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New digital technologies, financialization, and the Covid-19 pandemic: changes in the global productivity dynamics, the role of the State, and impacts on HEIC

Published: 25 Sept. 2023 (english version)
DOI: https://doi.org/10.29327/2148384.16.28-3

This article has financial support from Fiocruz through the project "Challenges for the Unified Health System in the national and global context of social, economic and technological transformations - CEIS 4.0". The opinions expressed here are solely the author's.

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Abstract

This article analyzes the recent changes in the global productivity and innovation dynamics and its impacts on the industrial and innovation public policies since the beginning of the millennium. Arguably, the main feature that singles out the current state of globalization is the strengthening of the financialization process. This has had significant impacts on transnational firms and the outreach of National States' actions. This article also discusses to what extent the Covid-19 pandemic is affecting the economy, the society, and the measures adopted by National States to face the current crisis. The role of new digital technologies in global changes, the industrial and innovation policies, especially in the health productivity and innovation system, are other discussion topics. Finally, this study highlights the structural changes in the global economy against the background of the Covid-19 pandemic and investigates the main challenges and opportunities for HEIC worldwide and in Brazil.

Keywords: Covid-19. Health Economic-Industrial Complex (HEIC). Unified Health System (SUS). Financialization. Industrial and Innovation Policy.

Introduction

Against the background of the pandemic and the sanitary crisis experienced worldwide in 2020, this article aims to discuss how the global production and innovation dynamics and the role of the territories and National States affect, condition, and provide opportunities to strengthen HEIC. This article has four sections. The first one presents a summary of the key features in the global economy and society in the past decades. The second one briefly highlights the main industrial and innovation policies that were devised and implemented in the millennium. The third section describes the main governmental responses to the serious problems caused by Covid-19 and presents the main uses of digital technologies during the crisis. Finally, the last section discusses opportunities and risks for HEIC.

1. The global innovation and productivity dynamic at crisis times

The Covid-19 pandemic is one of the biggest, most urgent challenges in the history of human civilization. Foreseen by analysts of several ideological backgrounds, it shows humankind the dangers of the brutal increase in nature exploration. This alters the fragile balance that has supported the human species evolution throughout millennia. The acute crisis caused by the pandemic is of significant importance. Not only is this due to its implications regarding public health, but because it overlaps with a chronic, multidimensional crisis (economically, socially, politically, and environmentally speaking). This situation has been taking place at the world stage since the 1980s.

It is against this background that we aim to investigate the changes in the global innovation and productivity dynamics that took place in the millennium. Such changes are mostly made by the main globalization actors' strategies: the main transnational firms (TFs) and the National States. The relationship between these actors, which has always been close throughout history, is

transformed as financialization has advanced in this millennium. This goes in tandem with the national governments and their policies, increasingly intertwined with the accumulation logic of the big companies.

By the late 1990s, it was clear that the acceleration of the technological changes had become one of the main specificities of the current globalization that was dominated by finance. It enabled the establishment of a new production organization pattern in the industry and services, facilitated concentration of capital through interpenetration of assets and the increase of regional trade intra-industry and intra-firms. The big TFs, which were increasingly controlled by finance, accelerated their oligopalization process in a world where liberalization has enabled and fostered the creation of world markets.

These changes had been occurring in an unequal way, strengthening the unbalances between countries and social classes. Meanwhile, the economic groups had increasingly become protagonists of the global geopolitics and economy. There was a "strong trend towards financialization and rent-seeking in capitalist economies... a process... [that] was not confined to the national borders" with an "impressive escalation of the amount of financial wealth (to a rate of at least 15% per year)... surpassing the growth in production and fixed asset accumulation" (Coutinho; Belluzzo, 1996, p. 137). The advance of financialization and its detachment from production was linked to a "wave of deregulation and liberalization [that] was strong and reduced the turning radius of the National States" (Coutinho, 1996, p. 49). This dismantled the structures that limited the "market" – both regarding the relationships among capitalist companies, and especially, the relationships between capital and labor (Serfati, 2015). Moreover, the State was deprived of its social welfare role because of the significant reduction of public spend on social services, including health and education, as well as the reduction in the welfare of the most vulnerable part of the society. This occurred especially through reductions in the fiscal spend and disinvestments in the maintenance of public services such as public transport, water, and sanitation (Harvey, 2005).

The big TFs are the main fosterers of a new global production pattern characterized by the world dispersion of production with functional integration of economical activities (Dicken, 2003). The main logic in the forming and

organization of what some named "global value chains" is, in the first place, the reduction in costs ranging from outsourced production to engineering and innovation activities. Such changes in organization of production and activities focused on technological development are extremely complex and multidimensional. However, they may only be explained as argued by Sauviat & Chesnais (2005), who stated this was a reaction from the big TFs to the power of labor and the salary mass participation in the product of the main capitalist economies.

Based on this political logic and the economical logic of minimizing costs and maximizing short-term profits, the new relationship between finance and the manufacturing industry starts modeling the investment pattern (including those focused on innovation) of the big corporations (Chesnais; Sauviat, 2003). With the free flow of capital of societies that had been provided by the "liquidity" of the stock market and helped by refined financial routines of the novel "corporate governance" style, financial institutions gained unprecedented power and actual control over non-financial TFs.

Thus, all these changes have been made possible in the past decades through the unequal introduction of information and communication technologies (ICTs), whose production and diffusion is concentrated in a few countries and companies. In fact, the domination of ICTs marks a new pattern of accumulation in the beginning of the 21st century. It is extremely high, as enabled by the initial technology monopoly with growing power over the traditional production and consumption logic that was typical of the post-war accumulation pattern. Since the beginning of the millennium, new actors, all of them linked to the ICTs – Google, Facebook, and Amazon in the USA; Alibaba, Tencent in China etc. – started to control a new business model based on information processing enabled by recent technologies, especially, artificial intelligence and big data. This model has connections with the big finance and industry oligopolies and is found within a deregulation context. It is also called "Surveillance Capitalism" (Zuboff, 2019) and it has to do with establishing a commoditization of personal data in order to make profits. These data may become marketable, and they are one of the most valuable resources for such system. According to Zuboff (2019), an economical logic based on the audacious and illegitimate colonization of the private human experience to a

new era of commercialization and control.

These changes have enabled a significant increase in the concentration of capital, with the formation of oligopolies in several markets. The scale of accumulation is so intense that the big TFs, which are controlled by finance, take over the leadership in the space race, the communication and surveillance satellite networks, as well as the control over the gigantic data volumes generated by all countries. In the West, the states are increasingly subordinate to them, having no full control over technology. The technology giants even compete with the traditional banks. They use independent payment and resource transfer systems based on virtual currencies that challenge the control of the central banks and the global financial system. Thus, the cutting-edge technology sector fuses with the financial system and the National State.

The changes occurred in the present millennium have been strengthened trends that had already been noticed then; moreover, they also present specificities found throughout the period, moving towards directions that were not previously foreseen. China's quick ascension as a global power is added to Surveillance Capitalism, particularly from a technological and productivity perspective. Also, the significant increase in the detachment of finances of the real world of production and the subordination of the States in the West to finance plans. All these factors reduce and condition the leeway of the governmental policies as a whole, as well as the national industry development and innovation ones.

Although it had already been noticed in the last decade of the past millennium, implementing the neoliberal prescription is strengthened in western countries. It comprises public spend cuts, labor rights limitations, and public service privatization, especially regarding health and education. This led to their deterioration, and the unfortunate consequences of such prescriptions are especially noticed now.

