Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
COVID-19 and the Brazilian manufacturing sector: Roads to reindustrialization within societal purposes

Esther Dweck, Marilia Bassetti Marcato, Julia Torracca, Thiago Miguez*

Institute of Economics, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

A R T I C L E   I N F O

Article history:
Received 15 December 2020
Revised 3 October 2021
Accepted 25 February 2022
Available online 28 February 2022

JEL Codes:
C67
L60
L52
I15

Keywords:
COVID-19
Input-output analysis
Industrial policy
Deindustrialization
Brazilian manufacturing

A B S T R A C T

The COVID-19 crisis represents a turning point to rethink industrial policy spaces and countries’ productive autonomy, especially for developing economies, such as Brazil, that call for new ways of thinking about manufacturing within societal purposes. Using an input-output model, the paper explores the pandemic-crisis-effects in the case of the Brazilian manufacturing sector. We find that the pandemic-crisis has harmful effects on the Brazilian productive structure, revealing the dependence on imports of the Brazilian Health System. Reductions in manufacturing gross output and value-added are mainly seen in knowledge-intensive subsectors, followed by job losses and tax revenue reduction. We suggest that the pandemic points to some roads to reindustrialization and resilience, given the reorganization of international production networks and the growing dependence on imports in key manufacturing sectors. Thus, the potential role of the manufacturing sector to achieve inclusive and sustainable growth reveals the importance of building productive capacity beyond the pandemic.

1. Introduction

The crisis triggered by the COVID-19 pandemic brought additional challenges for the manufacturing sector. The paralysis of production lines in many countries and the impacts on international trade reflect the deterioration of companies’ financial conditions, dramatic shortages of inputs, and shrinking domestic and foreign income. Given these constraints, some may question the possibility of manufacturing to be found as the main driver of economic development, employment, and social stability. We argue that COVID-19 represents a turning point to rethink the industrial policy space and the productive autonomy of countries.

The Brazilian experience amid the pandemic crisis is an interesting case. Brazil is known by its high social inequalities and massive societal challenges. As one of the developing countries with the largest and most diversified manufacturing sector, the Brazilian economy is also marked by premature deindustrialization and shortages of technological capacity, becoming increasingly dependent on imports of not only high tech but also essential products. In the midst of significant uncertainty and exchange rate volatility, the Brazilian government’s lack of active reaction to pandemic-related issues added major instability and negatively affected business expectations for the near future. The paralysis of domestic production has created huge problems for manufacturing jobs and tax collection. Concerns were growing about supply shortages and domestic production insufficiency of items essential to life at the time of crisis, such as medical equipment and diagnostic test supplies.

This paper argues that the inseparable relationship between public health, social interactions, and production systems must be taken as a starting point for a qualified discussion about long-term recovery trajectories. With that in mind, we argue that there is a need for measures that stimulate the gradual recovery of manufacturing activity from the current crisis, and this requires analytical clarity about the effects on manufacturing subsectors. The deterioration in the domestic supply of final goods and services may have further harmful impacts on the Brazilian productive structure, resulting in intra and intersectoral effects. In addition, some have documented that the impacts of the pandemic on the Brazilian labor market are uneven, with vulnerable groups being the most affected (Gimenez et al., 2020), and heterogeneous in sectorial terms, as we will discuss. We found that the pandemic-crisis have further harmful effects on the Brazilian productive structure, revealing the increasing dependence on imports of the Brazilian Health System. As a result, the reduction of manufacturing gross output

* Corresponding author.
E-mail address: thiago.miguez@ppge.ie.ujfrj.br (T. Miguez).

https://doi.org/10.1016/j.strueco.2022.02.018
0554-349X/© 2022 Elsevier B.V. All rights reserved.
and value-added is mainly seen in the knowledge-intensive subsectors, followed by job losses in other manufacturing subsectors and a substantial tax revenue reduction.

This study assesses how the COVID-19 pandemic affects or is likely to affect the Brazilian manufacturing subsectors. Based on an input-output model, we estimate direct and indirect impacts of demand-side shocks on three dimensions: (i) production-side, which will take into account the effects on gross output and value-added; (ii) labor market-side, considering the potential loss of occupations and aggregate payroll reductions, and (iii) tax-side, regarding the pandemic-effects on the collection of taxes on products. This paper is based on the previous work organized by Dweck et al. (2020) and uses an input-output model to characterize the possible effects of the current crisis on the manufacturing sectors in light of its sectoral composition and linkages. We explore insights from the construction of three scenarios (mild, reference, and severe) about the current crisis's effects on different components of final demand and draw on the reference scenario.

Our simulation exercises refer mainly to negative shocks in final demand elements over the Manufacturing subsectors, except the positive impact of government expenses related to the provision of Health Services. Therefore, we discuss separately how the sudden demand increase for the related goods and services revealed the high dependency of Brazil on imports, as well as the fragility of technological capacity of the Economic-Industrial Health Complex (EIHC). This complex can be understood as a producer of essential products and services and, at the same time, as a group of specific sectors with high potential to develop innovations and technological capacities in an economy. Given this circumstance, the Brazilian experience may bring light to potential roads to reindustrialization within societal purposes to restore the catching up trajectory and ensure economy-wide opportunities and sustained economic growth.

The rest of this paper is structured as follows: Section 2 brings a theoretical analysis about what is behind the reindustrialization enforcement and sets an overview of the Brazilian manufacturing sector, showing its evolution over time and revisiting some of the challenges the productive structure faced over the last 20 years. Section 3 describes our empirical strategy to analyze how the crisis triggered by the COVID-19 pandemic may affect manufacturing sector in Brazil, highlighting of its sectoral composition and linkages and brings up many relevant questions about the Brazilian productive structure and its weaknesses. Section 4 analyses the results of our simulation based on an input-output model, presents the impacts related to EIHC and compares our findings with an overview of the effective impact over the recently published official statistics. Section 5 outlines some of the main strategic questions of a research agenda on building productive capacity beyond the COVID-19 pandemic, while Section 6 concludes.

2. The reindustrializing agenda and the Brazilian manufacturing case

2.1. Theoretical analysis on the strategic role of reindustrialization

Some scholars argue that the aspirations of reindustrialization are related to the trend towards the servicification of manufacturing (Lodefalk, 2017; Lanz and Maurer, 2015). It is worth noting that the interconnection between services and manufacturing activities is closely related to GVCs. As GVCs have become more pervasive and intermediate goods are crossing borders multiple times, production processes exhibit an increasing need to coordinate multiple stages of a global production chain. This led to a growing service content of manufactured goods, due to the need for linking stages and guaranteeing increased product diversity and customization of products (Maurer and Degain, 2012). Consequently, services can take a much larger share in the domestic content of a manufactured product than manufacturing per se, which is more commonly seen in advanced countries.

There are other critical dimensions of servicification. On the one hand, services are increasingly being sold bundled with goods (Mirodout and Cadestin, 2017). The author argued that most of the distinction between firms that are producing goods and firms producing services is mainly artificial, because manufacturing firms are responsible for a significant part of services sales and exports. Beyond that, the author considers in-house services within manufacturing firms a key feature of servicification (i.e., “servicification inside firms”). Heuser and Mattoo (2017) argued that the role of services as inputs in GVCs changed the notion of GVCs centered in arm's length market-based transactions to functions within the firm. However, this is a tricky feature, once those activities are challenging to measure and, when taken to the limit, only can be identified as services in the sense that if they were outsourced, they would belong to services industries (Mirodout and Cadestin, 2017). To sum up, Baldwin et al. (2015) argued that some of the potential causes of this phenomenon are: i) reclassification (what was once considered manufacturing, as it was produced in-house by manufacturing firms, now is classified as services); ii) changes in connecting services and goods, as well as in the nature of final manufactured goods; and iii) changes in the relative price of tasks, with some manufacturing tasks being offshored driven by lower-cost reasons. However, the causes behind servicification are still an open question in the literature.

With the boundaries between manufacturing and services being increasingly crossed, outsourcing and offshoring strategies that dominated for decades now turn into a broad discussion about re-shoring and a revival of manufacturing. This means that reindustrialization in developed countries, such as the United States, the UK, and France, means to bring home much of the manufacturing that they have been outsourcing abroad. By investigating the drivers of a “manufacturing renaissance” in Europe, Dachs and Zanker (2014) observed that the most frequent reason for back-shoring is poor quality of the goods produced at foreign locations, followed by the loss of flexibility and too high transport costs. Frontier’s technologies can also mitigate the low-wage advantage of competitors and make manufacturing in these countries more cost-effective (Gilchrist, 2016). Beyond new production technologies, increasing wages in developing countries can deteriorate the cost advantages of several offshoring locations in the next decade. While scholars discuss reshoring strategies in the face of the servicification of manufacturing in the case of developed economies, what is left for developing countries?

