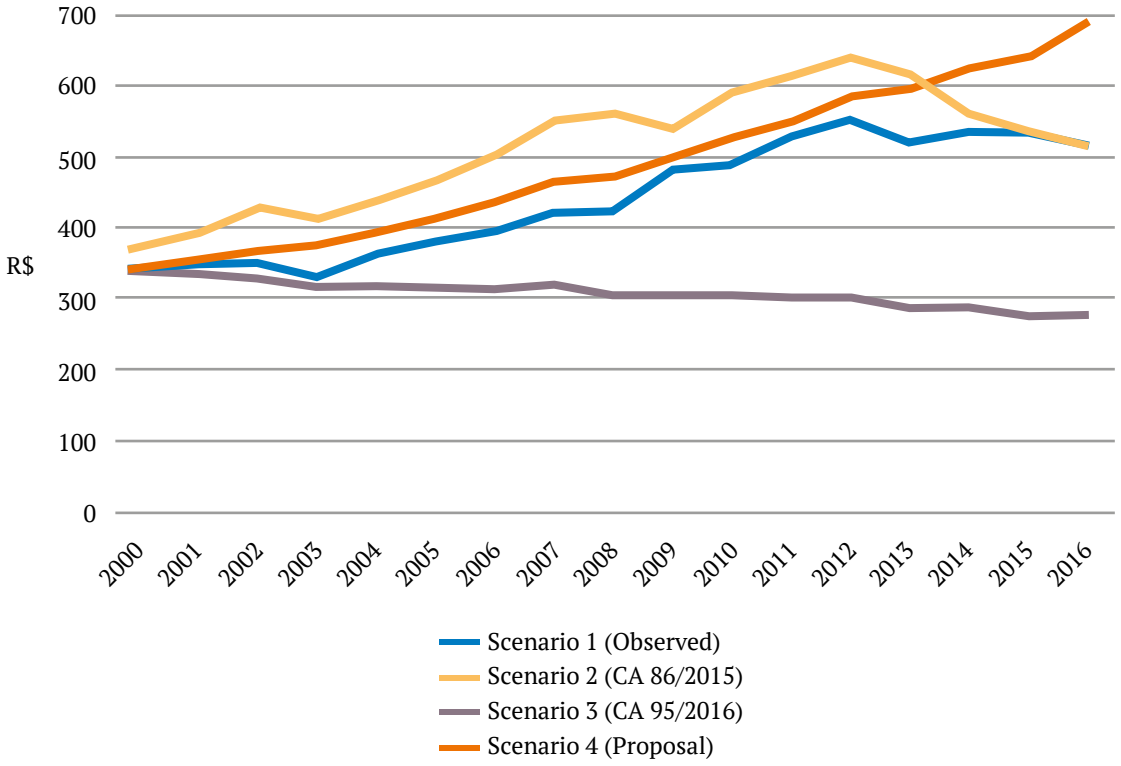
4 All scenarios consider the average nominal GDP growth rate of 6.2%, forecast by the Independent Tax Institution for the period 2025-2031, with a view to defining 2032 GDP. In addition, it is hypothesized that the growth of the RCL follows the nominal GDP.

5 In 2019, subnational entities applied 2.3% of GDP in public health actions and services, according to Siops data.

6 Available on: https://www.ipea.gov.br/portal/images/stories/PDFs/livros/livros/220202_livro_contas_de_saude.pdf.

in Brazilian public health spending (ASPS) in the period from 2000 to 2016, in four scenarios: Scenario 1) values applied according to CA 29[7]; Scenario 2) values applied according to CA 86[8] - 15% of RCL; Scenario 3) values applied according to the floor of CA 95, which froze the mandatory minimum health expenditure[9] in 2017, and Scenario 4) values applied according to the first proposal shown above: IPCA + average annual growth of the elderly population + 2.25% (inequity correction factor).

Graph 1. Estimate of federal per capita values in health (ASPS) 2000-2016 - (R$/ inhabitant, at 2016 prices*)



Source: Siop, STN, IBGE. * Average IPCA. Prepared by the authors.

7 CA 29, approved in 2000 and regulated in 2012, established a minimum contribution of resources from the three spheres of government in ASPS funding. The correction of federal minimum values was linked to nominal GDP variation. On the other hand, states and municipalities should apply at least 12% and 15%, respectively, of tax revenue, a rule still in force for subnational entities.

8 CA 86 was approved in 2015 replacing the criterion of CA/29, by establishing that the calculation basis for the application of resources by the federal government would be given by the Net Current Revenue (RCL), which would occur gradually in 5 years. Thus, for the first year following the enactment of the CA 86, the basis for calculating the application of resources by the federal government would correspond to 13.2% of the RCL. In five years, the percentage would rise to 15%, which would be applied from 2020.

9 For the purpose of the simulation, we consider, in the "CA 95" scenario, that the mandatory minimum expenditure would be frozen in the amount applied in 2000.

The indexed floor to a per capita value would mitigate the procyclicality of fiscal rules, ensuring the stability of SUS funding, even when the economic activity slows down. Floor rules linked to GDP and revenue can enable SUS funding at the time of activity discharge but will tend to reduce per capita health expenditure in the crisis when there is more demand for public network.

In the spirit of Keynes' capital budget, without reproducing the dichotomies between current expenditures and investments, the decisive thing to do is to apply more flexible rules to expenditures capable of stabilizing the economy (Seccareccia, 2014) and inducing the construction of a robust material basis for the provision of public services.

In this context, a budget management organized by agendas that express structuring challenges of the Brazilian society is proposed. In particular, the HEIC budget, with objectives and goals provided for in the budget guideline law, and which would contain headings aimed at structuring the material basis of the SUS, such as support for official laboratories, the use of state purchasing power, and the promotion of research. Thus, the increase in health expenditures would be combined with the strengthening of its productive base.

The HEIC budget would materialize the articulation of actions of several bodies, giving institutionality to the agenda. The budget values would act as a spending limit for the HEIC, expressing the planning of multiannual actions.

To support the proposal, it is essential to relate it to an adequate funding regime. The adoption of fiscal rules that reconcile the funding of strategic expenditures and fiscal sustainability requires a reform that broadens direct taxation, bringing Brazil closer to the countries of the Organization for Economic Cooperation and Development (OECD). Thus, it is possible to mitigate the fiscal impact of spending growth and add efforts to reduce inequalities, both on the expenditure and revenue side. It is also essential to ensure the distribution of resources from the exploration of the pre-salt oil to enable the new spending rules, avoiding the approval of a proposal underway by the National Congress that disconnects revenues from the oil surplus from the sharing regime, which should surpass R$300 billion at 2021 prices.

At times of low economic cycle, the preservation of SUS expenses – compatible with an acyclic application floor – and the HEIC budget would be made possible by debt issuance. Thus, it is ensured that credit operations are used to finance strategic expenditures, capable of working as automatic stabilizers and instruments to smoothen economic fluctuations.

Not only does the HEIC budget foster productive and technological development in the health sector, which represents almost 10% of GDP, but the services under the SUS are intensive in generating income and formal jobs. In addition, a growth pattern based on government consumption and public social services can be decisive, not only economically and socially, but also regarding environmental sustainability (Kerstenetzky, 2016).

The reasoning behind this involves the recovery and the elaboration of state instruments, especially in the tax and fiscal domain, capable of rebuilding capacities necessary for an inclusive development and growth project, articulating the strengthening of the productive and technological base and the guarantee of social rights.

The proposal for a new fiscal institutionality was presented under a logic that integrates more flexible fiscal rules, a federal health application floor that allows for the growth and stability of spending, a more progressive tax system, and inductive budgetary management of expenditure with multiplier and redistributive effects. The combination of these changes would give the government instruments of action to coordinate a development project marked by inclusive and sustainable economic growth, in which health would have a central role.

Health must be a motor for the recovery of the economy in the short term and be a channel of structural transformations, through the expansion and equalization of the supply of services in the territory, combined with the intensification of its productive base. Therefore, it cannot only be represented as a public expenditure with an impact on fiscal indicators, but as an opportunity to reconcile economic, social, and environmental changes and face the structuring challenges of the Brazilian society.

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The Health Economic-Industrial Complex: a Strategic Basis for Generating Good Jobs

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Between 2015 and 2022, Brazil faced a succession of high-intensity crises that deeply affected the economic, political, and social aspects of the country[1]. After a drop of about 7% in GDP between 2015 and 2016, there was an unsteady resumption of economic activity, representing the longest post-recession recovery cycle ever recorded in the country's turbulent economic history[2]. As a result, the industrial sector, which had been losing strength since the late 1980s, dropped to about 10% of GDP (the worst result since the beginning of the series in 1947), and the labor market quickly disrupted, reaching open unemployment rates permanently above 10%, with more than half of the workers without formal jobs and about ¼ of them working as self-employed.

It does not seem exaggerated to say that the neoliberal adventure – which began in 2015 and gave way to a sequence of institutional reforms with regressive and conservative nature – reveals itself as an inflection of the productive and social structure of the country. This is not the result of an incident or exclusively of exogenous shocks, but of a systematic set of policies of orthodox inspiration whose objective was to deconstruct the Brazilian Social State, which, besides difficulties and incompleteness, has been developed since the 1988 Constitution.

Faced with this scenario of broad regression, it is increasingly evident among different segments of the Brazilian society that the necessary reconstruction of the nation and the resumption of a sustainable development program will necessarily involve the reconstitution of the economic fabric, notably through a set of strategies that put in place a process of reindustrialization of the country.

1 Recession caused by orthodox economic policy (2015-2016); political crisis associated with the impeachment process (2016); dismantling of the bases of the social protection system through legal reforms (2016 tax reform; 2017 labor reform; 2019 pension reform); approval of the autonomy of the Brazilian Central Bank; strong cut of expenses in public investments; Covid-19 health crisis (2020-2021); war in Ukraine (2022).

2 It should be noted that in the first quarter of 2022, the Brazilian gross domestic product (GDP) was still 1.7% below the highest point in the historical GDP series, recorded in the first quarter of 2014. (See IBGE, 2022). Available on: https://bit.ly/3tgFyiS

However, for a number of reasons[3], it will be a herculean task that will require a great effort of political coordination, planning, and articulation between institutional, social, and business actors around a few key economic sectors, which must meet at least the following attributes: (1) good conditions of competitiveness to face international competition; (2) capacity to generate jobs of quality in large quantities; (3) potential to induce national scientific and technological development – notably of Industry 4.0 technologies; (4) capacity to help reverse regional inequalities; and (5) productive parameters converging to the goals of ecological transition and conversion of the Brazilian economy to a low carbon pattern.