2. The innovation and production policies and the structural changes in the millennium

Forsaken in the West during the last decade of the 20th century, the production and innovation policies reemerged in the international agenda after the 1998/1999 World Bank development report was published ("Knowledge for Development"). The report was centered on the proposition that "knowledge, not capital, is the key to sustained economic growth and improvements in human well-being" (World Bank, 1998) and it acknowledged the failure of the Washington Consensus proposals (deregulation, privatization etc.) that had been implemented in several countries. The report highlights areas where "information problems are most severe" and are in demand for governmental policies. This partial change in the World Bank stimulates the discussion and the design of policies focused on innovation (Cf. Cassiolato *et al*., 2014). The subsections below present the main outlining of policies focused on production and innovation of the past two decades. To sum up, we could briefly highlight three moments.

2.1 The Lisbon Strategy, China's joining the World Trade Organizaion and the period between the 2001 crisis and the 2007-2008 crisis

In the wake of the World Bank propositions, in 2000 the European Union, then led by Portugal, launched an ambitious economic and social transformation project: the Lisbon Strategy. This project aimed to make Europe a knowledge society in ten years.

Strongly based on the Schumpeterian ideas of innovation systems and the "learning economy," it set out to promote a profound social and environmental renovation, an improvement in the European population's labor and living conditions, better education, and a significant increase in investments and spending in science and technology (S&T).

Its complete failure – it contradicted the systemic view of innovation, which required a strong state presence, the liberalizing doctring that had been gradually taking over the European Union (Kok, 2009; Borrás; Radaelli, 2011)

– did not stop it from serving as a landmark for defining the innovation policy proposals by the main international agencies such as the Organization for Economic Cooperation and Development (OECD) and the World Bank. In other studies, we argued that the absolute majority of the western countries started using the main prescription points of these organizations (Cassiolato; Szapiro; Lastres, 2015).

In theory, such policies purported the systemic notion of neo-Schumpeterian innovation; in practice, they purported policy mechanisms that were typically neoclassic.[1] All in all, they were fiscal or credit stimuli to cheapen the innovation costs for companies. This resulted from several kinds of pressure so that the S&T public infrastructure, especially universities, became closer to the productivity sector. This seemed to come from an at least naïve interpretation of the effects and results of the 1980 Bay-Dole Act. The propositions were also strongly influenced by a naïve hi-tech entrepreneurship that ignores the structural characteristics of capitalism in the millennium.

The innovation policies proposed and implemented by the western countries since 2000 that had been founded on these premises already showed limitations mid-decade. Many analysts, initially in Europe, and then worldwide, tried to explain the failure in translating policies and big public and private spending in innovation that would generate development. This indicated the likely existence of "paradoxes" (innovation policies and greater spending in science, technology, and information – S, T&I did not present the expected results).[2] The failure in these policies is mostly linked to its inability to create policy actions and mechanisms that are actually systemic, and also acknowledge how financialization has changed investment, production, and innovation strategies in the big western TFs. Consequently, this led to several constraints.[3] It must be highlighted that countries such as China and Korea

1 In the first Globelics conference, which took place in Rio de Janeiro city, Reinert & Reinert (2003) stated that using the systemic notion of innovation in the policies of the first decade of the millennium was only "new icing on an essentially neoliberal cake".

2 See Dosi, Llerena & Labini (2006) for a discussion on the European "paradox", and Karo & Kattel (2010) for the case of the Eastern Europe countries. In the Latin American case, Kattel & Primi (2012) compare such "paradoxes" to Eastern Europe. In the Brazilian case, Lastres et al (2016) critically discuss texts by Brazilian authors who pose the same questions.

3 Among the exceptions, see Chesnais (2016) & Cassiolato, Szapiro, Lastres (2015).

adopted other strategies successfully, as they bore these aspects in mind. In the western countries, the only experience in this direction that also gave positive results (surely, withing the limits established by liberal macroeconomic policies) was the Brazilian one. Precisely, this took place in the health area in the first half of the 2010s (Gadelha, 2020; Gadelha; Temporão, 2018). Unfortunately, this policy experience was abandoned as of 2016, with the harmful results that were fully highlighted in the wake of the Covid-19 pandemic.

2.2 From the 2007-2008 crisis to the beginning of the deglobalization in 2015-2016: innovation directed to specific characteristics and needs in China and the States' being taken over by finance in the West

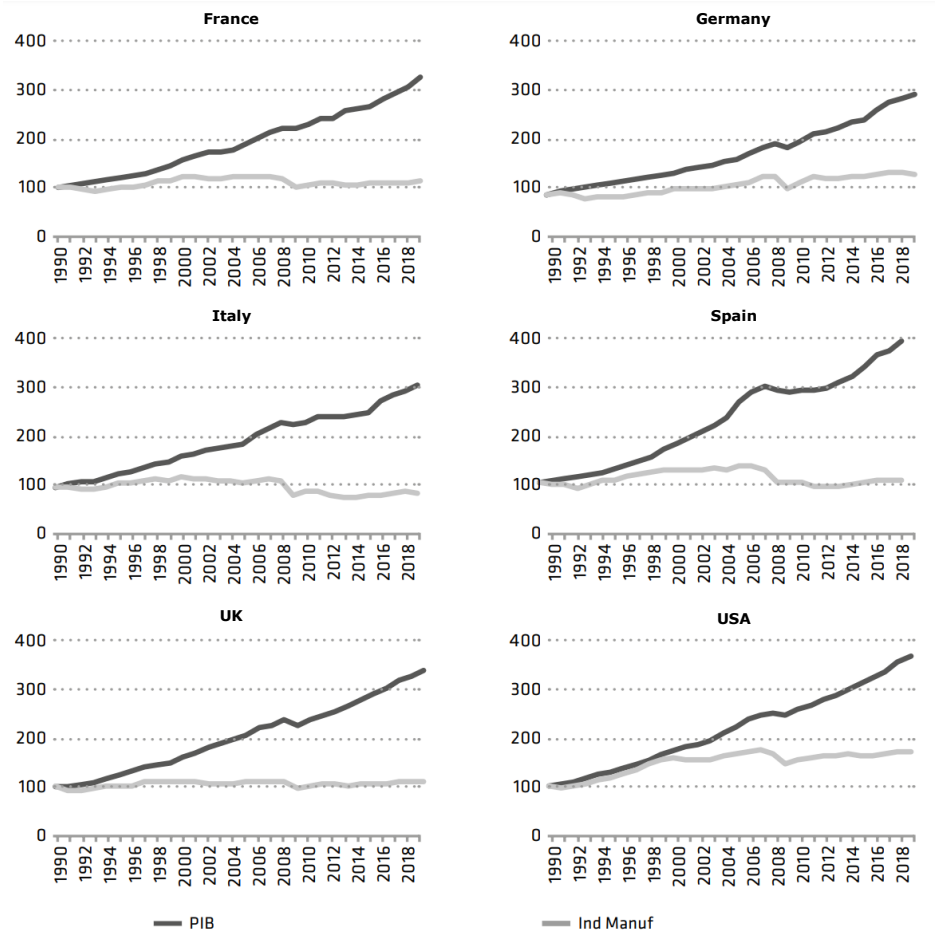
The 2007-2008 financial crisis highlighted important elements that affected structural changes and innovation and industrial policies significantly. During the peak of the crisis, when fiscal stimuli had been introduced to boost the economy in virtually all countries, some nations such as Germany, China, and Korea took the opportunity to direct their policy action towards alternative energy sources like solar and wind energy. However, if the intensity of the 2007-2008 crisis initially caused intense pressure for a new regulation of the financial system to minimize the chances of recurrence, reality took the opposite way. Actually, the banks (and the whole financial sector) proved to be able to shift the discourse on the crisis causes. They took the focus away from the search for extraordinary, growing profits and repeated the argument of the States' "fiscal irresponsibility" ad nauseam. To some analysts, it is not surprising that the world's most advanced liberal democracies' political institutions were not able to deal with the structural power and the ideological resources of the financial establishment (Woll, 2014).