Drawing on the case of developing countries, the declining share of manufacturing production and jobs over the past two decades has been of particular concern for policymakers and scholars. This is called premature deindustrialization, as it means that several developing countries are becoming service economies without having had fully industrialized in the first place (Rodrik, 2017). Tregenna (2015) suggested that the effects of deindustrialization may depend partly on the nature of deindustrialization. Apart from its negative effects on growth, we build from the author’s idea that the extent to which deindustrialization is considered undesirable is related to political and social reasons as well.

Bear in mind the heterogeneity of deindustrialization and that the policies to avoid it or reverse it remains place- and time-specific, the Brazilian case illustrates the strategic role of reindustrializing a country with high social inequalities and shortages of technological capacity to restore the catching up trajectory. Within the context of the currently disruptions in GVCs, one needs to identify the fragility of the Brazilian manufacturing sector as a specific case. In the absence of a broader base of productive capabilities, as it will be discussed in the next section, the Brazilian
economy has failed to build economic and social resilience through expanding formal employment opportunities and adding value locally.

2.2. About the fragility of the Brazilian manufacturing sector as a specific case

One of the main topics in the Brazilian economic debate is the role of manufacturing industries to promote and engage inclusive growth and sustainable development. Some pieces can be collected in order to better understand this big puzzle.

The Brazilian manufacturing sector has longstanding importance as a source of income. Over time, the Brazilian structure of manufacturing shows the coexistence between diversity and heterogeneity. The first dimension is related to the diversity in terms of subsectors and their interactions, with firms from different sizes, ownership structure, and production lines. On the other side, the heterogeneity dimension is observed from the differences within and among the subsectors, where a wide range of capabilities and levels of productivity coexist in the same environment (Kupfer and Rocha, 2005).

Although, we find a considerable reduction of the share of manufacturing in gross domestic product – from 15.1% to 9.8% between 2004 and 2020. Regarding the share in employment, the representativeness of the manufacturing gravitated around 11% over the last 20 years, in a movement completely the opposite as seen for the services, where the share in total employment grew up from 60.2% in 2000 to 68.1% in 2017. That said, there is a huge debate concerning the existence or not of a phenomenon such as deindustrialization in Brazil. Depending on what is meant by deindustrialization and the measures to identify it, the Brazilian case’s conclusions may vary (see Nassif; 2008; Opreiro and Feijó, 2010, and Nassif et al., 2015, to address this discussion in the case of Brazil).

However, there is a consensus regarding the deleterious effect of premature deindustrialization for countries like Brazil. According to Palma (2014), if the pattern and the dynamic of growth are crucially dependent on the activities being developed inside a country, premature deindustrialization has impacted the speed of the economic growth of developing countries and affects its sustainability. Authors like Andreoni and Tregnena (2018) argue that the premature deindustrialization shrinks the opportunity for technological development and reduces the country’s capacity to add value in CVCs and tradable sectors, imposing in some way the persistence of the middle-income trap.

Nevertheless, due to a truncated industrialization process, Brazil keeps facing an increasingly struggle to engage in activities that require and produce with greater technological content. Some authors call this phenomenon structural rigidity, as the industry remains unable to expand its productive capacity, diversify its production lines, or build a trajectory of innovation. The consequences are low productivity rates and a progressive challenge of entering the highest value-added chains in the domestic and international context (Kupfer and Torracca, 2019). As a representation of it, the share of medium and high knowledge-intensive sectors is in a progressive declining in domestic value added and in total exports. From a perspective that Manufacturing subsectors that are more knowledge intensive and require a higher technological content have the greater capacity to induce economic growth, developing countries as a whole, and Brazil in particular, continue to experience difficulties in building inside a system with more feedback links and realize their catching-up process (Reinert, 1994).

Another critical dimension of manufacturing’ role in the Brazilian pattern of growth is the macroeconomic perspective. As the macro regime is completely correlated to the micro framework from a systematic point of view, the scenario described previously evolved during the last years associated with a trajectory of low investment rates, uncompetitive exchange rates, and a contractionary fiscal policy. These forces together created a hostile environment that was not stimulating for manufacturing production.

This kind of competitive pattern seems to be much more structural than a current phenomenon. Fig. 1 synthesizes the main indicators for the Brazilian economy over the last 20 years. As shown, a four-year moving average trend line indicates a GDP expansion above 3% between 2004/2005 until 2013/14 and a sharp decline after that. Investment rate followed a cycle of growth and decline: from around 17% in 2005/6 to above 21% in 2013/14 and 15% in 2019/20, the lowest investment level since the turn of the century. Under such conditions, the capacity utilization rate remained around 80% from 2003 until 2013/14 and dropped to 77% in 2019. Accordingly, the share of manufacturing value added in relation to GDP was just above 14% in 2006/7, followed by a declining spiral towards a 10% ratio in 2020. So, in some sense, from 2010 until now, Brazil is experiencing a persistent downward economic activity, reducing both domestic absorption and productive capacity.

Therefore, since the trade liberalization during the 1990s, the Brazilian manufacturing industry somehow faces stagnation. Even during the commodities cycle and the return of industrial policies in the 2000s, the result was the expansion of the services not connected with high technology activities and the consolidation of a regressive specialization trend, directly linked with the increase of natural resource-based exports to China.

Since the peak in the end of 2010, the growth rate of manufacturing value-added is describing a downward trajectory independently of the seasonal variation (Fig. 2). This movement was dramatically reinforced in the first two quarters of 2020 due to the pandemic crisis’s effect – the loss associated with the second quarter of 2020 reached 20%.

The current international crisis derived from this amplified movement in the global arena found the Brazilian manufacturing industries already in a critical situation and added doubts to its role in economic recovery. This research sheds light on whether the Brazilian manufacturing industries remain relevant to strengthening sectoral linkages, how they were affected by the COVID-19 pandemic crisis, and what may be the role of manufacturing to build inclusive growth and sustainable development.

3. Method and material

To fulfill both objectives of a general view from the COVID-19 pandemic over the Brazilian economy and the specific impacts over the different sectors, we have chosen to use an input-output (IO) methodology. These models estimate direct and indirect impacts based on economic shocks, which were calculated simulating three different scenarios. Following, there is a brief explanation of how these models work and how the scenarios were done.

3.1. The input-output model

Input-output models are based on the IO matrix and seek to explain and quantify all interdependencies between the different sectors in a particular economy (or group of economies). Therefore, IO models estimate the direct and indirect impacts of eco-
nomic shocks and the sectoral spread these shocks assume. It is worth mentioning that these models allow estimations on a wide range of variables, such as output, value-added, employment, and aggregate payroll.

The main data source to calculate an IP matrix comes from the Supply and Use Tables of the System of National Accounts (SNA), the primary source of data for any national economy. The Brazilian SNA, is released annually by the Instituto Brasileiro de Geografia e Estatística (IBGE). However, the IO Matrix is only available every five years. The last IO matrix available for Brazil is for 2015. So, to have an updated model, the IO matrix used in this paper comes from the process presented on Passoni and Freitas (2020), on which the authors come up with a methodology to estimate IO matrices on an annual basis. The most recent matrix is for the year 2017, calculated by Passoni and Freitas (2020), and consists of 127 products and 67 industries, including agricultural, mineral, manufacturing, services and public administration.

The model used in this paper redesigns the methodology presented on Freitas and Dweck (2010) and Freitas et al. (2010). An important aspect of IO models is the division between the supply and demand sides of the economy. The supply side consists of every product (national or foreign) provided to an economy. The demand side is the use of these products, divided into two main destinations: the intermediate consumption and the final demand, subdivided, in this paper, into four components: “Household consumption”, “Government consumption and investments”, “Household and Corporation Gross Fixed Capital Formation” and “Exports”.

As mentioned, IO models work estimating the impacts of different economic shocks. In this case, the economic shock derives

---

3 Appendix A contains a brief mathematical explanation of how these models work.

4 Although it is not the case in this paper, non-economic variables can also be subject to studies on IP models, like carbon emissions, energy consumption, and natural resources usage.
from the consequences of the necessary measures to contain the COVID-19 pandemic. The shocks were built on the final demand side, changing the purchases of the 127 products on each final consumption element. For example, thanks to social isolation, we might suppose a reduction on household consumption for cars, but an increase in the household consumption for electricity. The impacts on the intermediate consumption are endogenous, as a consequence of the change in total output. For instance, due to the loss of car production we can also expect a reduction on the tires and car engines production. Which in turn can reduce the demand for rubber and steel and then for iron ore, and so on. Input-output models are an excellent tool to estimate these direct (tires and engines) and indirect (rubber, steel, iron ore, etc.) impacts of a primary shock (consumption of cars) on output or any other variable on which there is compatible information, such as jobs, aggregate payroll, value-added, imports and indirect tax.

In other words, this multidimensional analysis allows a broader understanding of the economic impacts of the COVID-19 pandemic. It can also be useful to support reflections on potential consequences and formulate public policies not only to minimize it but also for a faster recovery.

