COVID-19 and the Health Economic-Industrial Complex (CEIS): the Brazilian external dependence based on the GTAP model

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ÁREA 6 - Globalização e Competitividade Regional

RESUMO

Considerando o contexto do COVID-19 e a dependência externa brasileira de insumos para a oferta de serviços de saúde, o objetivo do presente artigo é contribuir para o debate do Complexo Econômico Industrial da Saúde (CEIS). A análise partiu da avaliação dos efeitos do aumento da demanda interna por serviços de saúde, que foi simulada com base no aumento da demanda do governo federal por bens e serviços com base no modelo Global Trade Analysis Project (GTAP), versão 10, calculado para 2014. Foram observados efeitos sobre a produção, as importações, as exportações e sobre a balança comercial brasileira, bem como sobre os seus principais países parceiros, no que diz respeito à origem das suas importações para o setor da saúde. O aumento da demanda do governo intensificou a produção no setor de serviços de saúde e impulsionou a demanda por importações, principalmente nos setores industrial e farmacêutico. Os déficits da balança comercial evidenciam a fragilidade dos setores vinculados ao CEIS, por outro lado, os parceiros comerciais brasileiros e o resto do mundo têm se beneficiado do aumento das exportações e dos superávits da balança comercial nesses setores.
Palavras chaves: COVID – 19**.** Complexo Econômico Industrial da Saúde (CEIS). Gastos do governo. GTAP.
Código JEL: I15**;** C68; F14.

ABSTRACT

By taking into consideration the COVID-19 context and the Brazilian external dependence on health services' supply inputs, the aim of the current article is to contribute to the Economic-Industrial Health Complex (Complexo Econômico Industrial da Saúde - CEIS) debate. The analysis started from evaluating the effects of increase in internal demand for health services, which was simulated based on increase in the federal government's demand for goods and services based on the Global Trade Analysis Project (GTAP) model, version 10, calculated for 2014. Effects were observed on production, imports, exports and on the Brazilian trade balance, as well as on its main partner countries, when it comes to the origin of their imports for the health sector. Increase in the government's demand has intensified production in the health services sector and boosted the demand for imports, mainly in the industrial and pharmaceutical sectors. Trade balance deficits show the weakness of sectors linked to CEIS, on the other hand, Brazilian trading partners and the rest of the world have benefited from increase in their exports and in trade balance's surpluses in these sectors.
Keywords: COVID-19; Industrial Economic Health Complex (CEIS); Government's demand; GTAP.
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1. Introduction and Background

The concept of health in Brazil has been changing over the past few years. Understanding health beyond the mere lack of disease opens room for a more comprehensive definition, which highlights the role played by health in the economic development process. The health sector is incorporated to the economic dynamics given the premise that health plays important role in inducing economic development and national competitiveness (Gadelha, 2009).

After the 1988 Federal Constitution was enacted and the Unified Health System (Sistema Único de Saúde – SUS) was created in 1989, the duty of the State to provide health services highlighted the need of developing an intervention strategy capable of effectively combining health's economic and social dimensions (Pereira, 1998). The sense of Health Economic-Industrial Complex (Complexo Econômico Industrial da Saúde - CEIS) emerges within this very context. Despite SUS creation in the 1980s, it was only in the 2000s that policies aimed at strengthening such a complex were observed (Gadelha, 2003, 2004).

CEIS was developed in the early 2000s to capture the association between healthcare services and development, based on an endogenous perspective that takes into account health services and the associated production and innovation system as parts of the development pattern. Accordingly, CEIS suggests a new approach to this sector and represents it as "an interconnected set of goods and services production for healthcare that moves in capitalist dynamics' context (Gadelha, 2003, p. 523)". The term "complex" refers to the intense economic relationship among different industrial sectors and consumers, service providers and suppliers, which is regulated by a specific institutional environment.

According to Gadelha (2006), CEIS is a set of economic activities focused on healthcare goods and services' production, which is formed by economic and industrial sectors, such as: i) chemical and biotechnological industries: composed of industries in the pharmaceutical sector, which mainly account for the production of vaccines, medicines, blood derivatives and diagnosis' reagents; ii) mechanical and material-based industries: composed of manufacturers of machines and equipment for medical, hospital, laboratory, and dental use, in addition to consumer materials; and iii) service providing sectors: formed by hospitals, outpatient clinics, and diagnostic and treatment services.

The subsystem of services works as derivative from the public and private health system, and it is composed of i) SUS (based on public funding by the three governmental spheres, namely: federal, state and municipal, ii) Supplementary Health System (individuals have private health plans and insurance, in addition to SUS), and iii) the private insurance and health services provision market (Borges, 2016).