From then on, the articulation between the financial system and the State apparatus was reconfigured in various capitalist economies. The State was taken over by the financial sector's interests (Lechevalier; Debanes; Shinb, 2019). The impact of such a change in the structural transformations of capitalism and the institutional scenario that watched the rebirth of industrial

policies after 2008 has been underestimated in the literature. Nonetheless, this is a key factor to understand and interpret the evolution of such policies and explain their failure from a wider perspective.

The first result of the changes mentioned above has to do with a brisk acceleration and strengthening of the "de-industrialization" processes of the great western capitalist economies. In these countries there has been a significant loss of their industrial framework and the links between the productivity systems. This has negatively impacted the level and the quality of jobs and wealth, as well as the possibilities of developing more relevant innovations, even in the USA and Germany. Figure 1 shows stagnation or negative growth of the manufacturing industry in several countries, highlighting the de-industrialization processes.

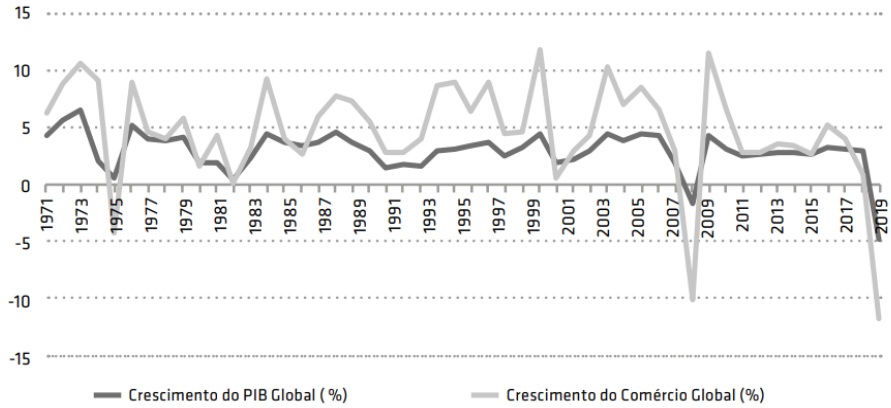
Figure 1 - GDP (PIB) - total and industrial production (Ind Manuf) - selected countries - 1990-2018 (1990 = 100)



Source: Adapted from OECD (2020).

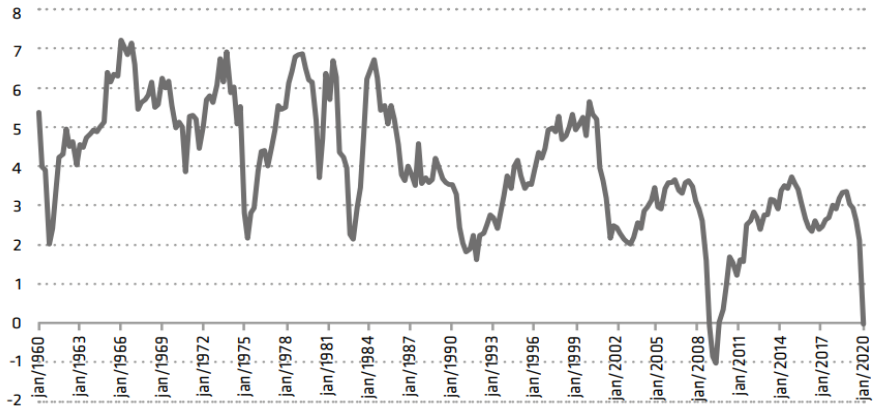
The exacerbation of the social and economic crisis after 2007-2008, the deepening financialization and the increase in inequality also cause a significant impact in the globalization process. Since then, the global economy has been marked by, among other things, a low real growth in the gross domestic product (GDP) and the global trade (Figure 2); a decrease in the investment in productivity activities (Figure 3) associated to a stagnation in demand (Figure 4) and the existence of global idle capacity in relevant activities. This picture is linked to a significant increase in social inequities (Figure 5) and in indebtedness of families, companies, and governments (Figure 6), in a world where financialization and investments in financial assets (a good parcel of them are speculative) continue to grow far above real production and global trade (Figure 7).

Figure 2 - Relationship between global trade growth and global GDP (PIB) growth 1990-2020 (% and rate)



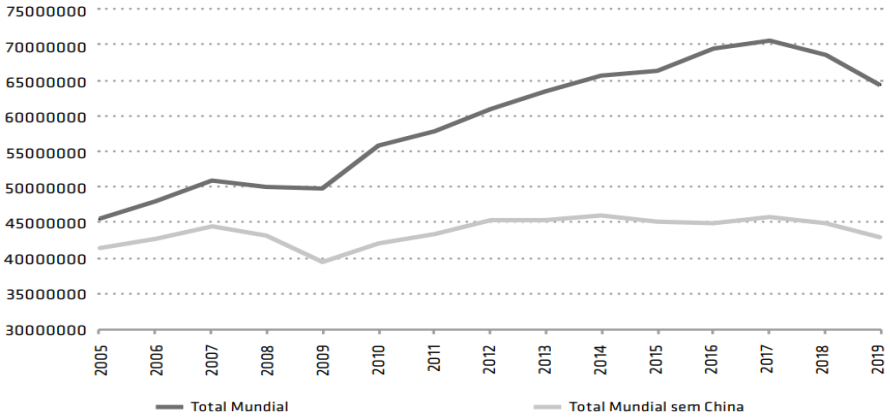
Source: Adapted from IMF (2020b)

Figure 3 - USA - Net private investment as % GDP (PIB) - 1960-2020



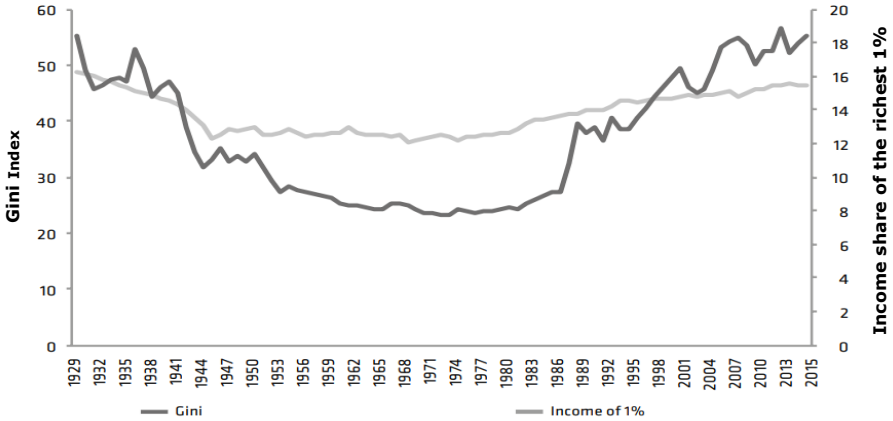
Source: Adapted from the Federal Reserve Bank of St. Louis (2020).

Figure 4 - Car sales - 2005-2019 - World total and world total excluding China



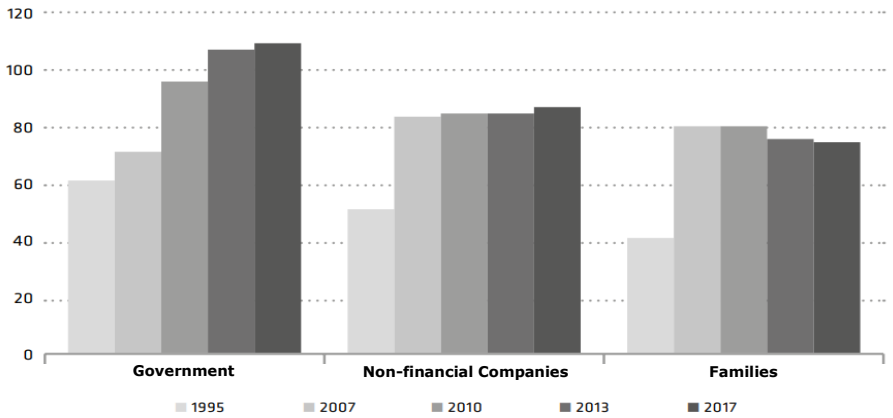
Source: Adapted from OICA (2020).