Before we proceed, it is important to notice that despite the scenarios were built changing product purchases, the IO model requires a sector by sector matrix to estimate the direct and indirect impacts. So, to achieve this condition, after the economic shocks were defined, we assigned the products to their corresponding supplier sectors, and all the impacts are measured at the sector level.

3.2. Building the scenarios

There are three scenarios based on the effects of social isolation measures, economic policies, and the potential economic recovery according to the effectiveness and the use of public policies: mild, reference, and severe. These scenarios followed Dweck et al. (2020), where the authors estimated the direct and indirect impacts of the COVID-19 pandemic for the entire economy and on the different sectors. This paper evaluates these effects focusing on “Mining and quarrying” and “Manufacturing” industries for six variables: gross output, value-added, employment, aggregate payroll, imports, and taxes on products.

The mild scenario assumes a “V” shaped path for output growth, which means a rapid recovery for economic activity. This scenario assumes an effective government action during the crisis to minimize its impacts on most companies' household income and the financial situation. Therefore, short and effective social isolation would be possible, avoiding long-term economic impacts. Looking at international trade, a recovery scenario for the world economy would prevail in the second half of 2020, especially due to a recovery of China's economic activity.

The reference scenario assumes a “U” shaped path, which means a slow economic recovery because of a longer social isolation period. We associate this scenario with less effective damage contention policies on both income and financial sides. The world economy recovery perspective is also slower, corresponding to weak demand for tradable products and a limited international capital flow.

The severe scenario assumes an “L” shaped path, which means a prolonged "U" shape or even a lack of recovery. This would be a consequence of inadequate measures to contain the coronavirus itself, not only its economic consequences, meaning a long period of social and economic disturbance. As socioeconomic fallout we can point to the disarticulation of supply chains, a wide deterioration of the labor market and an increase in poverty and inequality. The foreign forecast is marked by a slow recovery in the global economy and international trade, remarkably on the manufacturing production in the United States and the European Union that could rise only during 2021. The proliferation of protectionist measures is also considered.

The scenarios are based on perspectives for every 127 products classified in five categories of demand change: (i) large decrease; (ii) decrease; (iii) unchanged; (iv) increase; and (v) large increase. The classification considered not only the product itself but its final demand use. Therefore, it was possible to consider that the same product could face different perspectives depending on which final demand component it was directed to. For instance, some food categories would face a decrease in demand for international markets (i.e., Exports) but not on domestic sales (i.e., Household consumption). It is important to notice that although we give quantitative perspectives to the products, their assembly really depends on the final demand components' perspectives.

Regarding Household Consumption, the demand for food (fresh and processed) was considered “unchanged” on the mild scenario. At the same time, the demand for “Soap and cleaning preparations”, “Pharmaceutical products”, “Electricity, gas, steam and air conditioning supply” and “Human health and social work activities” were considered “increased”. All other products had their demand “decreased” or “large decreased”. On the reference and severe scenarios, the demand for food was changed to “decrease” and only “Soap and cleaning preparations” and “Electricity, gas, steam and air conditioning supply” were considered “increased”. All other products were considered “decrease” or “large decrease”.

The Exports scenarios must consider aspects such as the Brazilian export basket, its main partners' economic situation, and the domestic situation. Depending on how fast the world economy recovers, especially China, the United States, the European Union, and Argentina, Brazilian exports' demand may rise faster. On the other hand, if the domestic situation worsens, Brazil might not be able to increase its production even if the demand returns. An unbalanced international recovery may also compromise some supply chains more dependent on imports. With this in mind, the mild scenario reflects the hypothesis of a beginning in the recovery of Brazilian main partners in the second quarter of 2020. The reference and pessimist scenarios reflect both a worsening on the demand side for Brazilian exports and domestic difficulties to resume production on pre-pandemic levels.

Both Government Consumption and Gross Fixed Capital Formation shocks were simplified. Based on public announcements, the Government Expenditure shock was considered an increase of R$40 billion (around US$8 billion) on public health spending (investments and services) and assuming that other expenses will not change. Concerning Private Investment, a generalized impact of −10%, −20% and −30% was considered for every product on the optimistic, reference and pessimistic scenarios, respectively.

The results are summarized in Table 1, which shows the change in final demand elements in each scenario. The total final demand shock is also shown.

Finally, it is important to highlight that the scenarios did not consider the origin of the products, meaning whether they are national or imported. For instance, the 3.8% drop in Household Consumption in the reference scenario includes domestic and imported products. Thereby, the impacts on each product's national production differ depending on the rate it is provided by domestic or imported products, which were considered on the estimations.
Table 1
Shock scenarios and final demand elements impacts expected for 2020.

| Final demand elements | Household consumption | Government consumption and investment | Household and corporation GFCF | Exports | Total final demand |
|-----------------------|-----------------------|--------------------------------------|-------------------------------|---------|-------------------|
| Mild                  | −1.5%                 | 2.5%                                 | −10.0%                        | −6.6%   | −2.4%             |
| Reference             | −3.8%                 | 2.5%                                 | −20.0%                        | −15.7%  | −6.0%             |
| Severe                | −8.3%                 | 2.5%                                 | −30.0%                        | −20.4%  | −10.3%            |

Sources: Own elaboration on IBGE - Instituto Brasileiro de Geografia e Estatística, 2020.

Table 2
Average aggregate payroll and employment, value added, wages, and taxes coefficients.

| Manufacturing | Average aggregate payroll (R$/month) | Employment coefficient | Value added coefficient | Wage coefficient | Taxes coefficient |
|---------------|--------------------------------------|------------------------|-------------------------|------------------|------------------|
| Manufacturing | 2159.5                               | 3.3                    | 0.2                     | 0.1              | 0.19             |
| Services      | 2064.5                               | 10.3                   | 0.7                     | 0.3              | 0.04             |
| Other         | 746.9                                | 10.8                   | 0.5                     | 0.1              | 0.06             |
| Brazil        | 1804.7                               | 8.5                    | 0.5                     | 0.2              | 0.08             |

Note: All coefficients were calculated based on gross production rates.
Sources: Own elaboration based on IBGE - Instituto Brasileiro de Geografia e Estatística, 2020.

4. Impacts on Manufacturing sector

As discussed above, the IO approach used here seeks to estimate the different economic impacts of the COVID-19 pandemic in Brazil. Initially, it analyses the pandemic’s effects focused on the service sector, given that the needed social distance made several companies to stop its’ activities. However, using an IO model, Dweck et al. (2020) found that the manufacturing sector would be more affected than services, making the initial scenario even worse. In this sense, given the diversity of Brazilian manufacturing, our analysis focus in this sector, considering a division (proposed by Torraca (2017)) in four groups: agricultural commodities (AC), industrial commodities (IC), traditional manufacturing (TR), and innovative manufacturing (IN). These groups were designed considering the different competition patterns each Manufacturing sub-sector faces.

To highlight the importance of manufacturing in the Brazilian economy, Table 2 presents some indicators illustrating the structural disparities between Manufacturing, Services, and other economic activities. Manufacturing presents the highest coefficients on “average payroll” and “taxes”. Also, manufacturing has the lowest “employment coefficient” - a proxy for the inverse of productivity. On the other hand, Services have a higher “employment coefficient” and a lower “average aggregate payroll”, due to a high share of less qualified and informal jobs. However, due to its higher labor intensity, services present the highest wage and value-added coefficients.7

4.1. A comparative analysis of manufacturing and services simulated impacts

Considering the described shock on the total final demand for the three scenarios, Table 3 presents a comparative analysis between Manufacturing and Services. It is possible to see each sector contribution (on percentage points - p.p.), and the total impact.

The impacts were estimated for the following variables: (i) gross production; (ii) imports; (iii) employment; (iv) aggregate payroll; (v) value-added; and (vi) taxes.

In general, for the three scenarios, there is a larger contribution from Services to the fall in gross production and value-added, mainly due to the greater share of services in the Brazilian economy. The same goes for employment and aggregate payroll since the Services are traditionally more labor-intensive than Manufacturing. However, for the imports, the Manufacturing impact is greater because imported goods are demanded in a greater proportion by manufacturing subsectors.8 When we look at the fiscal dimension, Manufacturing also plays a greater role; its share on the taxes losses is around 70% in all scenarios. Therefore, despite the usual dichotomy between the “natural” replacements of Services on Manufacturing, it is important to notice that Manufacturing remains important thanks to its higher inter-sectoral linkages and tax collection. This is especially true in the context of a long-term crisis and the need to face it.

Although Services’ contribution to total impact is greater than from Manufacturing, this happens because of its major share in the Brazilian economy. If we look each sector individually, it is possible to observe that Manufacturing faces a major impact Table 4 presents the impact for each sector and the total impact of the selected variables. As we can see, Manufacturing is expected to contract at a larger rate than Services and the total economy in all scenarios and for all variables. However, it does not mean a uniform impact within Manufacturing.