Unfortunately, for those who pay careful attention to the Brazilian reality at the beginning of the third decade of the 21st century, it will be clear that there are few economic activity sectors that gather those attributes and that, therefore, could be raised to the status of a platform for the process of reindustrialization of the country. Faced with the flagrant scarcity of alternatives, the Health Economic-Industrial Complex (HEIC) emerges as "a winner", as the most evident and certainly the most meritorious and promising sector of activity to be embraced by a new cycle of national development, perhaps now guided not only by economic metrics but, above all, by the possibilities of social and cultural progress, as conceptualized by Celso Furtado and for which he fought.

Recent Dynamics of HEIC Occupations

From the perspective that the HEIC should be one of the pillars of the country's reindustrialization, we are dedicated to analyzing in particular one of the five attributes mentioned, namely the capacity to generate quality jobs in large quantities[4]. Therefore, we resort to some facts related to the dynamics of the HEIC labor market in the period between 2012 and 2019 (see Summary Chart).

3 Among others, we can mention the obsolescence of the Brazilian industrial park; the external environment stimulated by high-intensity commercial clashes; the dependence and relative technological delay that marks most segments of the national industry; the scarcity of long-term funding instruments; the unfavorable macroeconomic environment, with interest rates often among the highest in the world, an extremely volatile and almost always overvalued exchange rate.

4 The other attributes mentioned here and their relations with the HEIC are partially or fully dealt with in other articles of this same series of studies.

At first glance, the data that draw attention to the HEIC labor market is its size. Considering the group of people directly employed in the HEIC, which we call the "comprehensive category" (see categorization criterion in Figure 1), in 2019, there were 8,692,583 people working in the HEIC, which corresponds to 9.2% of the total number of people with occupation in the country that year (see Summary Chart)[5]. In the group that we categorized as "restricted" and that, in a way, corresponds to more nuclear activities of the health complex, a total of 6,792,495 workers (7.2% of the total with occupation in the country) was observed that same year.

Figure 1: HEIC's Labor Market Categorization Criterion

Source: Cesit/IE/Unicamp

In addition, the trajectories of these groups observed between 2012 and 2019 are as important as or even more relevant than the absolute and relative dimensions of these groups of HEIC workers in the Brazilian labor market. Despite the pronounced fluctu-

5 It is important to note that, according to the calculation of the HEIC multiplier effects on production, employment, and income in Brazil (Teixeira, Rossi and David; 2021), it is possible to consider that for each direct job existing in the HEIC, there are about 1.5 indirect jobs in activities "outside the HEIC" (Non-HEIC), whose dynamism depends, at least in part, on the expenses incurred in the HEIC.

ations that marked the economy in that period, the total number of people employed in the HEIC, both in the comprehensive and restricted categorization, continued to grow uninterrupted, having even jumped 12.6% (comprehensive) and 7% (restricted) between 2014 and 2016. Among those employed outside the HEIC (which we here call the non-HEIC set), there was a 2% contraction in the same time interval. That is, even at a time of acute recession, strong shrinking of the labor market, and also considering the incidence of a wide set of technological innovations associated with industry 4.0 that are labor-saving, the HEIC responded in a very positive way to the maintenance and expansion of jobs, revealing its remarkable quality both to serve as a buffer in relation to the level drops of economic activity and to compensate for possible eliminations of jobs due to new technologies in other activities of the complex that are now being stimulated.

When we consider the entire period in question (2012 to 2019), those employed in the HEIC grew very significantly, registering in only seven years a growth of 35.3% in the restricted categorization and 33.9% in the comprehensive categorization, while those employed classified as non-HEIC advanced only 3.9%, a pace not only much more modest, but much lower than the growth of the workforce (people aged 14 years or more), whose growth reached 10.4% between 2012 and 2019[6].

Following the analysis of the data shown in the Summary Chart, it should be noted that, in particular with regard to the regional distribution of the HEIC workers (from now on, we will always be considering the comprehensive categorization), we see the same thing occurring with the total number of people with occupation in the Brazilian labor market, that is: in 2019, there was a large concentration of professionals working in the two richest regions of the country, with about 2/3 circumscribed to the Southeast (51.2%) and South (15.1%) regions, while the remaining 1/3 of those with occupations was distributed between the Northeast (19.8%) Central-West (8.5%), and North (5.3) regions[7].

6 On workforce growth, see Quarterly Continuous PNAD (IBGE, 2022); Available on: https://bit.ly/2B4Nhrx

7 For a more in-depth study on the regional distribution of the main occupations of the health sector in Brazil, see Santos, Manzano and Krein (2021), available on: https://bit.ly/3NOwhqm

In relation to labor income, the professionals linked to the HEIC clearly show a better wage distribution, registering higher participation percentages in the higher salary ranges when compared to the situation of those employed in the non-HEIC group. If we analyze the year 2019, we see that there was a higher concentration of HEIC employees in the income range above 5 minimum wages (15.2% against 12.1% of non-HEIC) and a lower concentration of them in the lower salary range, up to 2 minimum wages (50% of those employed in the HEIC against 56.9% of non-HEIC).

Turning to the analysis of the distribution of those employed by sex, the distinction between the grouping of those with occupation in the HEIC in relation to other workers in the country (non-HEIC) is remarkable. Not only do women account for almost 2/3 of the occupations in the HEIC (66.3% against 33.7% of male workers), but the situation is practically reversed when contrasted with the gender distribution of the workers in the non-HEIC group (40.8% of women against 59.2% of men).

SUMMARY CHART. Workers in the HEIC x Non-HEIC by region, income, sex, legal classification, and working hours (Brazil, selected years)

Category		2012	2014	2016	2019
Workers in the HEIC *		6.491.424	7.431.940	7.952.495	8.692.583
Workers outside the HEIC (Non-HEIC)*		82.741.589	84.513.227	82.823.849	85.949.744
Working population		89.233.013	91.945.167	90.776.344	94.642.327
	Region	2012	2014	2016	2019
HEIC	North	5,5%	5,5%	5,4%	5,3%
	Northeast	19,1%	19,5%	19,3%	19,8%
	Southeast	52,9%	52,2%	51,9%	51,2%
	South	15,1%	14,9%	15,2%	15,1%
	Central-West	7,4%	7,9%	8,2%	8,5%
	Income	2012	2014	2016	2019
HEIC	Up to 2 MW	50,3%	48,4%	49,8%	50,0%
	More than 2 up to 5 MW	32,2%	34,1%	33,8%	34,8%
	More than 5 MW	17,6%	17,6%	16,4%	15,1%
Non-HEIC	Up to 2 MW	56,9%	54,8%	56,6%	56,9%
	More than 2 up to 5 MW	30,6%	32,3%	31,2%	31,0%
	More than 5 MW	12,5%	12,9%	12,2%	12,1%
	Gender	2012	2014	2016	2019
HEIC	Men	34,7%	34,1%	33,6%	33,7%
	Women	65,3%	65,9%	66,4%	66,3%
Non-HEIC	Men	60,2%	59,6%	59,0%	59,2%
	Women	39,8%	40,4%	41,0%	40,8%
	Legal Classification**	2012	2014	2016	2019
HEIC	Public sector	30,3%	29,1%	28,5%	27,6%
	State-owned company	3,0%	2,8%	3,1%	2,9%
	Public Sector + state-owned cos	33,3%	32,0%	31,7%	30,5%
	Private company	43,5%	44,9%	45,3%	47,3%
	Non-Profit entities	21,6%	21,6%	21,5%	20,9%
	Individual/other legal entities	1,7%	1,6%	1,5%	1,3%
Non-HEIC	Public sector	18,7%	19,0%	19,4%	18,8%
	State-owned company	1,6%	1,6%	1,6%	1,5%
	Private company	72,7%	72,5%	71,5%	72,6%
	Non-Profit entities	4,9%	4,8%	5,1%	4,8%
	Individual/other legal entities	2,1%	2,1%	2,4%	2,4%
	Working hours	2012	2014	2016	2019
HEIC	Up to 20 hours	6,4%	6,2%	6,1%	6,2%
	More than 20 to 40 hours	45,7%	46,6%	48,0%	48,9%
	More than 40 hours	47,9%	47,2%	45,9%	44,8%
Non-HEIC	Up to 20 hours	3,2%	3,2%	3,4%	4,1%
	More than 20 to 40 hours	24,3%	25,2%	26,5%	27,4%
	More than 40 hours	72,5%	71,6%	70,2%	68,5%

Source: Microdados PNADC/IBGE. Source: Cesit/IE/Unicamp

(*) The set "Working in the HEIC" corresponds to the comprehensive categorization.

Considering that the sexual inequality of the Brazilian labor market is a historical and structural problem that explains a substantial part of the country's social inequalities, this particularity of the HEIC must be clearly emphasized, since, due to the qualitative difference in their jobs, it results in significant improvements in terms of wages and the size of the average working hours per week, thus contributing to reduce the multiple facets of inequality that characterize the national labor market.

Regarding the average time of working hours, as can also be seen in the data of the Synthesis Chart, there is a considerable difference between those employed in the HEIC in relation to those who are in the non-HEIC group, especially with regard to the concentration of workers with working hours equal to or greater than 40 hours per week. In 2019, while in the set of the working population in the HEIC this contingent corresponded to 44.8%, among workers linked to non-HEIC occupations, this percentage reached 68.5%, a significant difference of 23.7 percentage points.

Another important distinction that can be seen in the comparison between the HEIC workers and others (non-HEIC) concerns the distribution of those employed by the legal nature of the institution with which they maintain their employment relationship[8], that is, whether they are public employees, work in state-owned or private companies, are related to non-profit entities or, even, whether they are self-employed.

Given the importance and scope of the Unified Health System (SUS) in Brazil – which is the only accessible health service for approximately 75% of the population[9] – in 2019, the proportion of HEIC workers in jobs related to the public sector was significantly higher than that observed for workers in the non-HEIC segment, respectively 27.6% versus 18.8%. On the other hand, in the same year, the amount of those working in private companies reached 72.6% in the non-HEIC segment, compared to a significantly smaller contingent of 47.3% in the group of HEIC workers. It should be noted that a significant part of this difference is explained by the relatively high percentage

8 It is important to note that all these are based on RAIS (MTP) and that are marked in the Summary Chart with " ** " correspond to occupations of the formal labor market.

9 See Dados Gerais da Agência Nacional de Saúde Suplementar (2022), available on: https://bit.ly/3xLSArd

of HEIC workers related to non-profit entities, which corresponded to 20.9% of the total in 2019.

Still in this regard, the analysis of the evolution of those employed in the HEIC over the period points to a trend of retraction in the participation of workers linked to the public sector, with a decrease of 2.7 percentage points between 2012 and 2019, while, in the same period, those employed in private companies increased their participation by 3.8 percentage points[10]. At first, this trend of change in the composition of the workforce in favor of private services may be related to two important processes that can be observed in the country in recent years and that somehow have supplied each other: the underfunding of public health caused by fiscal austerity policies and deepened by the approval of the "spending ceiling"[11] (see chapter 10) and the important advance of the funding and internationalization of the sector (see chapters 5 and 6).