Figure 5 - Inequity in the USA (Gini Index) and participation of the richest 1% in wealth - 1929-2015



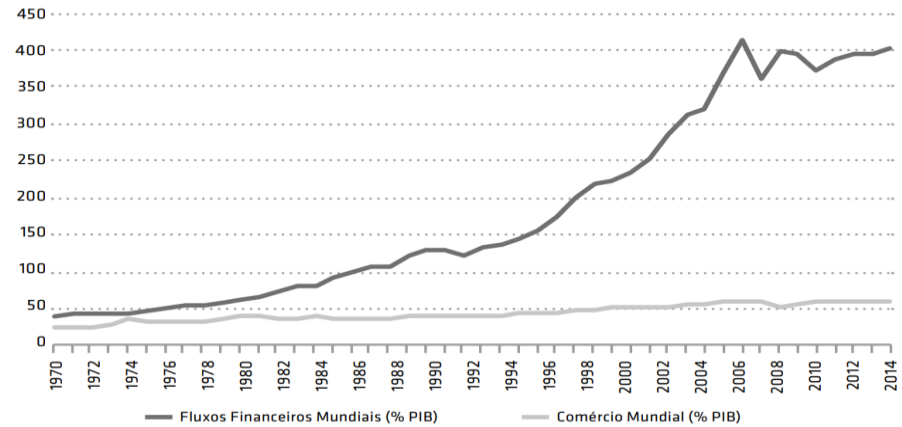
Source: Adapted from Atkinson *et al.* (2017).

Figure 6 - Indebtedness as % GDP (PIB) - Non-financial companies, government, and families - 1995, 2007, 2010, 2013 e 2017



Source: Adapted from BIS (2017).

Figure 7 - World trade and global financial flows as % of the world GDP (PIB) 1970-2014



Source: Adapted from BIS (2017).

Thus, the monetary and fiscal policies adopted as of 2008-2009 to contain the crisis and its subordination to finance interests help explain the additional persistence and growth of a fictitious financial capital mass in the form of speculative credits that has been causing an endemic global financial instability (Chesnais, 2016). The National States' being taken over by globalized finance has a significant impact on its action. Consequently, their public policies almost undoubtedly "do not tackle the increase in wealth inequality, the constant erosion of the political space, along with the smaller economic role of the governments and the main financial sector of the economy, which are the very causes of the 2008 crisis". (UNCTAD, 2014).

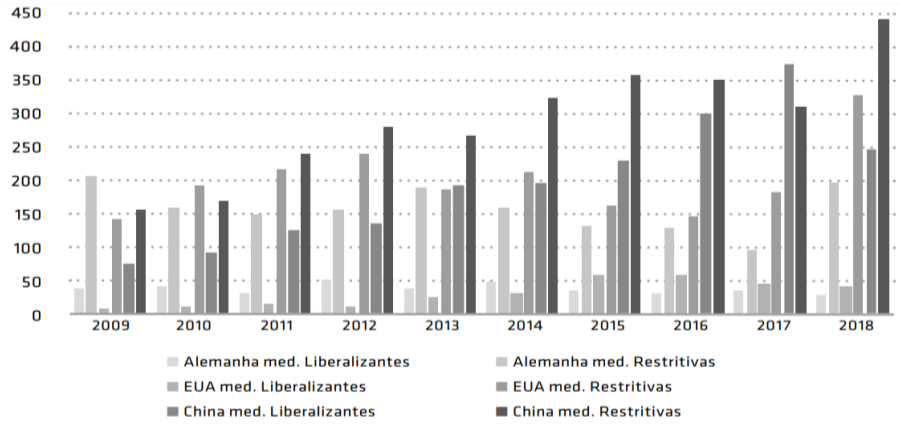
It is against this background that the industrial and innovation policy evolved in that period of time. On the one hand, it maintains the shyness of the previous period; on the other hand, it presents new features. From an industrial policy standpoint, the world trade stagnation can be linked to a significant increase in protectionism as of 2009, and it intensified after the 2011 euro crisis. Because of the deepening crisis, most countries' governments, especially the G-20 ones, have significantly increased the use

of tariff and non-tariff barriers to minimize their impact on productivity structures. It increases in virtually all countries, and it has been especially relevant in the three main ones: the USA, China, and Germany. Figure 8 presents information on the liberalizing and protectionist measures for the USA, China, and Germany. In most of the period analyzed, these countries increased the number of restrictive measures and limited the adoption of liberalizing measures. The USA and China reached the highest numbers of restrictive measures in 2018.

Moreover, the increase in protectionism relates to one of the most important factors in the slowdown in the international trade mentioned above, that is, the slow and progressive loss in dynamism of the so-called "global value chains" already noticed as of 2014 (Evenett; Fritz, 2015). This has many causes, but it is undoubtedly associated to the deepening Chinese industrialization.

As a result of the 2007/2008 crisis in the western economies, China promoted a quick change in focus in its national strategy. It was then centered on integrating its enormous domestic market and the growth propelled by what the Chinese name "internal circulation." In this case, they focused on increasing the internal added value progressively, both in the exports and the domestic market production (Cassiolato *et al.*, 2013). Such efforts gained new ground in the past few years as a result of the escalating friction with the USA trade and acknowledging that China's continuous economic expansion requires overcoming structural imbalances.

Figure 8 - Number of implemented protectionist/restritives and liberalizing measures - Germany, USA, and China (2009-2018)



Source: Adapted from the Global Trade Alert (2020).

China is known for its emphasis on investing in physical and logistics infrastructure (its annual growth rates over 20% between 2005 and 2020). This resulted in new railways, airports, highways, and port premises. The Chinese policy linked them to its local productivity and innovative development. For instance, in a little over ten years, China built a high-speed railway network of more than 35,000 km, which is nearly 70% of the world total, based on national technologies and companies. At that time, China also took the productivity and technological world leadership in many areas of a new productivity paradigm such as new energy sources. Furthermore, the Chinese policy enabled the construction of information and communication infrastructures in large scale, and it stimulated the private sector to innovate in activities such as mobile payments, e-commerce, the Internet of Things, and smart, advanced manufacturing.

The mid-2010's saw the emergence of a Chinese productivity and technological leadership that opposes a West dealing with a significant decrease in the role of the State. It is subordinate to finance while facing a

permanent crisis and watching a growing debate about a possible deglobalization. This became more noticeable after Donald Trump's election in the USA in 2016.

From an industrial and innovation policy standpoint, some relevant factors deserve highlight. In the context of submission of the State to the diktat of financialization, the new industrial policies logic is transformed. It has been increasingly focused on adjusting to the liberalization ambiance. One the one hand, privatizations reach new areas such as health and education, which leads to a quick deterioration of these public services. On the other hand, regarding explicit industrial policy, it leaves its strategic aspect aside to fully obey the diktat of financialization. According to a definition by the European Union (2012), the industrial policy must be centered on support so that companies perform better. Considering the market failures, it must help create an environment through which "winning entrepreneurs" will emerge (Bailey; Tomlinson, 2017).