4.2. Simulated impacts within the Manufacturing sector

In this study, we address how the pandemic crisis affects each Manufacturing subsector differently. These differences are due to structural discrepancies among them, reflecting not only the result for the entire economy, but also on each selected variable. From now on, we will take a deeper look within Manufacturing, considering the four major groups previously identified: agricultural commodities (AC), industrial commodities (IC), traditional manufacturing (TR), and innovative manufacturing (IN).

The AC and IC groups follow similar international competitive patterns. Their products tend to be homogeneous, intensive in natural resources (agricultural, mining, or energy), and follow a conventional export-led strategy, such as “Food and beverages” and

---

7 Furthermore, it is worth considering that the public administration (incorporated in services) has a high wage-share, which makes the importance of the aggregate payroll in the gross output of the service activities even greater than in the Manufacturing industry.

8 The share of imports in total manufacturing output was 20.8% in 2018 according to the SNA.
“Paper and paper products”. The TR group includes labor-intensive activities with low technology sophistication, such as “Textiles” and “Wearing apparel”. Finally, the IN group is responsible for more sophisticated goods requiring a higher technological development level, infrastructure and qualified labor, including activities such as “Machinery and equipment” and “Computer, electronic and optical products”.

Table 5 shows that AC has the smallest contribution for all variables. This was expected and is consistent with the main trends observed at the beginning of 2020 when domestic and international demands for these products remained sustained high. On the other hand, the IC and IN groups are the ones that most contribute to the fall in the gross production and value-added. Special attention to the IN group impact on the value-added, its share is around a third of the impact (−0.47 p.p. of −1.2 p.p. for total manufacturing in the reference scenario). The TR group presents the largest impact on employment, as expected considering it includes the most labor-intensive manufacturing activities. However, the aggregate payroll losses are more intensive on the IN group, because of its higher qualified occupations and wages. At last, the IC group is responsible for the largest losses in tax collection.

The simulations highlight a chronic problem the Brazilian Manufacturing has been facing: the difficulty to increase the share of activities embedded in technological progress and, therefore,
with a better capacity to increase productivity (Kupfer and Torracca, 2019). The structural differences between the four major Manufacturing groups influence how the pandemic may impact each of them. In addition, Table 6 reveals the connection between these activities and the expected impacts on each final demand element. We present only the effects associated with the “reference scenario”.

Table 6 presents how each final demand element impacts both the entire economy and Manufacturing, considering the reference scenario. It also shows Manufacturing’s contribution for the total impact. In a general perspective, the expected output loss for the Brazilian economy is 7.1%, with Manufacturing being responsible for more than a third of this impact (37%). At the same time, the estimated impact on manufacturing is −9.8%, greater than the −7.1% effect on total output. Looking at the value added, the share of Manufacturing on total final demand impact is lower (20.4%), but still important.

Similar analyses can be extended to other variables, especially for the taxes. Relatively speaking, the tax dimension is the one that draws most of the attention. Manufacturing is responsible for 71% of the 8.2% drop in tax revenues. Also, in all three scenarios, estimates point out that the contribution from Manufacturing to the loss in tax collection is around 60% to 70% higher than those from Services.

The variable with the smallest contribution from Manufacturing in total impact is employment (14.6%). Notwithstanding, the employment fall estimated for Manufacturing is not comparable to any other economic crisis in recent decades. The results indicate a potential reduction of 1.2 million manufacturing jobs, representing an unprecedented contraction of 11.0% of its workforce, higher than the 7.9% contraction rate expected for the entire economy. In the simulations, the loss of jobs associated with Manufacturing accounts for 14.6% of the total 8.3 million cuts in the reference scenario (Dweck et al., 2020). Moreover, the Manufacturing subsectors of low and medium-low technological intensity showed the most significant losses. Therefore, most of the threatened Manufacturing jobs are in these labor-intensive industries, with less qualified and less paid workers, along with scarce social protection and fewer chances of restructuring themselves from a reduction of working hours and destruction of jobs.

The distinct subsectors that most contribute to a potential reduction in employment and in the aggregate payroll point out the structural differences within Manufacturing. The automotive industry gives us a good example. The two subsectors that represent it (“Manufacture of motor vehicles” and “Manufacture of parts and accessories for motor vehicles”) occupy the second and third position among the subsectors that most contribute to aggregate payroll reduction.10 On the other hand, that is not the case for occupation losses, since the automotive industry is not labor-intensive, but pays relatively higher wages than the rest of Manufacturing, rising its importance in aggregate payroll.

On top of that, these impacts are not homogeneous inside Manufacturing, as we have seen in Table 5. For that matter, most of this heterogeneity comes from an expected differentiated pattern among the final demand elements, meaning that the economic effects of the pandemic depend on which subsectors are most impacted by each of these elements. The data presented in Table 6 also points in that direction.

First, looking at the Exports it is possible to see that Manufacturing has a huge influence on its performance. Manufacturing exports is responsible for almost a half of the total impact in taxes

---

9 It is important to mention that our simulations consider only the loss regarding taxes over production and consumption (discounted from the subsidies granted).

10 The “Manufacture of motor vehicles” and “Manufacture of parts and accessories for motor vehicles” accounts for almost 15% of the fall in the aggregate payroll of Manufacturing. If the −6.0% expected annual retraction is confirmed, it would be a historical fall (Cucolo, 2020).
(59.0%) and gross production (45%), more than a third in aggregate payroll (36.1%) and more than a quarter in value added (28.2%) and employment (27%). This smallest contribution to total jobs destruction is consistent with the Brazilian export basket, dependent on products from the AC and IC groups, that are intensive in natural resources and less intensive in labor. At the same time, the IC group is responsible for paying better wages, explaining the relatively larger contribution for the aggregate payroll coming from the Exports.

At the same time, Exports also explain a large part of the impact within Manufacturing, such as the −4.2 p.p. from the total reduction of −9.8% in Manufacturing gross production. Exports also has the highest contribution to Manufacturing drop in value added (−4.9 p.p. from −11.3%) and in the aggregate payroll (−5.3 p.p. from −12.2%). Inside manufacturing the activities that hold the biggest losses are “Manufacture of coke and refined petroleum products”, “Mining of iron ores”, and “Manufacture of basic iron and steel”, all related to the IC group. On the other hand, despite the AC group has an important share of Brazilian manufacturing exports, sales in this group are not expected to be largely affected.

**Government consumption** is the only component that offers a positive shock in our IO model simulation, due to expectations in a rise of public health services. The impact of Government consumption is around 0.5 p.p. for the selected variables, both for the entire economy and for Manufacturing, except for the Taxes with a smaller impact. On the other hand, most of the impact is estimated to happen on sectors with more technological intensity and, despite the low contribution for job expansion in Manufacturing (0.6 p.p.), it represents over 65,000 new occupations. Notwithstanding its low contribution, the expansion of public healthcare spending with hospital needs, protective equipment, supplies for medical tests and other medical equipment is a fundamental public policy to mitigate the pandemic’s negative economic effects, beyond the obvious sanitary needs. The most affected subsectors are those related to IN group, especially the production of goods to maintain and expand the medical supply equipment, such as “Repair and installation of machinery and equipment” and “Manufacture of computer, electronic and optical products”.

Considering **Household consumption**, Manufacturing corresponds to a third (33.3%) of the total impact in gross production. At the same time, this final demand element contributes in a similar proportion for Manufacturing’s gross production result (−3.2 p.p. of −9.8%). The impact is more pronounced for Manufacturing if we look at employment. The estimates point out to a strong impact on the potential retraction of Manufacturing employment (−4.4 p.p. of −11%), which corresponds to almost half a million occupations. All in all, despite it has the smallest share of Manufacturing on the total impact of employment (11.7%), it holds the most potential job destruction if we look within Manufacturing. The most affected subsectors are those related to daily consumed products in the TR group, such as “Manufacture of other food products”, “Manufacture of clothing apparel” and “Manufacture of textiles”. The last two subsectors account for almost a quarter of total potential contraction in Manufacturing occupations. On the other hand, Household Consumption contributes with less than a half of the expected drop in wages (−3.5 p.p. of - 12.2%) in Manufacturing, this difference can be explained because the reduction in Household consumption affects labor-intensive subsectors with low average wage occupations, which makes the drop in occupations more important than in aggregate payroll.

Finally, despite the estimated effects of **Household and corporation GFCF** in Manufacturing are similar to the case of Household consumption for gross production and value added, it mainly affects the IN group (the subsectors with higher technological content). This also explains the larger contribution for the drop in the aggregate payroll than in employment. This contraction in investments will not only affect subsectors like “Manufacture of machinery and equipment” and “Manufacture of motor vehicles, trail- ers and semi-trailers”, but also its supply chain like “Manufacture of fabricated metal products, except machinery and equipment”, “Manufacture of other non-metallic mineral products” and “Manufacture of computer, electronic and optical products”.