International Context and Changes in Technological Bases

Several international studies describe the processes of intense transformation that have advanced in other countries and point to the probable quantitative and qualitative impacts derived from the new technological revolution, called Industry 4.0, in the world of work in the health sector. These transformations already affect profoundly the production and supply of goods and services in the Health Economic-Industrial Complex, with intense and differentiated repercussions on the processes of creation, destruction, and transformation of jobs, which should result in positive or negative effects, depending on how each nation articulates or integrates with this wave of intense transformations. Along with the Industry 4.0 revolution, it is expected that the redesign movements of global value chains will advance, which should also be reflected in the reconfiguration of the international division of labor in the health sector, with possibilities to expand or reduce the immense international asymmetries (financial, productive, technological, and

10 See Santos, Manzano, and Krein (2021).

11 According to Aquila Mendes, a professor at the School of Public Health of the University of São Paulo (USP), between 2018 and 2022, SUS did not receive R$37 billion due to the limits established by the Constitutional Amendment No. 95 ("Expenditure Ceiling Law"), approved in December 2016 (see https://bit.ly/3beOjUj).

social and that affect the world of work) in the different productive systems directly or indirectly related to the health sector.

All these changes require a broader and deeper understanding of the main (international and national) determinants of the dynamics of work in the HEIC, especially the HEIC 4.0 and SUS in Brazil. Recent studies have shown that several countries, especially the richest and most developed ones, have been investing human, technological, and financial resources in research and innovation activities that guarantee them the leading role in this technological frontier associated with Industry 4.0 for a long time.

The analysis of the relationship between technology and work and its consequences on the future reveal a huge set of transformations that are already affecting and that will probably affect the HEIC in Brazil even more intensely in the coming years. If, on the one hand, there is already very tangible evidence that allows us to foresee the elimination of a wide range of jobs related to the health sector as a result of the advance of technologies 4.0, on the other hand, the needs to expand quality access to health, the tendency to increase the life expectancy of the population, the increase in the costs of health procedures as new technologies are incorporated, the expected increase in national per capita income, and the desirable consolidation of the SUS with a public and universal character are important movements that may counteract, perhaps with a positive net result, those labor force-saving effects.

Thus, depending on the responsiveness of each nation in particular to these profound technological transformations, a more or less virtuous result of redesigning the respective economic and industrial health complexes and, consequently, their internal labor markets should be consolidated (ILO, 2019). In this sense, the role of a broad set of public policies – social, scientific, technological, and economic –, the institutional design, the articulation between the public and private sectors and, also, the way of inserting the national economy in the global value chains (more or less concentrated on the production or consumption of health products and services) should be central elements in the inevitable reconfiguration of national health systems that is underway and that should deepen significantly in the medium term.

At the international level, in the health sector, the main innovations and technological advances of the industry 4.0 have been perceived in the incorporation of artificial intelligence (AI) technologies; 3D printing and bioprinting techniques; electronic health (ehealth) and m-health; genomics and proteomics, among others. Together, this cluster of very radical innovations is already affecting the organization of services, procedures and activities of health professionals, demanding new requirements for training, qualification and specialization of health professionals[12], as well as inducing a process of reorganization of work routines, either in the interpersonal relationship of health professionals, or in their relationship with new equipment and hardware and software infrastructures (ILO, 2018; METI, 2017).[13]

12 It should be noted that the new technologies have allowed to advance in the forms of personnel training itself, through simulation techniques, facilitating access to information, preventive diagnoses, and even encouraging patients to actively engage in monitoring their own health and in some treatment modalities (Dybczak. Przywara, 2010).

13 One of the most interesting aspects of the International Labor Organization (ILO) documents is the extensive description of important impacts of 4.0 technologies on jobs and working conditions in the health sector, which requires the ability of agile and flexible responses from various health services in an environment subject to permanent and profound transformations (ILO, 2018; HEEG Commission, 2016).

Proposition for Public Policies

By this brief analysis of the stylized facts related to the recent dynamics of the HEIC labor markets (in its restricted and comprehensive dimensions) and the contingent that we call here non-HEIC, it is possible to distinguish quantitative and qualitative aspects that reaffirm the strategic importance of this set of activities for a country's development project that has, among its central objectives, in addition to improving the living conditions of the entire Brazilian population through the expansion of health care, promoted the maintenance and creation of jobs qualitatively superior than the average of those that are in the vast majority of the segments of the Brazilian labor market.

The specificities of the jobs linked to the HEIC, either by the greater weight of ties with the public sector or in non-profit private law institutions, or by resilience in the face of cyclical fluctuations in the economy, or by the characteristics intrinsic to their occupations (higher incomes, more modest working hours, greater presence of female professionals), are a strong indication that the expansion of the HEIC is one of the rare opportunities for the country to reverse the already long deterioration of the labor market that has been observed since the recession of 2015-2016.

It is true that the challenges to advance the HEIC in Brazil are enormous, also because they depend on a remodeling of the national health system in favor of the public system and the recomposition of the SUS budget, strongly impacted by the austerity policies that have prevailed in the country in recent years, notably after the approval of the so-called "spending ceiling" or cap. It is also important to consider that the waves of intense technological transformations that affect the sector in the current block of history have the potential to quickly change the profile of the professionals who are necessary for the HEIC, which will require special attention in the articulation with the systems of training and professional qualification.

Finally, it is important to highlight that these effects of job creation and destruction tend to be quite different, depending on the specificities of each country, given the enormous asymmetry in terms of economic and social development, educational struc-

ture, financing pattern, and the ability to incorporate and produce innovation and technology. This set of characteristics, however, highlights other international asymmetries and constraints, as well as specificities and internal barriers that will also need to be faced so that the country can advance in this context of technological revolution and reorganization of the international division of labor.

Ultimately, the political, social, and ideological dimensions that modulate the country's relations with the central economies – increasingly with the transnational corporations that are headquartered in them – need to be brought to the forefront and, in this condition, be redirected so that SUS can advance and that the HEIC can be less dependent on external conditions and the interests of private corporations, as well as to establish a platform for economic, scientific, and technological development that results in consistent improvements in health care and, also, in a process of expanding opportunities for quality jobs for Brazilian workers.

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The HEIC 4.0 to Develop the SUS and Generate Good Jobs

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

Occupations and Public Policies in the Incorporation of New Technologies in the HEIC 4.0

The Health Economic-Industrial Complex (HEIC) is, at the same time, extremely capital- and labor-intensive. Simply put, it is a frontier space for the incorporation of machines, equipment, and systems characteristic of advanced manufacturing and new technologies 4.0 that, at the same time, expands the demand for an increasingly qualified workforce, by making health care and care for people, whose life expectancy at birth is increasing, broader and more sophisticated.

At the time of the bicentennial of the independence of Brazil, in the face of the current crisis and the permanence of structural traits of underdevelopment, strengthening the SUS and HEIC is key to implement social policies and benefits the Brazilian labor market, both due to the volume of occupations it houses and generates and due to the quality of activities, remuneration and the pattern of labor relations, in a historically disorganized labor market, with low qualifications, based on low wages.

Given this diagnosis, public policies for the HEIC should consider that it is a strategic complex for research and technological development in the 21st century, as well as for the generation of many good jobs. These characteristics are valid in other countries and, particularly, in Brazil because it is a continental country with a large population and has the Unified Health System (SUS) – the largest universal public health system in the world. In other words, Brazil has scales compatible with the requirements of complex productive sectors and an open field of superior health care for a population living with "diseases due to delays" and new pathologies characteristic of modern life.

But what could we do? HEIC 4.0 can – and should – be treated as a strategic space for the reindustrialization of the country at higher levels of absorption of technologies 4.0 in the industrial production base (see Chapters 1 and 5). This article highlights other actions that relate to competitive advantages in civil construction for health, the development of software, and occupational training necessary for health care under revolutionary and integrated technology and information bases.

The strong capacity to generate (good) jobs under the effects of the internationalization of the Brazilian economy, and particularly of the HEIC, with significant internalization of new technologies 4.0, has made occupations and provoked significant qualitative changes. There is a strong positive balance of occupations accompanied by changes in occupational content and skills required in the complex. Specifically, from primary health care to highly complex procedures, the creation and destruction of job positions and the transformation of the contents of each occupation, integrating new technologies and processes, are the focus of a radical movement of "creative destruction" within HEIC 4.0.

The General Problem and the "Potential Incidence of Technologies 4.0" on the HEIC occupations

Considering these characteristics, we sought to address the consequences of the incorporation of new technologies on the content of the HEIC occupations through the creation of the index Potential Incidence of Technologies 4.0 (IPT 4.0). It seeks to include the incidence, but also the potentiality, and therefore, the reality and what potentially can happen. The potential of the HEIC 4.0 to incorporate technologies and generate more jobs is generally subordinated to the consistency of a national development policy, the conditions of economic policy, industrial strategy, innovation policy, the penetration of financial interests, and the degree of internationalization, among others, in order to explore and encourage what is strong in the country and overcome what is limited and / or insufficient through public policies.

It is important to ask some questions, such as: what are (or will be) the occupations that will be replaced? Which ones will be created? Which ones will be displaced? Which will require new skills, new competencies or new tasks? In other words, the incorporation of technologies 4.0 in the HEIC occupations may have different effects on their contents, in the sense of fully replacing a certain occupation, or only part of its tasks, creating new ones, displacing some of them into the complex, requiring new skills and competencies for some occupations in the use of new technology tools.

In addition, it is necessary to think about a central characteristic of work in the area of

health services, as well as in the area of teaching and research, which is the issue of humanized work. This necessarily involves treating technology as a support for prevention, care, and humanized health care, and throughout the training courses (technical, higher, and graduate level), research, and knowledge production. In this sense, it can be considered that, unlike what occurs in several other sectors impacted by technological progress, most occupations related to health have considerable restrictions on the replacement of people with machines.

The creation of IPT 4.0[1] allowed us to measure and classify the incidence levels in each occupation and in the set of occupations, based on their technological content. The level of incidence was calculated from the variable "tasks", which is a relevant part of the characterization of the profile of occupations since it represents what people with different occupations do throughout their work routines. The tasks were analyzed and categorized based on a set of keywords associated with technologies 4.0, which could (or could not) characterize them. In the end, six levels, or categories, of IPT 4.0 were developed, based on the score of the set of HEIC occupations, namely: very high, high, medium-high, medium-low, low, and very low. The very high level represented a very high incidence of technologies 4.0, and the very low level represented the opposite extreme. At a later stage, the methodology was applied to the database of the Social Information Annual List (Rais).

The Potential Incidence of Technologies 4.0 in the HEIC Occupations

First, it is possible to see that 60% of health occupations will be highly affected by the technological transformations underway, since the distribution of the HEIC occupations in the IPT 4.0 categories is as follows: 5.2% are in the very high category; 20.3% in the high; 33.8% in the medium-high; 15.5% in the medium-low; 17.2% in the low; and 7.9% are in the very low.