International organizations lead a movement towards this "new" kind of policies by using phrasing lacking substance such as entrepreneurship and innovation ecosystems. Below are presented two examples of such policies proposed by the DG- RTD (Directorate-General for Research and Innovation) of the European Union in the late 2000s that were later copied by almost all countries.

The first one refers to the so-called public-private partnerships focused on research, development, and innovation. In 2008 one of such partnerships was established in the health area (Innovative Medicines Initiative Joint Undertaking - IMI) between the European Union and the European pharmaceuticals industry, represented by the European Federation of Pharmaceutical Industries and Associations (EFPIA). It had a public budget of 2.6 billion euro. The main justification for creating the IMI was to fund research projects to improve patients' health and access to medicine in areas in need medically or socially. Nevertheless, a detailed analysis of its 2020 results indicates that after 12 years, the program has not significantly invested in the focus areas, such as long-term preparation for epidemics (including the ones due to the coronavirus), HIV/AIDS, among others. A CEO article (2020) states that "the pharmaceutical industry lobby admitted in 2011

that IMI could be used to fund projects the pharmaceutical industry would have commissioned anyway".

Another example is the European Union's S3 program (Smart Specialization Strategies), the biggest, most ambitious regional innovation policy program worldwide, on a budged of nearly 80 billion euro in the 2014-2020 period. Founded on the ideas of the entrepreneurship ecosystem and smart specialization, which were both sharply criticized conceptually and empirically,[4] it became widely adopted by governments worldwide. It was conceived for functioning via public-private partnerships. The State would allocate resources for activities with unexplored technologies focusing on "entrepreneurial discoveries." The mimetic use in several countries do not seem to hide the failure of this "market-friendly" policies, compared to a panacea or placebo policy (Brown; Mawson, 2019) in many European countries (Pugh, 2018; Marques; Morgan, 2018; Schulz, 2019), in Korea and Japan (Lechevalier; Debanes; Shinb, 2019).

2.3 From the beginning of deglobalization to the 2020 pandemic: environmental degradation, the sharp increase in inequities, the deepening crisis, and the industry 4.0

The beginning of the "deglobalization" was marked by the ascension to power of politicians such as Donald Trump in the USA, a deepening crisis in the western countries, and the introduction of new and important items in the industrial and innovation policy agenda. The World Economic Forum, a known annual meeting of the global élites in Davos, had been shaken in 2015 by the success of Piketty's book (2013), which described the sharp increase in the wealth and richness inequality in capitalist economies.

In 2016, the reaction was to introduce a radical agenda on the inevitability of what was named Industry 4.0 or Fourth Industrial Revolution. Far from being a new techno-organizational paradigm as proposed by a part of the literature, the new technological developments stand for another

4 For more details on the critics of the ideas of smart specialization of an entrepreneurial ecosystem, see Cassiolato, Falcon e Szapiro (2020), Brown e Mawson (2019).

intensification of the main paradigm features of the ICTs. This was backed by the concept of techno-economic paradigms by Carlota Perez (Brixner *et al.*, 2019). Thus, many governments have been using their trade policy to protect their local industry and adopting policies focused on stimulating innovation as of 2016 through technological and innovation strategies regarding the potential possibilities and impacts of the new digital technologies (named Industry 4.0). Germany, the USA, and China, among other countries, have been seeking to effectively introduce advanced manufacturing technologies, with different results.[5] It must be mentioned that in all these cases, public resources are articulated with local industry protection measures described in the previous paragraph. Other mechanisms are also being used such as the State's purchasing power, and they are mostly restricted to locally-owned companies, except for the companies controlled by foreign capital. China has been achieving more impressive results[6] due to its long-term development program, and Germany has been achieving success at modernizing its metal-mechanics industrial park. Despite the great efforts and its renowned leadership in S&T infrastructure, the USA has been having more difficulty because of the American innovation system, which is mostly associated with the growing financialization of the big companies in the country (Chesnais, 2016; Lazonick, 2012).

The subordination of the productivity strategies to the financial logic by the American TFs has led to outsourcing in other countries. This aimed to reduce the costs of important stages of manufacturing, engineering, and other innovation-focused activities. Consequently, the American economy has lost its "industrial commons," its technological and productivity infrastructure, expertise, engineering and process development capacities. This picture shows extremely important abilities resulting from manufacturers,' suppliers,' and research organizations' systemic activities in several productivity activities. Their needs have emerged in these crisis times.

5 For a comparison between these countries' policies, see Kuo & Shyu (2018). Beside these three countries, Korea, Japan, and other European Union countries have invested a considerable number of public resources in these technologies.

6 China's arms and information industry base managed to build its own GPS network, alongside the ICT companies and related services. Available: https://edition.cnn.com/2020/06/24/tech/china-bei-dou-satellite-gps-intl-hnk/index.html. Access: June 2020.

The weakening American industrial core has been particularly relevant during the pandemic. This could be demonstrated by the lack of ventilators that stopped being manufactured on sufficient scale; such niche was taken over by China. Even though at least since 2010 the North-American Health Department had requested the creation of cheaper, more efficient ventilators, they were never manufactured. At that time, a small medical equipment company (Newport Medical Instruments) received US$ 1 million from the American Health Department to devise and manufacture such ventilators. However, in 2012 it was bought by big multinational Covidien company, which gave up the project on the allegation that it had already been manufacturing a similar ventilator in China that was more profitable (Dayen, 2020).[7]

Another aspect that deserves mention is that, against the lack of national policies and their mistakes, China has become more prominent in setting and implementing innovation strategies. Some subnational entities are confronted with the deepening economic, social, and environmental crises and powered by microelectronics technologies. Despite their limitations, they have managed to pursue and achieve strategic development aims based on alternative ST&I routes. Social innovations, people's collectives, often associated with the local power, have sought ways to survive in a hostile capitalist environment dominated by finance. Describing several experiences that took place in Europe after the 2011 Greek crisis, Mason (2016, p.12) stated that "almost unnoticed, in the niches and voids of the market system, entire sectors of the economic life started to move in a different direction. Parallel currencies, local banks, collectives, and self-managed spaces proliferated, barely noticed by their economic occupation, and oftentimes as a direct result of the post-2008 crisis old structures' disintegration".

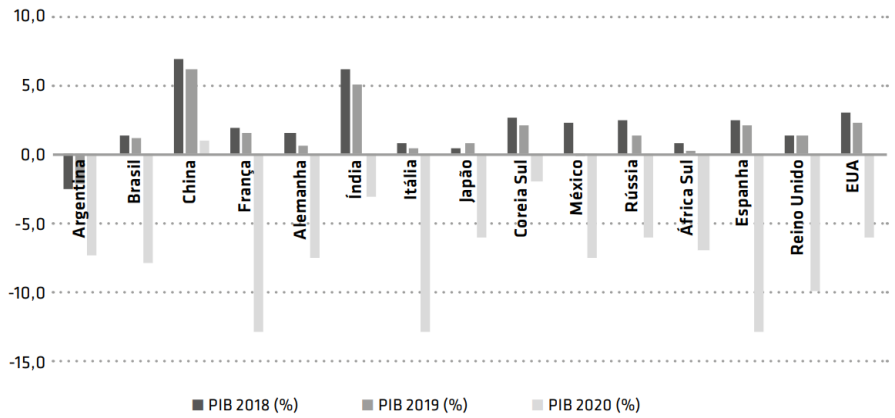
Such initiatives are generally rooted in productivity and social collectives, the local productivity arrangements (LPAs). Several examples, including a part of HEIC, can be found in extensive literature that documents such experiences (Cf.: Matos *et al*., 2017; Cassiolato; Lastres, 2003).

7 This is not an isolated case. In a study on this phenomenon, Cunningham & Ederer (2018) found an average of 45 cases per year of big pharmaceutical companies merging with competitors who had been devising more efficient, cheaper medicines and could reduce their profitability in order to just halt those projects.