In sum, a limited number of Manufacturing subsectors explains much of the pandemic-related economic effects. More specifically, the subsectors that most contributed to explaining the negative effects of the pandemic for Manufacturing, considering the different impacts resulting from the shocks in each final demand components, are: “Manufacture of coke and refined petroleum products”; “Manufacture of machinery and equipment”; “Repair and installation of machinery and equipment”; “Manufacture of textiles”; and “Manufacture of wearing apparel”. Table 7 illustrates the extraordinary recurrence of these subsectors.

Draws attention that two subsectors appear more prominently in Table 7: “Manufacture of coke and refined petroleum products” and “Manufacture of machinery and equipment”. The first case is not surprising if we consider that this subsector has a relevant share in the total Manufacturing gross output and since it produces inputs widely used by other subsectors (fuels), and not only by those in Manufacturing (for example, transport services). So, a large-scale slowdown in the economy undoubtedly increases its losses. In the second case, the huge drop expected for the GFCF hits hard and directly the capital goods industry mostly represented by “Manufacture of machinery and equipment”.

Beyond the numbers presented here, it is important to notice that even before the pandemic crisis, Brazilian Manufacturing production was already showing signs of extreme difficulty. According to the Brazilian industrial production index (PIM-PF/IBGE), Brazilian manufacturing production suffered a cumulative loss of 16% between 2013 and 2019. The capacity utilization index (NUI/CNI [12]) reveals a decrease of 5.4% in the same period. Both numbers show the difficulties companies faced in finding ways to increase their products’ demand. In fact, the domestic conditions to support this increase has not occurred.

To illustrate, according to the United Nations Industrial Development Organization (UNIDO), the share of Brazilian Manufacturing value added in world manufacturing value-added has dropped by more than 50% over the last 20 years (UNIDO, 2021). This trend has been considerably faster since 2013. Although other developing countries have also lost some share, mainly due to an increase in China’s participation, Brazil has been even worse than other economies. Another important factor is that the estimated data presented in Table 6 shows a drop in value added for the whole economy of 6.1%, while for Manufacturing it was 11.3%. Thus, the pandemic crisis tends to worsen this scenario of loss for Brazilian Manufacturing.

Even the positive shock expected from the rise in government consumption to face the pandemic crisis may face problems. The expansion of resources to priority areas must be combined with the guarantee of qualified personnel and the supply of essential inputs to face the pandemic, both hard to obtain in several amounts considering that every country in the planet is facing a similar situation. Also, the difference paths each country are driving the pandemic situation may constitute unbalanced path to the reestablishment of global supply chains. In other words, the severe sce-

---

[11] PIM-PF is the initials for ‘Produção Industrial Mensal - Produção Física’, which can be directly translated to Monthly Industrial Output - Physical Output. It consists of the main short-term indicator for Brazilian manufacturing and mining and quarrying industries output.

[12] IBGE does not calculate a capacity utilization index. However, the Brazilian National Confederation of Industry (CNI in Portuguese) consults its associates to calculate the mentioned index (NUI/CNI).
A summary of the main impacts on manufacturing sectors by the selected variables and final demand elements.

| Variables | Exports | Government consumption and investment | Household consumption | Household and corporation GFCF | Total final demand |
|-----------|---------|--------------------------------------|-----------------------|--------------------------------|-------------------|
| Gross Production | Coke and refined petroleum products (11.2%) | Repair and installation of machinery and equipment (22%) | Coke and refined petroleum products (19.8%) | Machinery and equipment (16.2%) | Coke and refined petroleum products (12.5%) |
| Value Added | Machinery and equipment (10.7%) | Repair and installation of machinery and equipment (28.4%) | Coke and refined petroleum products (13.0%) | Wearing apparel (32.8%) | Machinery and equipment (21.0%) |
| Employment | Textiles (10.9%) | Repair and installation of machinery and equipment (34%) | Wearing apparel (12.7%) | Machinery and equipment (21.9%) | Machinery and equipment (13.1%) |
| Wages | Machinery and equipment (12.3%) | Repair and installation of machinery and equipment (24.1%) | Wearing apparel (12.7%) | Machinery and equipment (21.9%) | Machinery and equipment (13.1%) |
| Taxes | Coke and refined petroleum products (36%) | Computer, electronic and optical products (32%) | Coke and refined petroleum products (29.2%) | Machinery and equipment (14%) | Coke and refined petroleum products (23.6%) |

Source: Authors based on IBGE - Instituto Brasileiro de Geografia e Estatística, 2020.

The greatest vulnerability in some subsectors (such as “Manufacture of textiles” and “Manufacture of wearing apparel”), regarding the potential loss of jobs, is associated with a business model based on subcontracting and an intense fragmentation of the supply chain. In this context, most of the activities performed by self-employed workers do not have manufacturing characteristics; in fact, it is more related to service activities. Indeed, the predominance of micro and small entrepreneurs, with tasks such as domestic sewing and clothing repair, are carried out by low-skilled workers subjected to exhaustive working hours, many of them working in informality. This corroborates an even wider and worrying phenomenon concerning the potential effects of the pandemic on the Brazilian labor market: the “entrepreneurship by necessity”, meaning people who start their own business not because they are embedded with some “animal spirit”, but because they are unemployed for a long time or facing difficulties to find themselves a new occupation in the formal labor market.

Another widely discussed aspect of the Brazilian labor market during the pandemic is the challenge of promoting productive transformation towards the new digital paradigm. The discussion about how to reconcile job creation with more intensive use of labor-saving technologies is historical but is gaining momentum with new digitization processes and the need to adapt work practices and places for remote access. Considering that the less qualified workers were the most affected at the beginning of the crisis (Gimenez et al., 2020), it is also certain that the pandemic has enhanced Brazil’s social abyss, for example, with arduous conditions for some home office activities and deepening the flexibility of labor relations.

It is important to comment that the “Medida Provisória 936” announced by the Brazilian government to contain the pandemic’s impact in the formal labor market may not mitigate the expected decline in aggregate payroll. Considering the drop in demand, the flexible working hours with flexible payment may have different effects on workers’ income depending on the level of wages. The highest wages will probably be the most affected since the government’s unemployment insurance may not compensate for the predicted wage reduction.

Finally, our findings indicate that neglecting the role of the manufacturing sector to tackle the pandemic-crisis may leave important revenue imbalances within federal and local governments. When considering the heterogeneous effects of the pandemic-crisis among Manufacturing subsectors and the spatial distribution of Manufacturing in Brazil, this can lead, in the long run, to an increase in regional disparities. All these results reinforce the weight Manufacturing wields in the Brazilian economy and the potential it may exert in the current (or any) crisis.

4.3. Provision of health service and vulnerabilities of manufacturing sector

The findings discussed so far were based on simulation exercises of the impact based on shocks in final demand elements over the Manufacturing subsectors. As explained, the only positive variation was related to government expenses related to the provision of Health Services. In Brazil, as in other countries, there was a rapid and concentrated increase in the demand for hospital and ICU beds and mechanical ventilators. As debated by Noronha et al. (2020), the projections showed a critical situation in the health system for meeting this potential demand. Even though Brazil has a universal health system, there is an unequal regional distribution of health infrastructure and equipment, and the authors pointed out that numerous health micro-regions, and macro-regions, would operate beyond their capacity.

The Brazilian Universal Health System (SUS, from the Portuguese translation) was created with the democratic Constitution of 1988, but its implementation took a longer period (Gadelha and Temporão, 2018). In the early 2000s, concerns were growing about...
the Brazilian public health sector’s dependence on imported products. The importance of addressing this dependence was one of the main reasons for the formulation of the concept of Economic-Industrial Health Complex (EIHC) (Gadelha and Temporão, 2018). There is a huge fragility in the local productive and technological capacity, whether in the supply of essential products or in the ability to set technology transfer agreements, and even the imports of immediate needs found huge obstacles (Gadelha, 2020).

This structural characteristic gained another dimension in pandemic’s face and the international competition for medical equipment’s acquisition. As pointed out by one specialist in a recent interview, only 40% of the Brazilian ventilators’ demand is supplied by domestic production. In fact, the degree of import dependence is around 80%, given that even for this domestic production, the most sophisticated components are imported. Even the production of diagnostic tests ran into the vulnerabilities of the Brazilian EIHC. Obtaining basic reagents to perform the COVID-19 molecular diagnostic tests became a major challenge due to the huge worldwide demand to acquire the necessary inputs. Given that, the few foreign suppliers prioritized the North American and European markets.14 The fact that the purchase of laboratory supplies depends on imports was one of the main obstacles to these tests’ production. The great demand also increased the price and with the currency devaluation, the imported inputs are even more expensive.

Our estimations of the increase in government expenditures to raise the provision of Health Services highlighted some of these problems. Based on announcements from the federal government, our study estimated the impact of R$ 40 billion (US$ 8 billion) expansion in public spending directed to the health sector, divided equally into government consumption (to increase the provision of health services, including hiring technical personnel) and investment (to increase the supply of hospital and ICU beds and mechanical ventilators). For government investment, we estimate an investment vector concentrated on equipment acquisition, assuming the expansion of hospital and ICU beds does not involve the construction of perennial facilities.