Regarding the number people with occupation, it is clear that the two largest ranges in all years analyzed, between 2012 and 2019, are those with low incidence of technol-

1 For more details on the methodology developed, see Gimenez et al. (2022).

ogies 4.0 (between 35.4% and 36.7%) and medium-high (between 28.5% and 30.2%). The greatest variation was in the very high incidence range (+119.1%) – a result that suggests a trend of change in the Brazilian labor market based on the incidence of technologies 4.0 in sectors related to the HEIC, with a high capacity to generate formal jobs, even in times of economic crisis.

Among the occupations with very high IPT 4.0, the growth of some occupations stands out, as can be observed in Table 1. The following occupations are the most present ones: biomedical professional (from 29.7% to 60.6%); technician in the maintenance of medical and hospital equipment and instruments (from 14% to 12.3%); biotechnologist (from 13.8% to 7%); neurologist (from 8.5% to 5.1%); electronic equipment assembler (from 21.3% to 4.6%).

Table 1. Variation in the number and identification of the sector of those with occupations in the HEIC with very high IPT 4.0

Classification (%)	CBO (Brazilian Occupation Classification)	Absolute Variance (2012-2019)	Percentage variation (2012-2019)	Sector
1th	Hospital Management Technologist	+258	661,5%	Services
2nd	Biomedicine professional	+13.200	347,6%	Services
3rd	Bioengineer	+354	316,1%	Research and Teaching
4th	Technologist in biomedical systems	+414	257,1%	Services
5th	Geneticist	+79	246,9%	Services
6th	Equipment maintenance and medical and hospital instrument technicians	+1.656	92,7%	Production and Maintenance
7th	Researcher in human biology	+112	38,4%	Research and Teaching
8th	Neurologist	+339	31,2%	Services
9th	Technicians in biotherism	+70	14,4%	Research and Teaching
10th	Biotechnologist	+189	10,7%	Research and Teaching
11th	Radiotherapist	+9	7,7%	Services
12th	Bioengineering support technician	-10	-2,9%	Research and Teaching
13th	Geneticist	-3	-6,1%	Services
14th	Electronic equipment assembler (medical appliances)	-1.432	-52,5%	Production and Maintenance
Total		+15.235	119,1%	

Source: Prepared by the authors based on the Rais data

In a continental country, the results of the regional analysis of IPT 4.0 also stand out, since this information represents an essential aspect for the understanding of how such changes have occurred in the various Brazilian regions and reveal territorial inequalities related to employment in the HEIC. This heterogeneity needs to be known and considered for the formulation of public policies that are appropriate to each reality, promoting a pattern of development that favors greater equity.

Table 2. Distribution of those with occupations in the HEIC according to IPT ranges by region, 2019 (%)

Region	Very Low	Low	Medium-Low	Medium-High	High	Very High	Total
North	5,3	5,7	7,4	5,2	5,8	5,0	5,9
Northeast	23,4	20,7	24,3	19,4	21,2	21,0	21,2
Southeast	48,9	50,4	46,0	51,2	47,2	53,3	49,4
South	15,1	15,4	14,2	15,4	15,9	12,7	15,2
Center-West	7,3	7,8	8,1	8,8	9,9	8,0	8,4
Total	100	100	100	100	100	100	100

Source: Prepared by the authors based on the Rais data.

In general, it is possible to notice that the regions show different profiles in relation to the distribution of occupations among the various categories of IPT 4.0, with emphasis on the importance of the Southeast and the growth of the presence in the Northeast. Most of those occupied in all ranges are located in the Southeast region, especially in the very high and medium-high ranges. Next is the Northeast, revealing a strong presence in the median range. According to the technology incidence ranges, between 2012 and 2019, there was a greater increase in the Center-West (+41.4%) and a lower increase in the North (+16.3%). Except for the North, in the other regions, the largest increase is in the very high range, with emphasis on the Northeast (+288.7%), followed by the South (+174%) and Center-West (+138.1%). In the case of very high incidence occupations, the Southeast concentrates the largest number of occupations in almost all of them.

The sectoral distribution of the number of people with occupation, according to the IPT 4.0 level, reveals that most of them are in the service sector in all categories of incidence. This is a universe of 2.8 million occupations in 2019 that grew by almost 20% compared to 2012.

On the one hand, its strong presence in the very low (in which it is the only sector and whose increase is 4%), low, and medium-low categories stands out. On the other hand, on the other extreme, the sector is predominant in the very high category, in which its growth was 270.6% and there are no people with occupation in the sectors of trade, insurance and plans and care. This not only demonstrates the importance of the sector for the

HEIC, which should be considered the center and the ultimate purpose of the complex, but also its great complexity and diversity and its overflow to other sectors, whose role should be to ensure the operation of services and health care, with emphasis on the actions and public health services of the SUS.

Table 3. Variation in the number of people with occupation in the service sector by IPT 4.0 categories

IPT 4.0	2012	2019	Absolute variance (2012 a 2019)	Perc. Variance (2012 a 2019)
Very low	69.396	72.260	+2.864	4,1%
Low	991.354	1.185.444	+194.090	19,6%
Medium-low	487.100	601.481	+114.381	23,5%
Medium-high	572.122	612.381	+40.259	7,0%
High	236.950	261.454	+24.504	10,3%
Very high	5.284	19.580	+14.296	270,6%
Total	2.362.206	2.752.600	+390.394	17%

Source: Prepared by the authors based on the Rais data.

Observing the distribution of people with occupation in two selected sectors of activity with direct relation to health care, on the one hand, we can see the most traditional sector composed of the outpatient, hospital, diagnostic and therapeutic services, and health surveillance, among others, which require the presence of a professional trained in the health area and/or with specific training to work in the sector; on the other hand, a sector that presents a trend of quantitative growth and importance in the face of increased life expectancy, which is the category of caregivers, including the figure of the caregiver of the elderly, which does not require specific training. In this category, the total number of people with occupation is concentrated on the low incidence of technologies 4.0, despite their growth of almost +191%.

The incorporation of technologies 4.0 has the potential to affect transversally the occupations of the health complex but will mainly impact the occupations related to health services and care – directly changing the tasks of the employed in the sector, or indirectly promoting changes in the routine and in the goods and services derived from the work

of the employed in the other sectors of the HEIC. Therefore, the technologies 4.0 have the potential to substantially transform the way health promotion, prevention and care are carried out. For this reason, it is vital to build public policies that have the capacity to promote the strengthening of the SUS, with the goal of generating good quality jobs and aligned with the demands imposed by the technological changes underway.

Proposition of Public Policies

SUS strengthening by generating jobs of quality in the HEIC

It is necessary to strengthen the SUS by generating jobs of quality throughout the HEIC. Because of Brazil's dimension, only a robust public policy can face the bottleneck of the lack of professionals in the SUS, particularly those focused on the area of technology applied to health. It is a huge frontier of development, humanized health care at a higher level, in its various levels of complexity, integrating the community agent to highly complex procedures, with all intermediate levels. It also constitutes a frontier for generating good occupations with greater qualification. Such integration highlights the complexity of HEIC›s occupational structure and its permeable need to absorb the advances of a productive structure that promotes technologies 4.0.

To advance in this direction, it is fundamental to resume the economic growth and strengthen the productive structure, as a basis for quality services. As Celso Furtado mentioned, the idea of "consuming without producing" is not compatible with a democratic society. Without national production, citizenship rights will remain restricted to a select group, fragmenting and segmenting the Brazilian society. Health in the 21st century highlights the issue, as it is the synthesis of radical social, demographic, and technological changes. The SUS cannot be a simple consumer of products, but a space for the integration of a broad, developed, and technologically sophisticated productive structure, with universal and humanized health care at higher levels demanded by democratic ambitions in the country.

From the definition of this structuring axis, there are different fronts for the adoption of public policies. In order to point them out, specialists, teachers, managers, researchers, and technicians integrated into the HEIC in various institutions, including universities, research centers and public and private structures, were interviewed. Three fronts identified in the research stand out here. They have a robust capacity for job creation and professional training, with the integration of HEIC 4.0 from the absorption of technologies and productive development (Gimenez et al, 2022).

Hardware Production and Software Development to Make the SUS and HEIC More Digital

Brazil is one of the largest health information technology markets in the world, behind India and the United States. Currently, China has strong advantages in hardware but is not as competitive in the software area. Despite this, it is not possible to give up the national production of machinery and equipment for health. Certainly, a progressive strategy to expand the national technological content is essential to meet the gigantic material demands of the SUS. On the other hand, Brazil has a high-level national tradition and technology in health software. The certification system in Brazil is pioneering, even before the United States, which acts as a technical barrier that represents a very high entry cost for foreign companies to adapt.

It is noteworthy, in this issue, that 70% of Brazilian hospitals have electronic medical records, but only three foreign companies have entered Brazil, with very few clients. If the development of national production in hardware is an imperative, Brazil already has advantages to strengthen the medical software area, since the country has accumulated both institutional and quality certification competencies. The National Health Surveillance Agency (Anvisa) is an excellent manager of practices and approvals for technical resolutions, which constitutes an important technical and regulatory barrier to foreign companies. It is an asset both for the development of the national hardware industry and for software.

One should also consider the peculiarities of obsolescence in hardware and software. Software is easy to update, allowing smaller companies, driven by public policies, to enter the market with a national base. With qualified teams, versions are updated daily in the format of cloud-enabled "continuous delivery". In a peculiar way, they have low added value compared to the state-of-the-art equipment produced by companies such as Siemens, Philips, and General Electric. At the same time, software generates a lot of jobs, it is labor-intensive, a characteristic reinforced by a dynamic that transforms it from a "shelf product" into a highly qualified service. State-of-the-art health equipment, in turn, imposes high installation costs and requires complex maintenance. Together, it transforms into highly specialized production and services.

Specifically, the development of CONECTASUS and the National Health Data Network (RNDS), in particular, have become the center of a policy of "interoperability and barriers" of health actors and data. Exchanging information is necessary for the development of the sector, in order to build a pattern for heterogeneous solutions. For example, having all information integrated of an unconscious patient, it is possible to follow if they were transferred from an emergency room to an ICU, from one city to another.

RNDS in Brazil, inspired by Canada›s experience – Canada Health Infoway[2], which covers all provinces and 98% of Canadians, with all the necessary, interoperable data, anywhere in the country – can be a way to implement a developed e-health, at the international level, approved by the World Health Organization.

In summary, both the production and incorporation of hardware, as well as the development of the health software, are possible ways to generate many high-quality jobs, incorporate technologies, to make the SUS more digital and advances in the humanization of care.