Another important characteristic is that, according to data from UNCTAD (2018), there is a strong decrease in new investment projects from TFs, which had been accentuated since 2016. This went in tandem with the deacceleration in fusions and acquisitions of such companies. Finally, one must remember that the 2010s end with the global economy quickly escalating towards a new crisis. In 2019 the global economy growth rates were the lowest registered since the 2007-2008 crisis (FMI, 2020b).

Because of the possibility of a new financial crisis, the families' demand for durable assets also weakened. This was noted in the automotive industry, also affected by the shared transport app popularization and the decrease in the income level (Figure 4). IMF data (2020b) show that there was a decrease in companies' industrial production, as well as in world trade in the past few years (Figure 9).

Figure 9 - Global GDP (PIB) - Growth rates - Selected Countries 2018-2020*



* Projection

Source: Adapted from the World Bank (2020).

The IMF states that central banks reacted aggressively to the weakening activity by cutting interest rates and buying assets again. In an attempt to

save financial speculation, the monetary policy remains harmless to reactivate the real economy.

3. The answers to the challenges posed by Covid-19

The Covid-19 pandemic occurs amidst a deepening crisis whose origins are related to the production and mass consumption pattern. They are typical of the growth patterns found between the 1950s and 1980s. Despite a few exceptions, the governmental responses occurred in the following context: a constrained State; an almost failed macroeconomic management, which was noticed in the governments' growing indebtedness and their systemic inability of limiting commodification of labor, nature, and money; the erosion of public infrastructure and collective benefits in several activities, especially the ones associated with public health services after privatizations (Streeck, 2013).

The pandemic occurred after two decades of growing deterioration of the health systems, which became increasingly private, fueled by profit (Giovanella; Stegmüller, 2014). In the same period, the HEIC productivity and innovation activities globally were also taken over by big companies focused on maximizing short-term profits and control the generation access to knowledge via intellectual property.

It is not surprising that the governments' response in most countries was much smaller than what was needed to contain the effects of the pandemic. Although that was not enough, there have been heavy investments in resources and training to face the crisis, mostly under control of public policies. The Covid-19 pandemic was officially detected in December 2019 in China and its origin is still controversial. By September 14th, 2020,[8] it had infected over 29 million people, with over 925,000 deaths in 188 countries.

The IMF (2020b) states that at least since 1870 there has not been such a sharp decrease in productive activity. They foresee a 5.2%-decrease in the global GDP in 2020. In countries such as Argentina, Brazil, France, Spain, and the United Kingdom, the foreseen decrease is about 10% (Figure 9). The WTO

8 Data from John Hopkins University published on September 14, 2020. Available: https://coronavi-rus.jhu.edu/map.html. Access: Sept. 2020.

foresees a decrease in world trade of nearly 10%.

While the pandemic spreads across the world, national and subnational governments have taken different sanitary measures, which are reflected in the case measurement statistics and how these measures are taken to curb the pandemic. Evidently, such actions have been impacted by health system institutions in many countries. It is not surprising that the ones who suffered the most were those where privatizations occurred more radically.

To illustrate this, Table 1 shows data on the evolution of Covid-19 in some countries (the USA, Brazil, Vietnam, New Zealand, and India), and subnational entities (the states of Kerala and Tamil Nadu, in India, as well as the states of São Paulo and Piauí, in Brazil). The data are as follows: number of confirmed cases and deaths on September 15th, 2020 (total deaths and deaths per 100,000 inhabitants), population (2018) and per capita income (2018).

The data highlights two countries with widely different political regimes and income levels where public policies had been organized in a centralized way. This helped control the pandemic and minimize damages in economy (New Zealand and Vietnam). In these cases, popular commitment, a quick epidemiological control, and several forms of aid to families were relevant. Vietnam, a country of over 97 million inhabitants, reported a small number of deaths and cases despite its long border with China. The Vietnamese government promoted a productivity restoration by devising diagnosis kits and medical items and provided free food for all the population. They even created an ATM-like device for distributing rice. New Zealand, a small but high per capita income country, managed to control and virtually eliminate contagion.

The data also shows regional differences, especially in the state of Kerala, India. Even though Kerala has a very low-income level, it has one of the highest Human Development Indexes (HDI) in the world. It is a territory where education and health are universal public services. This state differs substantially from India, who rode the privatization wave and now is dealing with contamination and death rates that are far higher. Kerala features a strong public health infrastructure developed throughout decades, which results from a program similar to the Family Health Strategy, with direct

action at all homes. Their program implemented welfare measures that included free food to its population of more than 35 million inhabitants. They conducted an industrial reconversion with the support of a youth movement – the Democratic Youth Federation of India – alongside other organizations that started to manufacture hand sanitizers, while women's collectives – Kudumbashree (4.5 million members) – started making masks.

Table 1 - Covid-19 - Selected Countries and States - Number of confirmed cases on 09/15/2020 (total and per 100,000 people), Number of deaths on September 15th, 2020 (total and per 100,000 people), Population (2018) and per capita income (2018)

Countries	Cases	Cases/ 100,000	Deaths	Deaths/ 100,000	Population (millions)	Per capita income (US$)
USA	6,574,889	2,010	194,397	59	328	67,426
Brazil	4,345,610	2,075	132,006	63	210	8,955
India	4,930,236	364	80,776	6	1,352	2,338
New Zeeland	1,801	37	24	<1	5	40,266
Vietnam	1,063	1	35	<1	96	8,066
States						
São Paulo (Brazil)	893,349	1,970	32,642	72	45	16,535
Piauí (Brazil)	86,538	2,655	1,973	61	3	3,500
Kerala (India)	108,278	324	439	1	33	2,900
Tamil Nadu (India)	502,759	697	8,381	12	72	3,000

Source: Adapted from *The New York Times* (2020).

The results of all these actions differ in terms of the territories' stances on the socioeconomic crisis, their political views, the structural differences between their economies, their health service institutions, and their place in the international division of labor. Some countries can protect their population, while others, oftentimes with higher income level, opt for an autophagic, tragic path. They are unwilling to adopt the necessary sanitary measures like social isolation, properly monitoring the pandemic, and mistakenly oppose health and the economy.

To the confusing reaction of most countries regarding public health ensued a quick and extensive intervention of the governments. Especially in the more developed countries, it took place in order to avoid a financial collapse due to unpaid debt and unemployment, as well as an economic collapse due to a sharp decrease in effective demand.

Table 2 shows the measures taken by a few select countries (IMF (2020a). Monetary and fiscal relaxation measures were taken such as: reducing interest rates; facilitating credit operations; extending deadlines or postponing tax collection; greater public indebtedness; transferring wealth to families in need.

Table 2 - Measures taken by selected countries, direct impact of the pandemic regarding contagion, deaths, GDP variation, unemployment and public debt, January-June 2020.

Countries	(a) Budget measures	(b) Budget measures (%GDP)	(c) Extra budget measures	(d) Extra budget measures	(e) Government guarantees	(f) Government guarantees (%GDP)	Public debt (% of the 2019 GDP)
Argentina	5.4	1.2	ND	ND	5.4	1.2	89.4
Brazil	42	2.9	53	3.7	6.9	0.5	75.5
Germany	159	4.4	223	6.2	1,285	23.4	70.0
Spain	15	1.2	11	0.9	114	8.9	117
USA	1,395	6.9	405	2.0	454	2.2	135
United Kingdom	83	3.1	423	15.7	ND	ND	117
China	380	2.5	ND	ND	ND	ND	ND

Source: Adapted from the IMF (2020a).