Thus, CEIS is featured by interaction among the generation and diffusion of technologies, social institutional dynamics and the State's structuring and its relationship with the private sector. Such an interaction accounts for generating consumption, investment, adoption of new technologies, new job positions and incomes (Borges, 2016). According to Costa, Metten, and Delgado (2016), CEIS activities account for 9% of the Gross Domestic Product (GDP), 10% of skilled jobs and for more than 25% of the country's investments in research and development. As for the World Bank (2018), total spending on health in Brazil (9% of GDP) is comparable to that of the average of countries member of the Organization for Economic Co-operation and Development (OECD); however, the public-spending share is relatively low (48%), lower than the average recorded for OECD countries (73.2%) and for middle-income countries (59%).

According to Gadelha, Costa and Maldonado (2012), despite acknowledging CEIS' strategic development, there are still barriers for the implementation of public policies aimed at strengthening it. Based on their study, such barriers are reflected on the growing deficit in

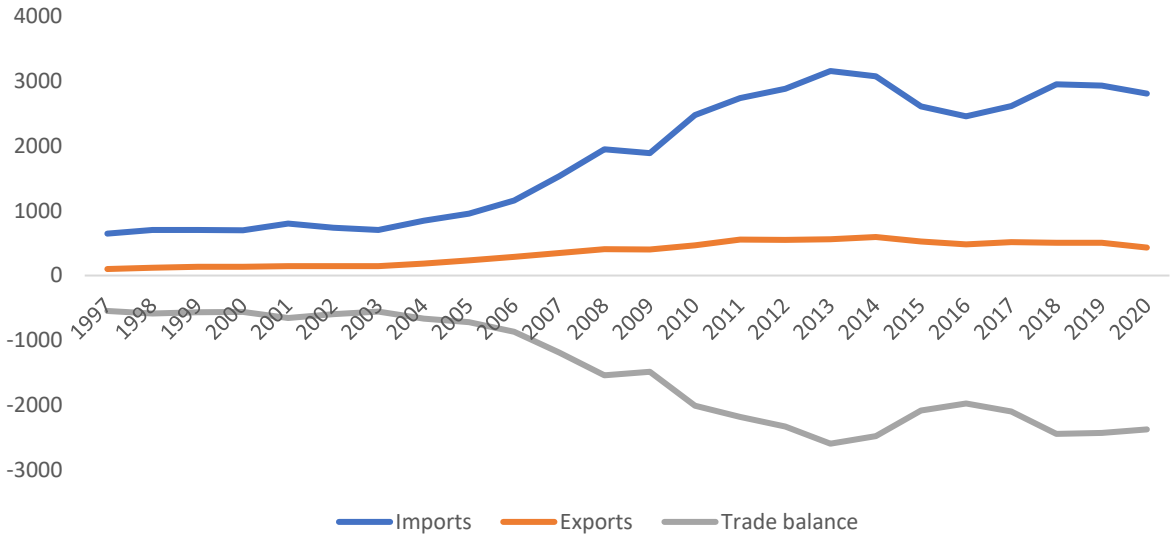
healthcare's trade balance, a fact that points towards the vulnerability of the national healthcare policy and to its lack of competitiveness at international level.

According to Gonçalves (1999), countries like Brazil, which depend on healthcare inputs and equipment's imports to fulfil the domestic demand for them, can suffer supply shocks in cases of instability in supply of such inputs by exporting countries, as recently observed due to the new coronavirus (COVID-19) pandemic that outspread in Brazil in 2020.

CEIS vulnerability and the Brazilian dependence on healthcare supply imports became evident during the COVID-19 pandemic scenario given the increased demand for products to healthcare sectors such as personal protective equipment (PPE), breathing apparatus, pharmaceuticals, and other components of the healthcare chain (EXAME, 2020). The pandemic highlighted a structural issue, Brazil's healthcare sector's technological and productive dependence. In total, 95% of medicines used in Brazil are imported, 80% of its ventilators is also imported and the most sophisticated masks, such as the N95, are imported. (Gadelha *et al.*, 2021).

The persisting deficit in the healthcare products' trade balance significantly increases SUS's costs and makes the country susceptible to economic disruptions in the international scenario, just as it happened during the COVID-19 pandemic. Figure 1 shows CEIS' trade balance evolution between 1996 and 2020, based on Comex Stat data[4]. It is possible seeing persistent trade deficit, which became even worse in the post-2008 crisis period. Increase in imports is linked to the deindustrialization process faced by the Brazilian economy and the growing dependence on manufactured imports, mainly from China (Cano, 2012; Hiratuka and Sarti, 2017). This country, back in 1997, ranked the 18th position among the main countries importing to the Brazilian health-related sectors, but in 2020, it ranked the 2nd position in this ranking - it was only behind the United States.