Occupational Training to Combine 4.0 Technologies with Humanized Care

The advance in the first front unfolds in the demand for qualified professionals for humanized care. In advanced occupational training in health, the so-called "two-stage training" prevails. For example, in training in health-oriented architecture, young architects and health surveillance agents, Anvisa professionals, and architectural offices, in addition to a part of lay people, seek courses in hospital administration and public health management, which reveals the fragility in the primary training of professionals related to the knowledge and skills required in projects for the health system.

This type of "two-stage training", in general, illuminates the problems of vocational training for HEIC 4.0. The main issue is to harmonize complex requirements, which demands a necessarily interdisciplinary training, with a strong weight of actions in projects with practical content.

2 The Institution is an independent, not-for-profit organization funded by the federal government that works with governments, health care organizations, clinicians, and patients to make health care more digital in order to facilitate faster, more seamless, and secure manner. For more information, see: https://www.infoway-inforoute.ca/en/

The challenge required is to work in teams based on concrete projects that absorb new technologies, which poses the need for the professional to translate them into common language, to work as an interface, that is, an interdisciplinary specialist. The technology that penetrates the structure of production and health services requires, fundamentally new interdisciplinary skills from those who work in the field.

It is important to emphasize that the future of the university and knowledge is interdisciplinary and the HEIC 4.0 is on the frontier of this training. In training and research, it is a challenge for the scholastic and departmental unidisciplinary tradition and a challenge to advance in training that is not a sum of skills incorporated into tight structures, but that requires radical interdisciplinarity.

The HEIC 4.0 presents a strong limitation of professionals in the technical area trained to work with technologies. In addition to the limitations of technical education, few medical, nursing or dental schools are teaching technology for work in interdisciplinary activities, in which it is not necessary to be a software developer, but a qualified user, a "power user".

The difficulty in qualifying health professionals who are familiar with information technology and the new technologies 4.0 applied to health cannot be seen in isolation. The available technology must be considered but, first of all, it is essential to relate technological progress with the humanized form of health care. Towards the process of structuring a national health system, China, with all its technology dominion in hardware and software, created the "Barefoot Doctors", which have training that produces great impact on family care.

It is known that health care involves a high cost and becomes even more expensive in the absence of early diagnosis, which does not necessarily depend on high technology, but can be strengthened by it. When the diagnosis is late, the cost of the entire system is increased, and more technologies are required to meet radical cases. Hospital care in large structures is impotent and starts to demand high technology directed to the patient. Therefore, it is possible to think, in primary care, about the incorporation of new simple and advanced technologies in health, which humanize the care, directed to the citizen

who is not sick. These technologies can increase welfare and quality of life, being feasible for dissemination in the SUS, generating, since primary care, many qualified occupations. A model that is radically different from that of the patient is needed, in which medical care focuses on a client with great ability to pay for individual care.

Fundamentally, it is a matter of incorporating into public policies the importance of new technologies in the hands of the community health agent, the family doctor and the caregiver of the elderly, alongside a large-scale occupational training policy that enables them to deal with them.

Sophisticated Civil Construction to Meet the Health Needs of the Future

Another important front of public policies for the incorporation of technologies and job creation is civil construction for HEIC 4.0. Projects in the health area have a strong empirical basis, considering the complex use of equipment under the conditions of Brazilian development. In health, constructions are increasingly complex, both due to direct equipment – hospitals and basic units, as well as indirect equipment – laboratories and specialized medical care spaces.

It is a sector in which all activities are complex, including civil construction. Despite having the largest universal health system in the world, the construction industry for health is underdeveloped in Brazil, with a strong presence of foreign companies and imported products. One can mention the hospital flooring industry, sealing systems, aluminum frames, «smart glasses» that darken and lighten automatically and other specific ones for the examination rooms, composed of lead, among others. What is the point? Simpler products are produced in Brazil. The structure of the hospital (the foundation, beams, etc.) is served by national production. However, the fragility is «inside» the building, with technical requirements such as the maintenance of temperature to acoustic and nuclear insulation, among others.

Another challenge, object of public policy, refers to the preparation and execution of projects. Brazil has scales compatible with the requirements of complex productive sectors,

and the SUS demands many projects with excellent quality. The SUS has the capacity to identify its needs, but there are serious problems of inadequate public standards for procurement and bidding in relation to the complexity of civil construction in health.

While carrying out these projects, between the demand by the SUS, which knows where equipment and hospitals are needed, and the design and execution of the projects by the offices and hired companies, quality is lost. In projects subject to the Bidding Law and public procurement rules, in which a competition model based on the lowest price prevails, an office wins the bid and often does not complete the service because it does not have technical competence. The construction company earns to execute a project of great complexity and has no execution capacity. On the contrary, in general, in projects with international funding, quality requirements prevail in the project and execution by the funding agencies, which makes it possible to meet the complexity requirements of civil construction in health.

The HEIC 4.0, the Integration of SUS, and the Jobs of the Future

The current situation caused by the economic and social crisis aggravated by the Covid-19 pandemic, reveals the radical need for the country to advance in the integration of the HEIC, and more, of a HEIC 4.0 not governed by the free play of market forces, but as an expression of a national development project that reflects a virtuous public-private articulation, submitted to the logic of long-term national planning. The superior quality of the occupations derived from a HEIC 4.0 implies the reformulation of university curricula and technical education, directed to the incorporation of the new technical skills required by the new pattern, as well as by a sophisticated humanistic formation capable of building a worker, a development partner, aimed at valuing life.

At a time of strong crisis and restructuring of the world of work, the more progressive discussions about the future of work point to the possibilities of generating jobs aimed at caring for people and the environment. The development of HEIC 4.0 can – and should – be a space for generating the jobs of the future, while promoting the modernization of the SUS, education, research, productive structure, and services in the country.

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Sovereignty in Health to Guarantee Universal Access: the HEIC in Public Policy for the Society

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This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

An equitable society, committed to well-being and the environment, will only be possible with the existence of a national economic and material subsystem that supports it. The bitter lessons learned from the Covid-19 pandemic revealed the high costs of the insufficiency of the national (productive, technological and innovation) economic subsystem, as well as the need for a systemic approach to public policies that support the right to health in Brazil. The articulation of the economic system with the organization of the SUS is an essential element to guarantee the right to universal, democratic, integral, and equitable access to health.

This systemic and structuring perspective, developed at the Oswaldo Cruz Foundation (Fiocruz) more than two decades ago, guided the formulation of public policies for the development of the Health Economic-Industrial Complex (HEIC), overcoming paradigms that place the social, environmental and economic dimensions in separate or opposite fields. The Brazilian experience, anchored to the purchasing power of SUS and to the articulation of social policy with industrial and ST&I policy was a historical milestone in which social needs guided development strategies. It was possible to demonstrate that the participation of public institutions in partnerships with the private sector can induce investments and research for social objectives. Instead of being antagonistic to the objectives of universal access, the strategies for productive development in health showed an innovative path whose experience can – and should – be expanded and updated to the contemporary context.

Given the profound global transformations underway and the serious situation of economic and social regression of the country, the defense of life must be reinforced and assumed as a paradigm of public policy – the life of people and the planet. Building a democratic society that guarantees the universality of rights and protects the environment cannot be dissociated from the need to reindustrialize the economy and restructure the Brazilian State. A new generation of public policies that is able to guide the national economy to meet the demands of society is essential for the country to grow again by inserting itself in global processes guided by sovereignty, solidarity, and the right to life of different peoples and regions.

It is essential to discuss the relationship between the context of global and national economic and technological transformations and the experience of adopting the HEIC concept as a guiding perspective for public policies for health development. The structural vulnerability of the SUS and the attempts at articulated responses, which resulted in the creation of public policies and the maturation of new institutions and instruments, are addressed in this article to present proposals for future advances. The construction of institutions that guarantee a State policy for the development of the HEIC has the continuity, improvement, and consolidation of both norms and practices as a great challenge within a strategic vision towards universal access. The economic viability of well-being continues to face conceptual and political limits so that social demands lead the development strategy. This text aims to contribute to this text.

The Feasibility of Universal Access to Health in Brazil: The Structural Deficit And the Gateway to Health Development Policies

Brazil has been going through profound social, technological, and economic transformations that stress the state of social well-being and particularly the SUS. On the one hand, there is a strong dynamism and social impact derived from the conception and execution of a Universal System in a country with continental dimensions. On the other, it is necessary to recognize the restrictions imposed on the advance of this system, both for its historical and increasingly restrictive underfunding, and for the fragility of the material subsystem that sustains it.

The 1988 Constitution, by recognizing health as the right of everyone and the duty of the State, paved the way for the creation and development of the SUS with the Law No. 8080, 1990 (BRASIL, 1990). This was followed by the universalization of the access to public health, which was previously restricted to formal workers. Even with public investment below the average of other countries in which there are universal systems, the SUS guaranteed access with unprecedented comprehensiveness and scale, and made possible important institutional innovations in various policies in the health field.

From the 1990s, however, the Brazilian economy began to show a strong tendency to de-

nationalization, deindustrialization, and reprimarization, exacerbating the technological asymmetry and dependence on imports in the face of the movement of the global economy. Increased dependence translates into growing vulnerability in the supply of products.

In the health area, this process also occurred sharply in this period (GADELHA, 2003). Only in the area of pharmachemicals, between 1989 and 1999, more than 400 production units were paralyzed, which represented almost 40% of the total existing until then in the country (RADAELLI, 2012). This process has cooled down in the health segment. The consequence was an increasingly pronounced tendency to reprimarize the balance of trade in health. A significant portion of imported drugs were of low technological complexity and 83% of imported drugs in the late 1990s were also drugs with patents prior to 1977 (MAGALHÃES et al., 2003).

The country was not dependent and importing only new medicines from modern technologies, but also pharmaceutical inputs and basic medicines. The same was happening in routine equipment, medical devices, and medical consumables, with traditional and widely known technological routes, revealing the deepening of productive-technological dependence (GADELHA, 2003).

With the expansion of the SUS, the gap between the demand for medicines, supplies, and other health products increases and the necessary counterpart for the development of the national productive and technological subsystem of this sector has become even more pronounced. This high, growing, and widespread trade deficit in the health segment is an important indicator of economic and social vulnerability, which places the integrality of the health service at the mercy of unstable macroeconomic variables, such as those that recently occurred with the pandemic crisis.[1]

The question that arises is how to alleviate the fragility of guaranteeing universal access to health in the face of the insufficiency of productive, technological, and innovation material

1 This structural vulnerability manifested itself in the pandemic as a restriction on the right to one's own life. The deficit deepened rapidly, from 15 billion to 20 billion dollars, which is equivalent to the level of a budget of the Ministry of Health, without generating employment, income, and taking advantage of the knowledge and innovation of Brazil (GADELHA, 2022).

base that sustains it. Understanding this imbalance was one of the main justifications used to introduce and prioritize health on the industrial policy agenda in the early 2000s.