Despite having adopted fiscal and monetary measures to avoid a financial, social, and political collapse, and in some cases, stimulate effective demand, the governments that let the sanitary crisis continue uncontrollably. Not only were there contagion and deaths, but they also ended up infecting their economies with a high degree of uncertainty and negative expectations.

The geopolitical tensions build up, and the massive increase in the social crisis, poverty, and unemployment is linked to a pronounced movement from the élites towards a pretend return to a previous "normality." The second quarter of 2020 witnessed a worsening in all traditional socioeconomic indicators while the stock market boomed (Khanthavit, 2020). For instance, in the USA, although the destruction of jobs had reached levels unseen since the Great Depression, there was an 18%-increase in the Dow Jones index,

which was the best quarter since 1987 (Mars, 2020).

However, there is immense pressure for radical changes in human behavior, production organization, management of technology, innovation, and national strategy development, as well as the role of the State and how it organizes itself.

The pandemic unveiled serious issues in the political, social, and production order, which seemed to have been veiled to a significant parcel of the society. The pandemic showed how important it is to understand the sanitary question dialectically and articulate it with environmental, food, social dimensions. It also reintroduced the meaning of treating it as a public asset that requires priority attention from all governments.

Although the élites continue in the same direction as before, issues like sanitary and food safety are already part of the public policy agendas of many countries. Being aware that depending on HEIC product imports – even those with smaller technological content – is incompatible with the needs that have emerged during the crisis. They have led several countries to implement policies to make them endogenous. Meanwhile, the food question and the countries' vulnerability as to importing food has made several governments implement policies to foster local agriculture production, improve food distribution, and redefine input strategies.

Emphasizing localization and making productivity and innovation health and food systems is part of a strong movement associated with changes in the energy matrices. However, this conflicts with a strong resistance from the status quo, as mentioned above.

These movements have been accelerated by the pandemic and involve capital destruction, productivity reallocation, changing the energy and technology matrices. Any attempt at predicting how they will end is premature since they are at the center of geopolitical matters and internal politics disputes in all countries.

Finally, this crisis shed light on the importance of recent technologies. Despite the uncertain future, it is undisputed that one of the most significant pandemic consequences will be a deceleration in development and use of disruptive technologies of the so-called Fourth Industrial Revolution. This development shall change how people live, work, and maintain relationships

in most countries. The possibilities of change brought by such technologies have been deeply affected by the major financial globalization players – the TFs. As mentioned above, most countries defined policies to organize and manage productivity and technology development. Nevertheless, in western countries, executing policies has been left for the market, which cannot make the high investments that are needed. Consequently, it will not facilitate the efficiency gains expected from disruptive technologies. On the contrary, under the domain of financialization, technology advances in areas such as artificial intelligence and robots have been deemed "of the so-so kind".[9]

China has been implementing systemic policies by defining projects, planning investments and funding. Because of its purchasing power, it has been distributing stock among several companies, preferably national ones.[10]

The Covid-19 crisis has proven the viability of stimulating major innovations by making use of recent technologies in a quick and inexpensive way. In fact, innovations have been produced, and a good part of them have been made by small companies and local collectives.

The World Economic Forum (2020) suggested several Industry 4.0 trends that were rapidly consolidated during the pandemic: online shopping and deliveries made by robots; contactless, cashless digital payments; remote work; distance education; telemedicine; virtual entertainment; improvements in productivity chains 4.0 (including big data, blockchain, IoT and cloud computing); 3D printing; robotics, and drones. From a social perspective, the recent technologies and the radical confinement for an indefinite period of time have developed new habits and values in people's behaviors and social lives. Because these technologies have boosted the dissemination of facts and acts and served to mobilize people collectively, they have become key for societies to react and protest against unequal treatment and police brutality.

Among these technologies, artificial intelligence (IA) has emerged as one of the most powerful tools to tackle the crisis. IA advances like language

9 "Automation technologies aimed at substituting machines for humans in these tasks are likely to be of the so-so kind" (Acemoglu; Restrepo, 2020, p. 29).

10 An example of this is how China has been successful at their smart city projects (Tan-Mullies *et al*., 2017).

processing, voice recognition, data analysis, "machine learning," and deep learning are already being used to face the pandemic in multiple ways, from diagnosis to monitoring.

Artificial intelligence and robotics are already being used in several forms to fight Covid-19: helping diagnosis; using robots to sterilize and deliver food; supplies and medicines; medicine R&D; surveillance and tracking diseases; detecting infected or non-conforming individuals; using supercomputers and big data to search vaccines for the coronavirus; training.

Besides, drones are being used in the fight against the coronavirus in many ways: virus detection; spraying; food delivery; surveillance; medical emergency delivery.

The speed at which several innovations based in these technologies have been created via multiple articulations between different areas of the public sector and the society (including collectives, civil society organizations, and companies). These results seem to prove the technical viability of such innovations, which feature high social content. They also demystify ideas that suggest that less developed countries can play a more active role in stimulating such innovation. Rather, they should seek them in the international market and only focus on their more effective use.[11]

4. Challenges for HEIC

Because of the trends and structural changes in the world economy, the Covid-19 pandemic has found countries in varied, specific situations of their historical paths. In 2020, each country's heritage has enabled somewhat quick and efficient responses to the pandemic. They have differed regarding fiscal capacity to leverage resources, innovation structures, communication, production, logistics, welfare, education, and health systems. These differences in capacity and public policies resulted in the first structural issue exposed by the pandemic. It stemmed from the globalization of productivity and innovation systems. Depending on products and inputs such as serology

11 For more information on the use of the Industry 4.0 technologies, see Cassiolato *et al.* (2020).

tests, personal protective equipment (PPE), ventilators and respirators, as well as active principles of medicines caused several reactions that highlighted the need for productivity capacity and the creation of training programs to foster innovation.

The trade war between China and the USA and the geopolitical dispute for the new market of 5G data transmission technologies had already been taking place before the pandemic. This situation was hardened and gained contours of a systemic crisis when the sanitary aspect was added to trade, economy, finance, and technology matters on the world stage. The war technologies – the arms races between the USA, Russia, the EU, and China – were like a classic competition arena. However, they were suddenly expanded by the health technologies, in which the competition for tests, vaccines, antiviral medications, equipment, and software took over the media. This affected the capital markets worldwide.

Consequently, some countries like the USA use their political and economic power to access high-demand, limited-offer products unilaterally. Although the WTO tries to organize and regulate international trade of these goods, many [countries] restricted and even forbade the sale of these items. They even retained full production for national security reasons (BDI, 2020).

Likewise, the big transnational firms take advantage of the crisis to make huge profits and restrict access to certain goods by making use of their monopolistic powers.[12]

To sum up, national interests shall have a greater influence on access to HEIC products. The great TFs shall maintain their strategies: using their power in the market, they shall maximize their short-term profits and define who will have access to their products and on what conditions.

Moreover, there are ongoing studies to explain to what extent the global value chains will be reverted or constrained due to the evidence of vulnerability in HEIC as highlighted by the pandemic. The national policies are taking this discussion into consideration. For example, Spain and Germany

12 Numerous examples can be given, but the most telling one is the recent decision of the USA government to buy all the world supply of remdesivir, an antiviral medication produced by American biotechnology company Gilead. Gilead announced that it will charge over US$ 3,000 from American citizens for a five-day Covid-19 treatment with use of remdesivir (SIROTA, 2020). This medicine was developed with strong governmental support and according to specialists, it could have been sold for US$ 10 with a significant profit margin (Whittington; Campbell, 2020).

have been promoting industrial reconversion backed by policies of fast-track approval of models and special funding for manufacturing health equipment and tools. However, these very countries, which signaled radical changes to make production and innovation endogenous and improve their health system working conditions by larger public involvement, are already dealing with the Realpolitik of submission to the neoliberalism diktat.[13]

Social distancing enabled people to spend more time in virtual communication, whether this is for work, study, entertainment, shopping, or interactions with friends and family. Large-scale confinement demanded new ways of labor regulation. Two consequences accelerated structural changes announced since the beginning of the 21st century, especially in education, health, entertainment, and trade.