As can be seen in Table 6, the direct and indirect impacts on the economy generate a contribution in the order of 0.4 pp. in the gross output of the economy. The increase in government expenditures tends to affect basically only two subsectors, the Public Health sector itself and Manufacturing (Table 8). Our estimations pointed out two potential bottlenecks to the increase in health services. First, the dependence of imports to increase government investments, since one-quarter of the total supply was mainly imported manufactured goods. The import dependence of manufacturing goods is also relevant for government consumption, as a fifth of the manufacturing supply is imported. Within the manufacturing industry, the increase in government investments is associated mainly with innovative manufacturing activities (IN group),

Table 8

| Government investments | Government consumption |
|------------------------|------------------------|
| Gross Output (R$ million) | Imports (R$ million) | Jobs unit | Gross Output (R$ million) | Imports (R$ million) | Jobs unit |
| Manufacturing | 13,313.4 | 6590.5 | 57,078 | 2103.7 | 667.0 | 8154 |
| Agricultural commodities | 200.1 | 9.4 | 2079 | 72.2 | 4.4 | 388.3 |
| Industrial commodities | 1715.2 | 464.0 | 3884 | 604.5 | 147.4 | 1220.4 |
| Traditional manufacturing | 576.8 | 144.0 | 2579 | 746.6 | 113.4 | 3226.7 |
| Innovative manufacturing | 10,761.3 | 5973.0 | 48,537 | 680.4 | 401.7 | 3318.5 |
| Services | 4813.7 | 363.9 | 44,787 | 25,227.0 | 423.9 | 262,811 |
| Others | 768.2 | 76.3 | 2494 | 1331.0 | 48.9 | 12,584 |
| Total | 18,895.4 | 7030.6 | 104,359 | 28,661.8 | 1139.9 | 281,549 |

Source: Authors based on IBGE - Instituto Brasileiro de Geografia e Estatística, 2020.

14 https://jpmorgan.com/br/infografia/5393-reagente-teste.html
ments, whose revenues sharply dropped during the first months of the pandemic-crisis, while the support package was only approved at the end of May 2020, with the first transfers from the central government only mid-June.

It is important here to address some issues of the Brazilian Government’s responses to the pandemic crisis. The central government was able to use escape clauses of the main fiscal rules to mobilize resources and accelerate emergency spending. However, given the loss of public sector capabilities, the success of the response was biased. As Mazzucato and Kattel (2020) discussed, the pandemic stressed the need for dynamic capabilities and capacity of governments. In Brazil, after congress’s approval of a large income transfer program, the government could use the already available system of “Bolsa Família” to pay more than 68 million of benefits per month. Although it represented a large increase in the usual number of beneficiaries, around 14 million, it was possible to use the same structure: an online public register system (“Cadastro Único”) and the payment through a public commercial bank. On the other hand, the attempts to increase health spending and, especially, to foster domestic production of necessary products to increase health services did not succeed. In part, this reflects the dismantling of important instruments in the Ministry of Health to promote industrial capacities related to the sector. Until the beginning of August, after almost 5 months of the pandemic, according to budget data of the Integrated System of Management and Budget, only half of the authorized transfers of the Ministry of Health to the subnational government (R$ 16.8 billion from a total of R$ 31.7 billion), and less than one-third of the direct acquisition by the Ministry (R$ 2.2 billion from a total of R$ 9.0 billion) were actually paid.

To have a more disaggregated comparison, we also compare our results with monthly data from other surveys or government statistics. In Table 10, we compare the estimation for Manufacturing gross output growth, year-over-year, for the three scenarios with the result of the PIM-PF, Jan-July 2020 from the same period a year ago. The survey showed a 13.9% decrease, which can be compared to the Reference Scenario variation, −9.8%, given the different analysis periods. Our estimations are an annual projection, while the survey is related to the first 7 months of the year. Looking at the monthly result, the major decrease was on April, and since then, there was some recovery. Even so, the Manufacturing gross output from this survey dropped 24.6% in the second quarter from the same quarter a year ago (1st quarter −0.7%).

This survey allows us to look into more disaggregated results Table 11, presents the comparison of our estimation for two scenarios (Reference and Mild) with the actual results of each subsector’s contribution to the total percentage change of the Manufacturing sector. The comparison is also for the same time reference as the previous table. As expected, the AC group were the least affected by the pandemics. In our estimations it had a very low contribution to the contraction of Manufacturing (−0.33 to −0.55 pp.), but the actual result was a small positive contribution (0.4 p.p.).

In addition, in our estimation, the IC group includes the subsector “Coke and refined petroleum products”, which had a different result than expected. This sector presented a positive change in the official statistics, contrasting with our estimations. The behavior of the TR group is in line with our estimations. The largest drop for all groups (except the AC group) occurred in April. Since then, TR and IC groups have shown a positive trend, while the IN group maintained a downward trend.

Looking at more disaggregated data, Table 12 compares the most affected Manufacturing subsectors according to our estimations with the official statistics. The main difference is due to the “Coke and refined petroleum products” subsector, which, according to our simulation, would be the subsector that would most contribute to the drop in the gross output of Manufacturing. However, official data shows that this subsector contributed mostly positively to the change in Manufacturing gross output change. However, our simulations were corroborated by official data when we look at sectors such as “Manufacturing of automobiles, vans, utilities, trucks and buses” (2nd in our estimations), “Manufacturing of parts and accessories for motor vehicles” (6th in our estimations), and “Iron and Steel” (4th in our estimations).

5. Policy responses beyond the pandemic

The international production system is experiencing a perfect storm, with the crisis triggered by the COVID-19 pandemic adding more complexity to existing challenges from the new industrial revolution, growing protectionist tendencies, and the sustainability imperative (UNCTAD, 2020). During the pandemic, several countries discovered how dependent they are on foreign suppliers, with dramatic shortages of essential medical supplies and equipment. This pressure to increase national autonomous productive capacity and other pandemic-related political responses in support of companies and employees, and social support to vulnerable groups. Together with building a degree of local self-sufficiency, there is a greater emphasis on supply chain resilience to systemic risks, which may accelerate an ongoing trend towards reshoring or regionalization of international production (Javorcik, 2020; De Backer and Flaig, 2017). In the aftermath of the pandemic, the reorganization of international production will bring huge challenges and opportunities and may leave developing countries at particular risk.

In Brazil’s particular case, far from having all the answers that can guide policy responses to ensure economy-wide opportunities and sustained economic growth, we aim to explore some of the main strategic questions of this research agenda on building productive capacity beyond the COVID-19 pandemic.

There are several roads to reindustrialization and resilience but all of them should focus their attention on how to tackle the massive societal challenge for the post-COVID-19 (and the pre-COVID) Brazil: income inequality. Yet, strengthening production capabilities also requires tackling wealth concentration and inequality of opportunity in access to basic services, including nutrition, health utilization, and basic infrastructure, and insufficient attention has been paid to inequalities based on gender, ethnicity, and race (see also Dweck and Rossi, 2019). We argue that rethinking the role of manufacturing in Brazil must be built within societal
purposes. This requires new foundations to align public-sector capacity with citizen longstanding needs, which often requires developing the dynamic capabilities of the public sector (Mazzucato and Kattel, 2020), and calls for action. The pandemic will likely increase inequalities across countries, and those taking coordinated policy responses to mitigate the COVID-19 associated economic impact might suffer less. Conversely, the Brazilian government failed to rethink the industrial policy space and coordinate a strategic plan among the diverse actors.

Some have said that ‘globalization has gone too far’ and others stated that ‘globalization has not been given a chance to demonstrate its potential’. Rather than being considered one of the least integrated countries in the international production networks, the reality is that Brazil suffered from shortages in the midst of the pandemic and watched its domestic manufacturing collapsed in a scenario on which it had already increasingly become dependent on imports. In order to overcome the middle-income trap, which Brazil reached in the 1980s and 1990s and have since stalled, Nathan (2019) pointed to ‘the importance of not just being in GVCs but also, sometimes, of leaving them in order to form one’s own GVC’ (p.374). Basically, one may not shift from knowledge utilization to knowledge creation before catch-up in production. In that sense, the author argued about the need for developing countries to stabilize their own lead firms, and mainly about the importance of developing capabilities in carrying out non-routine tasks to move towards creating new technology.

At the same time, the importance of co-location between different activities along the value chain may be discussed regarding its feedback effects between manufacturing and innovation activities (Berger, 2013; Pisano and Shih, 2009), which sometimes might be easier to manage in a short supply chain (De Backer et al., 2016). Fundamentally, this analysis concerns developed countries that usually host R&D and innovation centers (as discussed in Section 2.1). But that discussion also has consequences for developing countries, like Brazil, that have failed to develop their higher knowledge-based capabilities, and might be even more stagnant in the value chain’s low-value segments.