Guaranteeing access to goods and services has become a need and opportunity for productive and technological development in the country. In this sense, the existence of a structural deficit of the balance of trade in the health area was one of the most used justifications for the development of a range of policies related to the material subsystem of this sector. And it was this advance of health on the agenda of industrial and innovation policies that led to the emergence of new actions, programs, and instruments to act in this imbalance.

Political and Institutional Developments and The Role of Health in Development Policies

In the 2000s, the incorporation of a perspective of structural and long-term transformation of the productive, economic, and social subsystems led to the emergence of strategies for State action that began to guide concrete policies for the development of the HEIC. The diverse experiences of productive and technological development policies and the institutionality created in this period have demonstrated that Brazil can build institutional, scientific, and productive capacity to aim for a less vulnerable position in relation to ensuring access to a universal health service of quality.

Since 2003, after two decades without mentioning the topic in public debates, industrial policies have emerged. Three development policies were designed and since the beginning health is recognized as a strategic field. The policies implemented were: Política Industrial, Tecnológica e de Comércio Exterior, PITCE (the Industrial, Technological and Foreign Trade Policy), Política de Desenvolvimento Produtivo, PDP (the Production Development Policy), and the Plano Brasil Maior, PBM (The Basil Maior Plan). The vision of national development, the favorable economic environment, the political support, as well as the performance of agents interested in industrial policy are among the main factors that enabled the resumption of an industrial policy agenda in which the development of the HEIC was inserted.

The formulation of PITCE in 2003 has led to the need for an industrial policy that guides development. It was a policy aimed at addressing structural problems of an economic nature and kept the economy and social policy in separate fields. PITCE was based on three pillars: productive modernization, innovation, and foreign trade. It was understood that it would not be possible to separate industrial and innovation policies, productive modernization, and foreign trade. It was an economic perspective that identified bottlenecks and instruments for state action.

It was during the formulation period of the PITCE that the Ministry of Health created the Secretaria de Ciência, Tecnologia e Insumos Estratégicos (the Secretariat of Science, Technology, and Strategic Inputs) (SCTIE) (BRASIL, 2003a), which becomes the main locus of action and coordination of the primary policies for the development of production and innovation in health. Over time, after gaining maturity and determining the scale of the policies developed, the Secretariat assumes the coordination of industrial policies in health and operates important instruments. The segment of pharmaceuticals and medicines was one of the four strategic options chosen as the focus of action of the policy (BRASIL, 2003b). The Ministry of Health played an important role in the association between the deficit of the balance of trade and the vulnerability of access to health, with emphasis on the creation of the first List of Strategic Products (BRASIL, 2008a) that linked the needs of the SUS with the mobilization of a broad set of public policies, involving from the use of purchasing power to funding, such as the Profarma Program within the BNDES.

The Production Development Policy, launched in the end of 2008, resumes the PITCE, expanding its scope, articulations, and goals and deepening how the structural issue in the health area is seen. The policy constituted a milestone when it ranked the economic sectors in three broad categories: areas that carried the future; productive sectors in which Brazil was competitive and sought to consolidate and expand leadership, and sectors where Brazil had lost competitiveness and needed to be strengthened. The Production Development Policy continues with a strong economic direction but improves the design of development policy from a structural perspective in defining priority areas. Its main goals were to increase the rate of investment and private spending in Research and Devel-

opment (R&D), increase the participation of Brazilian exports and boost Micro and Small Enterprises. The Health Industrial Complex was one of the five strategic areas selected.

In this context, the HEIC approach, which articulates health policy endogenously to industrial and ST&I policy, becomes the great reference to guide health development policy. One of the decisive factors for incorporating the vision of the HEIC in government policies was its inclusion as one of the strategic axes of the Planning of the Ministry of Health in the Mais Saúde Program, 2008-2011. In the PDP, institutional advances enabled the creation of the main governance structure of development policy in the health area, the Executive Group for the Health Industrial Complex (GECIS) (BRASIL, 2008b). GECIS was established as a political coordination body, which brought together ministries in the social, economic, and ST&I areas, the Office of the Chief of Staff, BNDES and FINEP, regulatory agencies, and Fiocruz, as well as a forum for articulation with the civil society. The Ministry of Health guided this industrial development policy (BRASIL, 2008c), coordinating GECIS and the first industrial public policy guided by national challenges and missions.

The Department of Industrial Complex and Innovation in Health (DECIIS), part of SCTIE (BRASIL, 2009), was also created in this period, aimed at acting in the development of the promotion of the material subsystem of health. For this, the General Coordination of Chemical and Biotechnological Base and the Coordination of Equipment and Materials for Health Use were created, making it possible to develop actions for the various segments of the HEIC in the department, following the theoretical approach developed (GADELHA, 2003). DECIIS, the first industrial policy institution within a ministry in the social area, played a significant role in the articulation of several actions and instruments in this area, among them, the first production development agreements that gave rise to the Partnerships for Production Development (PDP).

In an adverse international context, PBM began in 2011, seeking to foster innovation and the productive densification of the Brazilian industrial park, in addition to creating and strengthening critical competencies of the national economy. Despite the involution in the design of public policy, with the expansion of sectors and the loss of the hierar-

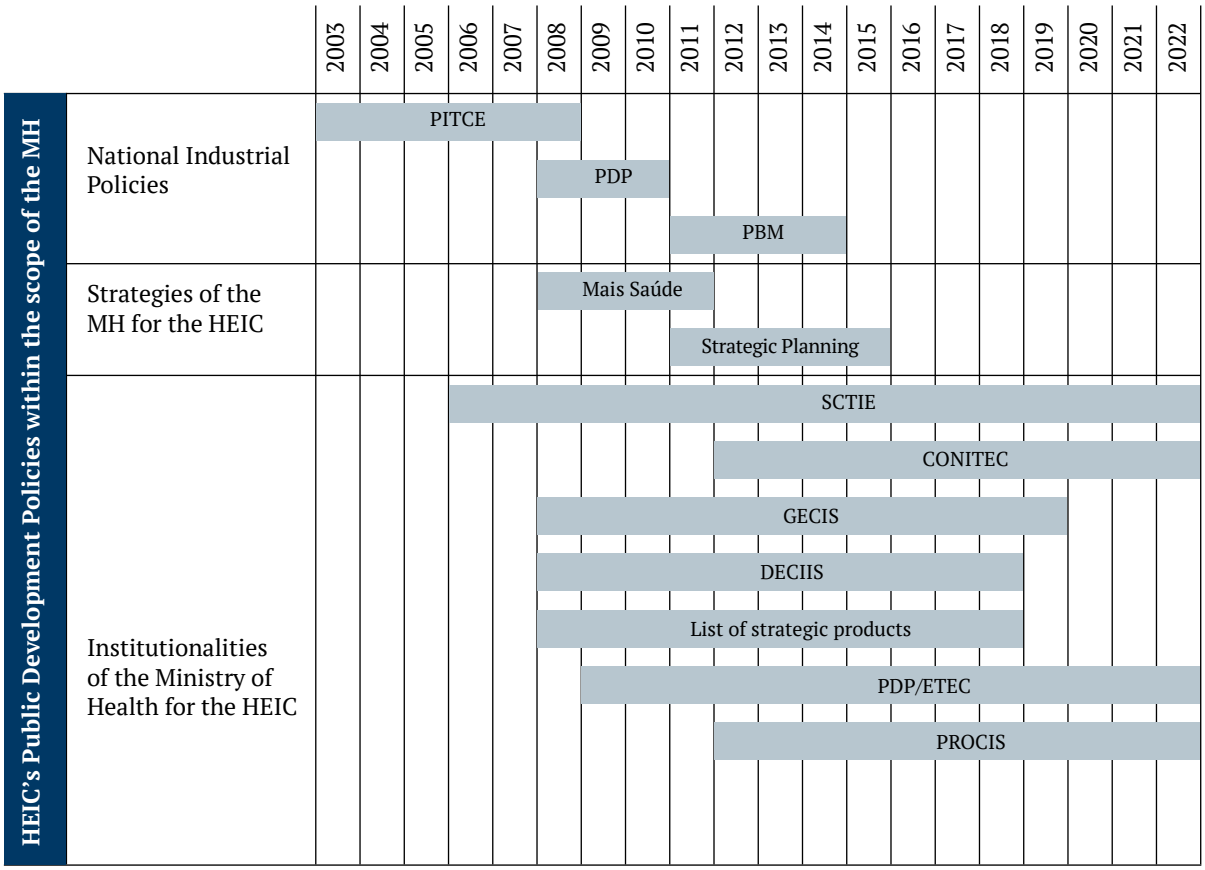
chy achieved by the Production Development Policy, a strategic action of the Ministry of Health preserved the institutionality of GECIS, maintaining the important governance structure built. The preservation of GECIS and its strengthening allowed the consolidation of the health development policy model that was underway. Thus, the governance structure became the most comprehensive and articulated industrial policy management initiative in Brazil (GADELHA and SAFATLE, 2022), marking an innovative experience in the country of a public policy guided by national challenges and missions.

Based on the PBM, the advance of institutional maturity in the Ministry of Health gave public policy a huge gain in scale and systemic articulation, reaching, as a more prominent example of this new perspective, the result of more than a hundred Partnerships for Production Development systemically agreed upon between public policy institutions and the productive sector. Thus, the policy for the HEIC, by articulating several instruments focused on the challenge of universal access, can be considered as the first mission-driven industrial and innovation policy in the social area (MAZZUCATO, 2021). In an unprecedented way, a ministry of the social area coordinated an industrial and innovation policy and brought together instances of public policy, recognizing that health is an area of high sensitivity, vulnerability, and opportunity for the productive and technological development of the country, responsible for promoting concrete measures and actions related to the health development strategy.

The industrial policy and the governance structure of the GECIS made it possible to develop coordinated and articulated actions and measures that transcended the regimental structure of the Ministry of Health, guaranteeing the potential for transformative state intervention. It was no coincidence that, with the end of the industrial policy that enabled all this guiding articulation in health, the State's capacity to act in this segment was gradually affected, with the institutionality within the Ministry of Health being compromised.

The table below summarizes the set of public strategies and policies presented as responsible for the development of the HEIC in Brazil and demonstrates the importance of the context of the resumption of industrial policies and the development vision in which the HEIC is supported.

Table 1. Public development policies for the HEIC within the Ministry of Health (MH)



Source: Prepared by the authors

The guarantee of universal, integral, and equitable access to health depends on ensuring the provision of the material subsystem that gives sustainability to this access (GADELHA and TEMPORÃO, 2018). And by transforming universal access into a national challenge, as in the course of industrial and innovation policies in the 2000s, it was possible to develop structuring actions for the development of the productive and innovation system of the health sector with systemic impacts on society and the Brazilian economy.

For this, it was necessary to strengthen and empower the State to act from these great challenges to mobilize the set of necessary elements. This articulation is extremely difficult, because at several times these elements are not fully aligned. For this reason, the emerging institutionality in this historical process must be thought in terms of trajectory (rhythm and direction), limits, and opportunities and institutional maturation.