The first one comprises formal and qualified workers, a part of society that has been diminished because of the several financial crises since 2008. The second one comprises the great mass of independent, informal workers with precarious/temporary contracts that have been legalized by liberal policies after the 2008 crisis. On the one hand, formal trained workers moved on to distance or home office work. They received equipment, ergonomic furniture, and stipends to help them pay their internet and energy bills. On the other hand, the remaining workers received a wealth stipend in the form of emergency aid to maintain their families and/or received access to emergency credit. The State was responsible for both ways of supporting families and small businesses.

Finally, the pandemic exposed an issue in the social structure resulting from the greater wealth inequality. It also accelerated a structural change in the organization of labor (offices do not exist anymore; production is controlled by artificial intelligence) and how remote work is done (information and communication technologies enable virtual presence). Building the needed infrastructures to support a digitized world and keep up-to-date with the most recent technology will be key for any company to remain competitive in a post-Covid-19 world. Also, they must adopt an inclusive, human-centered approach of technology.

13 Examples of this fact can be found in De Barron (2020) & Campbell (2020).

This idealistic view finds problems in the political sphere, as there is no consensus regarding the importance of the State role in providing public health services. The current conflict between models that foster public, universal primary attention – which is needed and effective to face the pandemic – and those who propose a mix between public and private (or even those who defend full privatization of health systems) has been rapidly escalating. It must be noted that even in privatization models, the State maintains its tax collector role. Because of its purchasing power, it plays the role of funder and fosterer of research, development, and innovation. It subsidizes health services and maintains citizen databases that today are one of the main information sources for innovations in health and enablement of greater profitability for the private sector.

These models predict profound technological changes. Many of them were briefly assessed during the pandemic and led to choices between more health worker training, the use of technologies to replace the workforce, and the use of high-complexity services. These could be robots for simple nursing services and disinfection, telemedicine, and artificial intelligence (all of them inseparable from big data).

The epidemiological systems of monitoring via social networks and mobile phone applications were widely accepted by societies, politicians, and specialists during the Covid-19 pandemic. They are being implemented, which has been dramatically changing the perception of what is public or private, the levels of privacy and individual freedoms. What hybrid (public-private) and monopolistic model shall emerge after the pandemic for sanitary surveillance purposes? What hybrid health services (human being-machine) shall become consolidated in the years to come and what investments shall be needed to train health professionals for this new form of work? Will the community health agents be replaced by an application in a watch or mobile phone? Will the imaging test AI analyses be more efficient than the doctors' analyses?

These are some of the main questions that will need to be discussed and answered in the years to come.

The pandemic also exposed a structural issue in the environmental realm that could not have been exposed despite years of debate on the need to

change the energy matrix and avoid catastrophes. Fossil fuels can be abandoned to make the economy "greener." For instance, the European Union strengthened and expanded its transition program towards a new energy matrix for sustainable consumption during the pandemic, which had been previously launched.[14] However, the way these European plans were made into concrete actions is still subordinate to the diktat of financialization, from a traditionally neoliberal perspective.

The absence of basic sanitation in several countries worsened the situation of families and communities with no access to water and sewage treatment. Hunger threatens entire populations in several countries, whether or not they are poor, including those with high wealth inequality, such as Brazil. Alerts on the disorganization in the food production chain were issued by the United Nations (UN) and the Food and Agriculture Organization (FAO). One cannot visualize what the concrete possibilities are of a huge wave of investments in data networks, schools, hospitals, or sanitation after the pandemic. Uncertainty is still high; the countries,' families' and companies' levels of indebtedness increases considerably; the governing authorities' political view is imprisoned by the financialization logic. This has not made room for proposing build-back plans considering the teachings of the pandemic regarding both keeping public health as a priority and acknowledging territorial differences.

To conclude, five structural issues can be made to exemplify change inductors or factors that deepen the systemic crisis worldwide and pose relevant challenges for the productivity and innovation health system. Not only is there a challenge concerning the organization of the productivity and innovation chains globally, its control and threats to national security, but there are also challenges concerning wealth inequality and the new labor market. Also, there are questions concerning the role of the State and funding; new artificial intelligence technologies that will influence work, world trade, and means of production control. Finally, there are questions concerning the relationships between health and the environment (the

14 See "European Commission: A European Green Deal" [036/2020] (the Climate Law) and a story by *El País.* Publication Data: April 19th, 2020. Available: https://elpais.com/sociedad/2020-04-19/la-reconstruccion-verde-tras-la-crisis-se-abre-camino-en-europa.html>. Access: Sept. 26th, 2020.

climate crisis, pandemics, and investments in the energy transition for economic and social infrastructure).

All of these issues and challenges are developing within the context of an acute crisis that is part of a chronic crisis that has been deepening since the 1980s, as mentioned above. The Covid-19 pandemic has worked on the economy and society as an enzyme. It has boosted reactions and structural changes previously noticed. Their directions are still uncertain. Whatever is looming seems to be gaining contours regarding technologies and priorities. However, the forces that are small in quantitative terms but powerful economically and politically are using all their knowledge to ensure that "the new normal" is limited to changes in human behavior after this pandemic. The current business models will remain intact. The increase in poverty and inequality has already been taking place and will inevitably expand. It will probably question this perception, and what is to unfold politically and economically is hard to predict. Yet, important political, economical, and cultural decisions (pacts and social values) must be made so that changes will enable and consolidate the public health system as one of the foundations of economic development and production.

Considering the new global innovation and productivity dynamic influenced by the changes mentioned in previous sections, Brazil has been facing serious challenges. To face such challenges, new public policies must be devised in order to overcome structural issues, foster innovations, and introduce recent technologies. This will enable the health innovation system to be transformed into one of the axes that will boost the economy and stimulate development in Brazil.

In as much as in several countries, in Brazil the question of external vulnerability was highlighted by the Covid-19 pandemic. Brazil's dependence on equipment, medicines, and input imports reached high levels, and it was deepened because of the pandemic. Such situation proved to be unacceptable. The importance of autonomous productivity, technology, and innovation in strategic segments stood out due to the restrictions dealt with during the fight against Covid-19. There must be a way of changing how the State functions and implementing new innovation and production policies that must prioritize instruments focused on generating, incorporating, and

diffusing recent technologies.

One of the most important challenges has to do with the utmost need to increase local productivity and innovation within a global and local context of economic, social, and technological changes.

Other studies (Szapiro; Vargas; Cassiolato, 2016) argued that HEIC industrial and innovation policies that had been adopted in the period 2003-2015 had a systemic character. They were able to articulate instruments that would support R&D, promote cooperation between universities and research institutes, stimulate regulation, public laboratory improvements and the public purchasing policy by the Health Ministry. This instrument was one of the main foundations of the productive development of health policy in the period mentioned. Such articulation originated the creation of a more systemic productive development policy that had greater impacts.

The industrial and innovation policies were widely halted as of 2016. Analyzing the impacts of such policies may contribute to learning about public policies in Brazil, as well as restarting the ones that seemed more effective and had greater impacts regarding the development of the local productivity and innovation capacity.

Although this question needs an in-depth discussion, it seems logical to bet on regionalization of health productive activities. To do so, compromises and articulations among several local players – governments, education and research institutions, community agents, etc. – must be sought. The Kerala experience in India, mentioned in the third section, is a relevant contribution because it shows how viable this can be, even in situations in which the federal sphere actions are not effective.

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