In the current context, it can be conducive to discuss alternative policy initiatives that tackle the following aspects:

- **Brazil became less diversified and then more exposed to systemic risks.** From a resilience perspective, developing local value chains to serve domestic and regional markets may accommodate disturbances, like supply shocks, and enhance other benefits – e.g., relieve critical shortages, create employment, promote small and medium-sized companies (SMEs), and smaller climate footprint.

- **The pandemic illustrates the importance of close-proximity between suppliers and importers, including local sourcing and a regionalization strategy.** This calls for regional trade agreements, which follow rules-of-origin that likely promote complex international production networks activities, and recently have a greater effect in reducing transaction costs (tariffs and non-tariff barriers) than WTO negotiations (Li et al., 2019).

- **The building of productive and technological capabilities, which are critical for avoiding a ‘middle-income technology trap’ (Andreoni and Tregenna, 2020), requires the mobilization of political space to face and reverse the process of premature deindustrialization registered over the last decades and support reindustrialization.** This means that manufacturing as a whole is taken as an engine of economic growth, and one may not name the relative decline in subsectors like textiles or automobiles as ‘deindustrialization’ (Tregenna and Andreoni, 2020). Rather than Brazil giving up on manufacturing, we argue that the country should learn from the voices in advanced countries16 calling for a “manufacturing renaissance” and formulate responses through active industrial and innovative policy interventions.

- **Creating an industrial policy space requires a new pact between public and private actors, avoiding harmful and common rent-seeking practices.** In this sense, the essence of industrial policy is coordination, which is presented at three levels: (i) political, (ii) economic policy, and (iii) management (Suzigan, 2017). Here we reinforce that a new social pact is at the center of political coordination, which in turn must seek legitimacy. In the absence of a clear command that coordinates industrial policy actions, dispersed actions may fail to achieve effective results for social demands.

- **Following the Structuralist tradition and from a Kaldorian/evolutionary perspective on the role of manufacturing, the basic intuition is that specific sectors and activities matter because they enhance different learning opportunities and different income elasticities of demand.** Overall, producing microchips is not the same as producing potato chips (Palma, 2006; Dosi et al., 2020). With MNEs seeking greater proximity to the market, which may mean shorter delivery times and greater agility to changes in consumer behavior (fundamental in some industries, as in the textile industry), Brazil has the chance to attract MNE operations. This obviously cannot result from exogenous forces and ought to be guided through institution-building and policies to increase the gains without deepening income inequalities. Bearing in mind that even producing microchips can fail to attend societal purposes and contribute to increasing income inequalities.

- **The COVID-19 pandemic has brought to the fore the gap between the massive Brazilian social needs and the national industry capacity to tackle them – either because of the Manufacturing structural rigidity, technological regression and lower levels of industrial density, or because of the absence of politi-**

---

16 See to discuss about how the declining manufacturing employment may have contributed to increasing inequality in advanced countries, especially in the case of the United States.
The turbulent pandemic–scenario highlights a longstanding important economic debate in Brazil: how to promote inclusive growth and sustainable development. The findings here are a reminder of the undeniable role of manufacturing industries to achieve these goals. Nonetheless, the pandemic-crisis has shown an opportunity and the need for reindustrialization in Brazil. This paper has set out to explore the effects of the pandemic crisis on the Brazilian manufacturing sectors and the importance of building political space to discuss social needs within the scope of industrial and innovation policy.

With the hindsight, from the current data available we know that the manufacturing sector recovered somewhat in the second half of 2020, even before the service sectors most affected by the pandemic. Nonetheless, this rebound showed the problems we highlighted, such as dependence on imported inputs that are scarce in world trade and lack of manufacturing industry’s resilience which, in turn, has already slowed down again.

Throughout the paper, we argued that the manufacturing sector in Brazil, which was already facing huge obstacles to entering in higher-knowledge activities, was further harmed by the effects of the pandemic-crisis on the Brazilian productive structure – that in considering intra and intersectoral linkages extended the pandemic-crisis effects on the Brazilian labor market, gross output and value-added, and tax revenues. However, at the same time, it is also revealing that an increase in government investments in healthcare would trigger mainly innovative manufacturing sectors output. Meanwhile, the Brazilian Health System showed increasing dependence on imports. In line with these observations, we reject the protectionist trends to engender unfashionable import restrictions and beggar-thy-neighbor currency devaluations. This might lead to trade distortions, increase average prices, and adverse effects in short and in the long run. With this in mind, we focus our proposals into a direction that reindustrialization is among the tools to attend Brazil’s societal challenges.

At the age of disbelief in science, the COVID-19 pandemic represents a milestone in human history, and it may leave developing countries at particular risk. In Brazil’s case, we hope the pandemic bright side perhaps be the creation of the political space – within a social pact between public and private actors – to develop higher-knowledge-based capabilities and dynamize manufacturing industries within societal purposes.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT author statement

**Manuscript title:** “COVID-19 and the Brazilian manufacturing sectors: roads to reindustrialization within societal purposes”

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before its appearance in the *Struct. Change Econ. Dyn.*

**Authorship contributions**

**Esther Dweck:** Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing;

**Marília Bassetti Marcato:** Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing;

**Julia Torracca:** Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing;

**Thiago Miguel:** Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing;

**Acknowledgments**

We are grateful to the Group of Industry and Competitiveness members - Institute of Economics – Universidade Federal do Rio de Janeiro (GIC/IE-UFRJ) and to Kathelyn Ferreira and Maria Christina Vilar for excellent research assistance.

**Appendix A. Input-output model**

Input-output models seek to explain and quantify all interdependences between the industries. They make possible to estimate direct and indirect effects of economic shocks not only on production but also on a wide range of economic (and even non-economic) variables. On this appendix we provide a brief explanation, for more details one can consult, for example, Miller and Blair (2009), Raa (2005) and IBGE - Instituto Brasileiro de Geografia e Estatística, 2020 for the Brazilian case.

Mathematically, the industries interdependences are represented by an equation system containing "n" equations and "n" unknown variables as follow:

\[
\begin{align*}
X_1 &= Z_{11} + Z_{12} + \ldots + Z_{1n} + f_1 \\
X_2 &= Z_{21} + Z_{22} + \ldots + Z_{2n} + f_2 \\
&\vdots \\
X_n &= Z_{n1} + Z_{n2} + \ldots + Z_{nn} + f_n
\end{align*}
\]

On the equations above, \(X_i\) is the gross production for industry \(i\), \(Z_{in}\) is the production from industry \(i\) used as an intermediate commodity for industry \(n\), and \(f_i\) is the production from industry \(i\) destined to final demand. It is also possible to write the equation system as matrices:

\[
X = \begin{bmatrix}
X_1 \\
\vdots \\
X_n
\end{bmatrix}, \quad Z = \begin{bmatrix}
Z_{11} & \cdots & Z_{1n} \\
\vdots & \ddots & \vdots \\
Z_{n1} & \cdots & Z_{nn}
\end{bmatrix}, \quad \text{and } f = \begin{bmatrix}
f_1 \\
\vdots \\
f_n
\end{bmatrix}
\]

leading to \(X = Z \cdot i + F\) \hspace{1cm} (A1)

Now, "\(X\)" represents the gross production matrix, which means a matrix containing the production from all industries. Similarly, "\(Z\)" is the intermediate consumption matrix and "\(i\)" the final demand matrix. The \(i\) vector post-multiplying \(Z\) is a row operator (a column vector containing only numbers 1 as elements) and its purpose is only to put \(Z\) to the same dimensions as \(X\) and \(F\).

We can express the interindustry relations expressed by \(Z\) as a ratio of each industry production. This clarifies the idea that the flow of intermediate consumption from one sector to another sector \(j\) depends on how much sector \(j\) itself is producing. This ratio is
named technical coefficient and the set of all technical coefficients creates the technical coefficient matrix:\n\[ a_{ij} = \frac{z_{ij}}{x_j} \text{ and } A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix} \]

We name \( a_{ij} \) as the technical coefficient of inputs provided by activity \( i \) for activity \( j \) and \( A \) is the technical coefficient matrix. Now we can write Eq. (A1) as follows

\[ x = AX + f \]

\[ (I - A)x = f \]

\[ x = (I - A)^{-1}f \]

\[ x = Lf \]

On Eq. (A2), \( L = (I - A)^{-1} \) is known as “Leontief Inverse” or “Total requirement matrix” and it represents all necessary production - direct and indirect - to attend final demand. Because it is a linear equation model,\(^7\) we can also say that

\[ \Delta x = L\Delta f \]

IP models allow us to calculate the direct and indirect impacts not only for production needs. As matter of fact, we can estimate them for any variable, economic or not, if compatible industry information is available. For example, to estimate how many jobs are involved on a given production we could use

\[ E = e.x \text{ replacing } x = Lf \]

\[ E = e.Lf \]

\[ E = \hat{L}.f \]

\[ \Delta E = \hat{L}.\Delta f \]

On Eqs. (A4) and (A5), “\( E \)” is the total - direct and indirect - number of employees involved, “\( e \)” is employment coefficient matrix and \( \hat{L} = e.I \) is the total requirement matrix for employment. The same logic may be applied for any other economic variable, such as wages, value added, or non-economic variable like energy consumption, \( \text{CO}_2 \) emissions, water usage.