Broad Strands of Public Policy to Consolidate the HEIC as a National Strategy Option

The understanding that productive and technological dependence on health is an economic expression of the structural vulnerability of the SUS has unfolded into a theoretical-political approach[2] that integrates the social, economic, and environmental dimensions and, at the same time, into a systemic and structural approach to development policies.

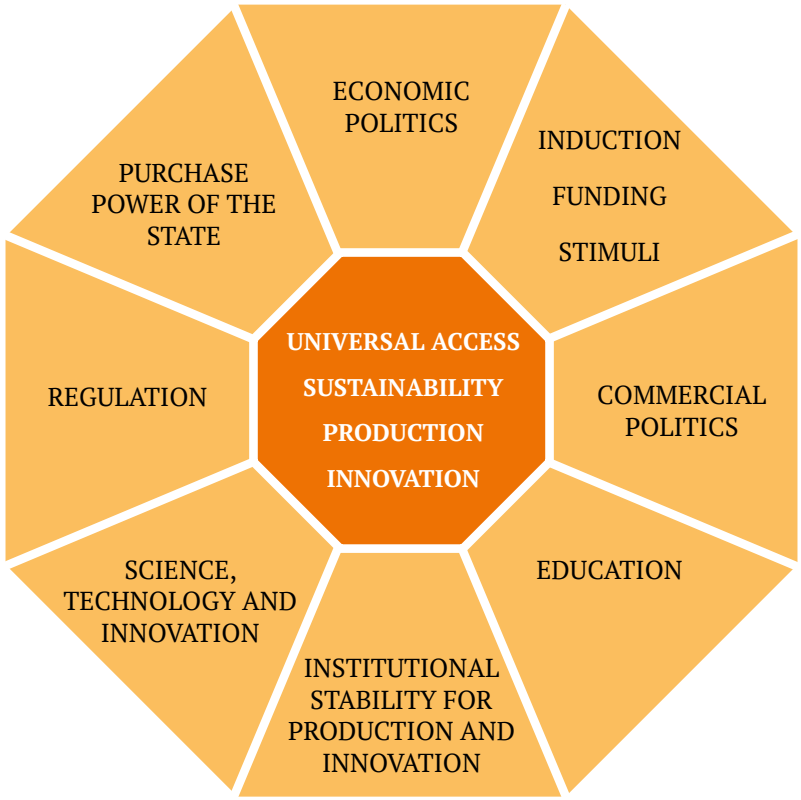
In this complex path of interaction between theory and practice, a range of fundamental policies, programs, and instruments have been developed to reduce the vulnerability of the SUS, along with the institutionality that emerges in this period.

Figure 1 shows the main elements of the approach to a systemic and structural public policy whose first foundations were outlined and need to be expanded and strengthened to guide the innovative approach. To provide the necessary support to ensure the sustainability of the health system, it is necessary to develop a systemic approach that involved a series of perspectives[3], ranging from the use of state purchasing power and economic, commercial and funding policies and incentives for innovation to regulatory policies, intellectual property, education and institutional stability to enable structuring public and private investments for innovation.

2 This complex path of interaction between theory and practice provided the development of a range of policies, programs, and fundamental instruments to reduce the vulnerability of the SUS. The institutionality that emerged in this period was the answer found by the State for the vision of the HEIC, mediated by the influence of other national visions and projects and structurally conditioned by previous historical experience and the opportunities and obstacles that emerge in the process of implementing this vision. For more details of the HEIC as a theoretical perspective that integrates the economic, social, and environmental dimensions of development, see chapter 1 of this book.

3 Many of these approaches were based on the perspective of the Health Economic-Industrial Complex, which has been developed for more than 20 years at Fiocruz (GADELHA, 2003).

Figure 1. A New Systemic Approach to Development Policies: The State Committed to Challenges and Missions



Source: Prepared by the authors.

This systemic approach, its elements, and the set of instruments of political action that derive from this perspective should be articulated, contributing to a development strategy of the HEIC and the country linked to social needs. This advance will only be possible with the strong coordination of policy that allows guiding the movement of advance and the constant overcoming of institutional limits, making it possible to take a leap in the conception of the HEIC as one of the priority economic complexes for society and the national economy.

Given the current global transformations and the challenges presented in this book, it is essential to point out forms of State action in a new generation of public policies that allow for the coordination and development of the HEIC activities in order to guarantee universal, integral, and equitable access to health in Brazil. The contributions of this book were aimed at analytically subsidizing this effort.

Public Policy Propositions

We present eight major strands of public policies to consolidate the HEIC as a national strategy option:

1. Institutional strengthening to enable a State committed to the production and innovation of the HEIC and focused on the challenge of universal access

The development of the HEIC is linked to the capacity of the State to implement public policies capable of guiding production and innovation in health from the challenge of universal access. It is essential to create mechanisms to deepen the articulation between social, industrial, and innovation policies, strengthening the link between the use purchasing power of the of state and the strategic products for SUS. It is important to ensure stability after the completion of the processes, predictability of investments and purchase at fair, monitored and evaluated prices. It should also ensure an institutional environment conducive to decision-making in the implementation of public policies and for constant learning, advancing the discussion with the control bodies and improving the normative framework so that the innovative manager and the innovative producer can commit and learn from the risks and uncertainties inherent in the innovation process.

In this perspective, in order to enable the long-term horizon of investments and innovation, the public policy for the HEIC is proposed so that the HEIC has a superior inter-ministerial strategic coordination linked to the Presidency of the Republic, ensuring the institutional integration of the various public policies and their orientation so that structural economic conditions to enable equitable, universal and integral access to health are possible. Thus, the prospect of a new standard of State action linked to national challenges and missions may show all its power in a strategy to overcome underdevelopment.

2. State purchasing power: industrial policy towards health needs

The intense and active use of purchasing power enables the technological incorporation of productive processes in public and private institutions through the guarantee of pur-

chase of these products for the public health system. Rather than the SUS being seen only as a consumer market for the purchase of products, an institutional arrangement is built in which meeting the demand of the SUS is linked to transferring technology, income, and employment to the country. These public policy interfaces, in a systemic pattern of action, are critical for investments, productive transformation, and innovation regarding the needs of the SUS. Instruments such as PDPs, Technological Orders, Offset, and margins of preference, among others, derive from this.

It is necessary to strengthen this agenda and move forward in these instruments. The State's purchasing power is the concrete link that guides the economic development strategy to social needs and environmental sustainability and should be the direction for the new development approach for the country.

3. Funding for production and innovation

Funding for health production and innovation is a key element for the consolidation of the HEIC as a national strategy option. The guidelines of public policies to fund the production and innovation of funding institutions, especially BNDES and FINEP, should be aligned with HEIC's development approach. There should be an expansion of funding through the stimulation and strengthening of the productive and innovative capacity of the HEIC. It is also necessary to promote the modernization of the national health productive park through financial and technical support to public and private producers, the promotion of startups and support for the professional qualification of the sector.

4. Guidance of the regulatory environment for the development of the HEIC to integrate the objectives of economic development with the socio-environmental ones

The transformation of the innovative regulatory environment, involving health surveillance, intellectual property, prices, technological incorporation, and health data and articulated with the development and the context of innovation is fundamental for the HEIC. The role of regulatory bodies in the face of the national context and the contemporary challenges of regulation require greater interaction between their constituent bodies and

articulation with the fields of research, production, and innovation.

The challenge is to build regulatory intelligence for the regulation of intellectual property, health, prices, and health data and information directed to the development of the HEIC and to sustainable technological incorporation, integrating the objectives of economic development with the socio-environmental development .

5. Strengthening of ST&I within the HEIC: production and national technology to enable digital public health of precision

Science, technology, and innovation institutions are fundamental to raising knowledge and the conditions for qualified training for the challenges of the future. It is necessary to continue improving the institutional framework responsible for encouraging innovation, recovering the public budget for ST&I and linking policies and incentives to social needs.

In this sense, incentives for the promotion, creation, and development of innovative initiatives, based on science and in collaboration with academic institutions, of ST&I, should be expanded, both in support for the conception of public policies and in interaction with the productive sector. The challenge of resilience, preparation, and capacity to innovate in order to meet universal access is posed by the ongoing Revolution 4.0, which constitutes an essential prospective front for the dynamism of the HEIC and the reduction of vulnerability in health. With this perspective, digital health must be strengthened and guided towards the objectives of public health, enabling accurate public health to face the great contemporary challenges without reducing us to only data providers and buyers of "packages of algorithms and information," which characterizes the new relationship of structural dependence on health in the 21st century. This is one of the new development fronts for the HEIC as a strategic vector of national development.

6. The HEIC as a productive and technological model of an economy committed to environmental sustainability and the territory

Taking care of people and the planet has the potential to become a vector to overcome the current situation of predatory crisis and stagnation. In Alma Ata and the 1988 Constitution, health is considered a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity. According to this view, the incorporation of sustainable technologies in the SUS is unavoidable since health as a quality of life cannot be affirmed on a planet in degradation.

Thus, the productive and technological base of the HEIC should be structured to support another health care model, with the strengthening of sustainable prevention and promotion activities. It is also necessary to promote the sustainable transition of the HEIC through systemic and structural industrial and innovation policies to insert its subsystems in the route of the bioeconomy and circular economy and to enable the profitable and sustainable use of Brazilian biodiversity and progressively reduce CO2 emissions by 2030, neutralizing carbon emissions in all subsystems and industrial and service sectors of the HEIC by 2050. From this perspective, the regional and territorial dimension emerges as a structuring and transversal axis for the integration of the country at the macro-regional, sub-regional, and local scales. In summary, the HEIC should be an exemplary leader and model of a new development pattern that promotes life, articulating economic dynamism and the construction of a sustainable welfare state in Brazil and harnessing the potential of its regions and territories.

7. The HEIC in the global and regional cooperation strategy to reduce mismatches

The COVID-19 pandemic revealed the tension between the global health vision and the interests of national states and regional blocs. The vulnerability of access to health care has even been shown in developed countries, where there has been a lack of medicines, equipment, and basic health products. On the international scene, global challenges related to the future of health, especially innovation and access, are in place and under wide discussion (Lima NT, Gadelha CG. 2021). In this context, Brazil is a key

actor for the potential of the HEIC and for the leadership that the country exercises regionally and globally.

The HEIC should be placed as a structuring axis of the global cooperation strategy and productive integration for local production at the regional level, with emphasis on Latin America and Africa.

8. Improvement of the HEIC management and social control

The expansion of development policies requires, in the first place, the creation and strengthening of a systemic institutional base with decision-making power towards the SUS, with stability and transparency, for the strategic management of the interests and purchasing power of the State. It is essential that every development policy decision has broad participation and social control to ensure that the production and innovation strategy does not detach from the needs of the population and to give transparency to the use of public resources.