References

Andreonii, A., Tregnana, F., 2018. Stuck in the middle—premature deindustrialisation and industrial policy. CCRED Working Papers 11.

Andreonii, A., Tregnana, F., 2020. Escaping the middle-income technology trap—A comparative analysis of industrial policies in China, Brazil and South Africa. Structural Change and Economic Dynamics 54, 324–340.

UNIDO - United Nations Industrial Development Organization, 2021. Annual Report 2020. UNIDO, Vienna.

Baldwin, R., Forisid, R., Ito, T., 2015. Unveiling the evolving sources of value added in export’s, IDE JRP Series 161.

Berger, S., 2013. Making in America from innovation to market. MIT Press.

Dachs, B., Zankner, C., 2014. Backshoring of production activities in European manufacturing. European Manufacturing Survey Bulletin 3.

De Backer, K., Flair, D., 2017. The future of global value chains: business as usual or “a new normal”? OECD Science, Technology and Industry Policy Papers 41.

De Backer, K., Menon, C., Desnoyers-James, L., Moussieit, L., 2016. Reshoring: myth or reality? OECD Science, Technology and Industry Policy Papers 27.

Dosi, G., Riccio, F., Virgili, M., 2020. Varieties of deindustrialization and patterns of diversification: why microchips are not potato chips. LEM Working Paper Series 11.

Dweck, E., et al., 2020. Impactos macroeconômicos e setoriais da Covid-19 no Brasil. IE-UFRJ Discussion Papers 7.

Dweck, E., Rossi, P., 2019. Políticas sociais, distribuição, crescimento e mudança estrutural. In: Leite, M. (Ed.), Alternativas para o desenvolvimento brasileiro: novos horizontes para a mudança estrutural com igualdade. ECLAC.

Fajnzylber, F., 1983. La Industrialización Trunca De América Latina. In: La industrialización trunca de América Latina. Editorial Nueva Imagen, México, D.F, p. 416.

Freitas, F., et al., 2010. Modelo de geração de emprego: metodologia e memórias de cálculo. IE-UFRJ.

Freitas, F., Dweck, E., 2010. Matriz de absorção de investimento e análise de impactos econômicos. Relatório Final do Estudo Transversal do Projeto Perspectivas e Oportunidades de Investimento no Brasil. IE-UFRJ.

Gadelha, C., 2016. Política Industrial, desenvolvimento e os grandes desafios nacionais (orgs). In: Lastres, H., Cassiolato, J., Laplane, G., Sarti, F. (Eds.), O futuro do desenvolvimento. Unicamp, Campinas, pp. 215–251.

Gadelha, C., 2020. Complexo econômico-industrial da saúde: uma oportunidade estratégica para o desenvolvimento econômico e social do Brasil. In: Costa, G., Pochmann, M. (Eds.), O Estado como parte da solução: uma análise dos desafios do desenvolvimento brasileiro. Fundação Perseu Abramo.

Gadelha, C., Temporão, J., 2018. Desenvolvimento, inovação e saúde: a perspectiva teórica e política do Complexo Econômico-Industral da Saúde. Ciência e Saúde Coletiva 23, 1891–1902.

Gilchrist, A., 2016. Middleware Internet Internet of Things Platforms. In: Industry 4.0, the industrial internet of things. Apress, pp. 153–160.

Gimenez, D., Baltar, P., Manzano, M., 2020. Os efeitos iniciais da pandemia sobre o emprego no Brasil. Cesit/Unicamp.

Heuser, C., Mattoo, A., 2017. Services trade and global value chains. World Bank Policy Research Working Paper 8126.

IBGE - Instituto Brasileiro de Geografia e Estatística, 2020. Matriz de Insumo Produto - Brasil: 2015. IBGE, Rio de Janeiro.

Javorcik, B., 2020. Global supply chains will not be the same in the post-COVID-19 world. In: Baldwin, R., Everett, S. (Eds.), COVID-19 and trade policy: why turning inward won’t work. CEPRESS, London.

Kupfer, D., Rocha, C., 2005. Productividad y heterogeneidad estructural en la industria brasileña. In: Gimoli, M. (Ed.), Heterogeneidad estructural, asimetrías tecnológicas y crecimiento en América Latina, ECLAC.

Kupfer, D., Torracca, J., 2019. 20 anos de importações industriais no Brasil. Boletim do Observatório da Indústria 3, 53.

Lanz, R., Maurer, A., 2015. Services and global value chains: some evidence on service-virtualization of manufacturing and services networks. WTO ESRD Working Paper 3.

Li, X., Meng, B., Wang, Z., 2019. Recent patterns of global production and GVC participation. In: WTO (Ed.), Technological innovation, supply chain trade, and workers in a globalized world. WTO.

Lodelfalk, M., 2017. Servicefication of firms and trade policy implications. World Trade Review 16 (1), 59–63.

Maurer, A., Degain, C., 2012. Globalization and trade flows: what you see is not what you get. Journal of International Commerce, Economics and Policy 3 (3).

Mazzucato, M., Kattel, R., 2020. COVID-19 and public-sector capacity. Oxford Review of Economic Policy 36 (S1), S256–S269.

Miller, R., Blair, P., 2009. Input-output analysis: foundations and extensions. Cambridge University Press, Cambridge.

Nathan, D., 2019. GCVs and development policy: vertically specialized industrialization. In: Nathan, D., Tewari, M., Sarkar, S. (Eds.), Development with global value chains: upgrading and innovation in Asia. Cambridge University Press, Cambridge, pp. 373–408.

Nassif, L., Teixeira, L., Rocha, F., 2015. Houve redução do impacto da indústria na economia brasileira no período 1996-2009? Uma análise das matrizes insumo-produção. Economia e Sociedade 24 (2), 355–378. doi:10.1590/1982-3533.2015v24n2r5.

Mesoudet, S., Cadestin, C., 2017. Services in global value chains: from inputs to value-creating activities. OECD Trade Policy Papers 157.

Nassif, A., 2008. Há evidências de desindustrialização no Brasil? Brazilian Journal of Political Economy 28 (1), 72–96.

Noronha, K., et al., 2020. Pandemia por COVID-19 no Brasil: análise da demanda e da oferta de leitos hospitalares e equipamentos de ventilação assistida segundo diferentes cenários. Cadernos de Saúde Pública 36.

Oreiro, J., Feijó, C., 2010. Desindustrialização: conceituação, causas, efeitos e o caso brasileiro. Brazilian Journal of Political Economy 30 (2), 219–232.

Palma, J., 2014. De-industrialisation, “premature” de-industrialisation and the dutch-disease. Revista NECTA 3 (5), 7–23.

Palma, J., 2006. Stratégiess actives et stratégies passives d’exportation en amérique latine et en asie orientale. La croissance lié à la composition particulier des produits et à la spécificité des institutions. Revue Tiers Monde 186 (2), 249–280. doi:10.3917/rtm.186.0249.

Passoni, P., Freitas, E., 2020. Estimação de matrizes insumo-produção anuais para o Brasil no Sistema de Contas Nacionais Referência 2010. IE-UFRJ Discussion Papers 25.

Pisano, G., Shih, S., 2009. Restoring American competitiveness. Harvard Business Review July-August July-August.

Raa, T., 2005. The Economics of Input-Output Analysis. The economics of input-output analysis. Cambridge University Press, Cambridge.

Reinert, E., 1994. Catching-up from way behind: a third world perspective on first world history. In: Fagerberg, J., Verspagen, B., Von Tunzelman, N. (Eds.), The dynamics of technology, Trade and Growth. Edward Elgar, London.

7 The linearity “hidden” the hypothesis of constant scale returns to production. Also, IP models generally assume the economy still have production capacity to attend extra demand.
Rodrik, D., 2017. Premature deindustrialisation in the developing world. Frontiers of Economic in China 12 (1), 1–6. doi:10.3868/s060-006-017-0001-9.
Suzigan, W., 2017. Elementos essenciais da política industrial. In: Albuquerque, E. (Ed.), Metamorfose do capitalismo e processos de catch-up. Editora UFMG.
Torraca, J., 2017. Coevolução das estruturas de produção e comércio exterior da indústria brasileira: convergência ou desarticulação? [unpublished PhD Thesis]. Universidade Federal do Rio de Janeiro.

Tregenna, F., 2015. Deindustrialisation, structural change and sustainable economic growth. UNIDO Working Papers 2.
Tregenna, F., Andreoni, A., 2020. Deindustrialisation reconsidered: structural shifts and sectoral heterogeneity. UCL IIPP Working Papers 6.
UNCTAD, 2020. World Investment Report–International Production Beyond the Pandemic. United Nations Publications, Geneva.