For this, the mechanisms of transparency and participation of social control in the HEIC instances must be strengthened, linking development policy, health policies and socio-environmental needs.

These eight major strands of public policy, which started between 2003 and 2015, must be recovered and at the same time transformed to face the challenges of the future in a perspective in which the HEIC is one of the three priority economic complexes to reindustrialize and rebuild the national economy according to the new national standard of development focused on well-being and sustainability.[4]

4 For more information, see: Diretrizes de Reconstrução e Transformação do Brasil e Carta para o Brasil do Amanhã https://divulgacandcontas.tse.jus.br/candidaturas/oficial/2022/BR/BR/544/candidatos/893498/5_1659820284477.pdf and https://lula.com.br/carta-para-o-brasil-do-amanha/

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MANIFESTO
Health is Development
The Health Economic-Industrial Complex as a National Strategic Option

This chapter was elaborated under the project "Challenges for the Unified Health System in the national and global context of social, economic, and technological transformations – HEIC 4.0," coordinated by CEE/Fiocruz. The opinions expressed here are solely the authors', and do not represent the institutional view on the subject.

A new country project guided by welfare, equity, and environmental sustainability must guide a new strategy to rebuild the national economy capable of overcoming the false polarization between the economy and the lives of people and the planet.

Recently, we have witnessed the tragedy of a country that does not grow, does not generate jobs or income, denies science, returns to the hunger map, and whose fragile state is unable to fulfill its elementary roles of providing health and education, taking care of people and caring for the environment. Violence shows itself in the weapons used against poor and black people in territories excluded from the rights of citizens.

We propose a vision of development to raise again the head of a people that managed to build SUS as the largest universal system in the world in terms of population, here in the tropics, in the Southern Hemisphere, against all the perverse pessimists who did not think it was possible for us to have a system that guarantees universal, integral and equitable access for 212 million Brazilians. It is time to move on and destroy other myths that need to be shattered. Utopias need to be rebuilt; energies of solidarity cooperation need to be rekindled.

This bold project of social solidarity, a fundamental objective of the 1988 Constitution, is only possible in a new national economy. The commitment to the development of the Health Economic-Industrial Complex (HEIC) represents the reconciliation of a development model with human rights, substantive democracy, and life. What is considered to be our flaws and weaknesses are our economic opportunities to rebuild and remake a better country based on a new human and planetary ethics.

Health and socio-environmental rights not only represent the commitment to the population and the planet but are also the new sources for economic recovery and reconstruction, generating product and income, decent and quality jobs, and acting as the engine of research carried out in the country in the context of the ongoing digital revolution, providing the potential for reducing global inequality regarding knowledge.

The perspective of the development of the HEIC in Brazil shows that it is pos-

sible to reconstruct to overcome the legacies that go back to slavery, exclusion, racism, and inequality among people and regions. It takes a new State to rebuild and change society, to take care of the people and territories that are the soul and energy of our country.

We should grow! We should create jobs! We should resume investments! We should innovate and expand knowledge! But always asking for what, for whom and where! We should build a sovereign, equitable, and democratic society. We should integrate the nation and rebuild the broken life between territories and prisons that trap our solidarity and our construction of a common good, in fact.

Based on this perspective, at the same time ambitious and realistic, we present ten conceptual and political pillars to guide the necessary transformation:

1. Life and the economy are not exclusive. Economy is the means. Life is the goal. And the defense of life generates a new model of development. The HEIC can guide a dynamic, sustainable, and inclusive new national economy, generating 10% of GDP, 20 million direct and indirect jobs, and 35% of national research.

2. National sovereignty and the reduction of health vulnerability depend on a strong, innovative, and universal access oriented HEIC. Today, the HEIC relies on US$20 billion in imports per year that not only represent an economic dependence, but an option veiled by exclusion based on a model of national economy that perversely separates ethics and economy, income and life, and denies access to health for most people. The country must strengthen the national production of strategic health goods and services, ensuring universal access in a sovereign way.

3. There is no opposition between Economy and State, as revealed in the health sector. According to the historical experience of all developed countries, two pillars have proved essential: a State capable of guiding, explicitly or implicitly, a project of society and global insertion, and a strong and dynamic economy, capable of generating income and employment and funding social public policies and ST&I. Social spending

articulated with local production induces innovation, increases GDP, and makes us a better society.

4. The project to strengthen the HEIC gives a new meaning to national reindustrialization, guided by social demand and our Constitution, to generate inclusion, access to public goods and the defense of the environment. Health plays a key role in all industries of the future and forms an economic system that connects production to social demands through health services and the performance of health professionals throughout the national territory, enabling the reconnection between the pattern of economic development and the care of people.

5. The territories and regions in Brazil have enormous unexplored power because of the cognitive limitation of the (under)development patterns of the past. The HEIC is present in all territories that have primary care. The HEIC is a huge possibility to integrate the country by defending life, generating solidarity and, above all, decent employment to overcome inequalities between people according to their place of birth.

6. Health is quality of life and not absence of disease. There is no environmental policy, sustainable development, or Agenda 2030, without a strong SUS and without the economic and productive basis of health as an inducing and leading activity of sustainable technologies and practices. A new model of care focused on promotion, prevention and guided by primary care should serve as an example of productive reorientation that may not pollute, produce toxic waste and contribute to increase global warming. We present the HEIC as a new sustainability model for the country and the world!

7. Social welfare and SUS funding are valuable investments of society. By expanding production, employment, and productivity, the strengthening of the HEIC contributes to the balance of the relationship between public debt and GDP, funding the State and increasing the Product. The sad binarism between life and economy must be dismantled and presented as a fallacy so that a few earn money in a stagnant economy. The HEIC is a way to generate good jobs on a large scale. It can directly or indirectly mobilize 25 million decent jobs to take care of people, provide qualification and permanent

learning in new digital technologies, promoting inclusion, care for the environment and overcoming inequalities in income, race and gender.

8. There is no health with misery and hunger. The potential of generating employment and income within the health itself, mobilizing the HEIC and articulating innovation with a national and local network of life caregivers is presented as a structuring solution that guarantees at the same time tax revenues for social protection and a stable and expanding employment structure. Health once again breaks the false dichotomy between innovation and unemployment by strengthening humanized collective care and incorporating new digital technologies. Universal systems generate assistance, a social safety net, and the solution for misery and hunger.

9. Health provides a key to articulating a simultaneous effort to strengthen science, technology, and innovation and their orientation to national challenges. Health and the responses of the SUS, as revealed by the context of the pandemic, require a sovereign ST&I to reduce structural dependence and allow for the acquisition of knowledge covered by the 4th technological revolution. The confrontation of contemporary social and environmental challenges depends both on scientific knowledge that allows us to guide care (such as the use of masks or primary care) and innovations related to vaccines, tests, equipment, medicines, and new treatments. The HEIC impacts more than a third of all research produced in the country and can be an example for a science committed to people, welfare and the planet.

10. We propose that this new development project should integrate the national dimension with the global one. The HEIC presents itself as a strategic possibility of cooperation between the people that, in addition to philanthropy and meritorious donations, is based on a geopolitical action that strives to reduce global health asymmetries and leaves no one behind, especially in Latin America and Africa, and contributes to the strengthening of Brazil as a global agent.

Health is development and the HEIC has shown its power as a strategic option for the country. An option that, at the same time, is a new country project. It is a commitment

to the nation and its regions, to democracy, equity, science, the planet and to a new state rooted in society to face the great national challenges.

Brazil, December 2022

Signature of all authors of the book:
Health is development – The Health Economic-Industrial Complex as a National Strategic Option

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HEALTH ECONOMIC-INDUSTRIAL COMPLEX (HEIC) A NEW NATIONAL DEVELOPMENT PATTERN GUIDED BY CHALLENGES AND MISSIONS

Development and economy

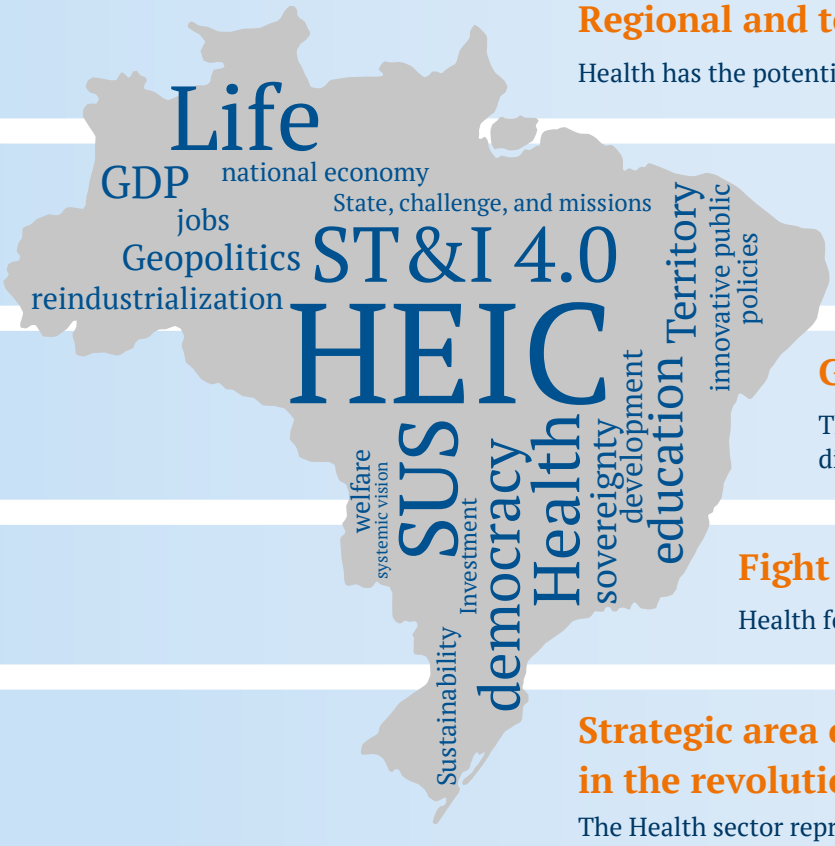
The Health sector represents 10% of GDP

National Sovereignty and reduction of SUS's vulnerability

Dependence on importation: US$20 billion/year

Regional and territorial development

Health has the potential to dynamize all the regions in Brazil



Reindustrialization of Brazil

Productive base guided by welfare and sustainability

Good jobs in large scale

The health sector generates more than 20 million direct and indirect jobs

Fight against misery and hunger

Health for productive inclusion to take care of people

Strategic area of knowledge in the revolution 4.0

The Health sector represents 35% of the national research

Global geopolitics

Conductor of productive integration with Latin America and Africa

Sustainable transition

Production in health as a model for environmental sustainability

Ministério da Saúde

FIOCRUZ
Fundação Oswaldo Cruz

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