Figure 1 - CEIS Brazil's Trade Balance Evolution (1996 to 2020) – values in millions of dollars



Source: Elaborated by the author based on Comex Stat.

[4] Based on ISIC classification, the sectors shown in Chart 1 are: Medical and dental practice activities; manufacture of measuring and control equipment; manufacture of medical and dental instruments and supplies; manufacture of pharmaceuticals, medicinal chemicals and botanical products; retail trade in pharmaceutical and medical products; manufacture of irradiation, electromedical and electrotherapeutic equipment; cultivation of medicinal and pharmaceutical spices.

Increase in public spending to face the pandemic in 2020 rose the government's demand. The Federal Government strengthened SUS' structure by increasing the delivery of equipment, supplies, and resources to fight the pandemic. The Ministry of Health supported states and municipalities for the acquisition and delivery of lung ventilators, personal protective equipment (PPE), medicines, as well as increased the number and extension of Intensive Care Unit (ICU) beds (Brazil, 2020a).

Accordingly, the aim of the present study was to analyze the effects of increased domestic demand for healthcare services, based on the simulation of increase in the government's demand for goods and services through the Global Trade Analysis Project (GTAP) model, version 10, calculated for the year of 2014. The effects were observed on Brazil's production, imports, exports and trade balance, and on its twelve main trading partner countries for imports by the health sector, namely: United States, Germany, China, Switzerland, Italy, France, Japan, United Kingdom, Ireland, Belgium, India and Mexico.

The literature about the association between the health services' sector and its interaction with other economic sectors in Brazil was herein assessed, as well as the relationship analyzed through both input-output matrices (Nicolella and Guilhoto, 2004; Andrade *et al*, 2011) and the Computable General Equilibrium (CGE) model (Motta, Perobelli and Domingues, 2017). This is an innovative analysis since it focuses on the effects of the government-driven increase in the demand for healthcare services based on the GTAP model framework, which allows analyzing these effects at domestic and international level.

Nicolella and Guilhoto (2004) used the input-output matrix in 1999 to analyze the contribution of the public and private health sectors to the economy and showed its capacity to generate new job positions and to increase sectoral production. Andrade *et al.* (2011) built an input-output matrix with sectoral disaggregation for subsectors related to healthcare. This matrix enabled the structural evaluation of healthcare products' production chains in Brazil. Based on the calculation of multipliers, they observed that subsectors associated with pharmaceuticals and medical devices' production accounted for great internal and external economic effects, given their broad participation in imports.

Motta, Perobelli and Domingues (2017) analyzed the impact of changes in household consumption of healthcare goods and services, as well as the effects of such a reallocation on macroeconomic indicators and economic welfare They found increased demand in different health-related sectors, which would entail diversified effects on the Brazilian economy. When it comes to welfare (equivalent variation), income variation in healthcare services and medicines' sectors should be higher in order to compensate the increase in the consumption of these sectors.

Besides the introduction, the present article has three more sections. The next section details the methodological procedures, mainly the theoretical GTAP model framework, the database, and the empirical strategy. The third section presents the results and, finally, the fourth section presents the final considerations of this study.

2. Methodology and Database

2.1 - GTAP Model

The GTAP framework is based on microeconomic fundamentals, on data from countries' input-output and on external sector matrices (exports, imports, tariffs). GTAP modeling was documented by Hertel *et al*. (1997) and McDougall (2003).

GTAP shows a regional agent to represent each region/country accounting for collecting income resulting from the production process (VOA) and taxes deriving from private agents, government, producers (TAXES) and from exports (XTAX) and imports (MTAX).

The collected income is distributed among the three components of the final demand, namely: private agent (PRIVEXP), government (GOVEXP), and global savings (SAVE). This distribution is ruled by the *per capita* utility function, based on the Cobb-Douglas functional form. Therefore, each one of the three components has a permanent share in the regional income.

In mathematical terms, the utility maximization of the regional agent is expressed by

$$\begin{gathered} \max U = U_P^{B_P} U_G^{B_G} U_S^{B_S} \\ s.a\ Y = PU \end{gathered} \tag{1}$$

Wherein, U represents the regional agent utility, which is formed by the utilities of the private agent (P), government (G) and global savings (S), based on the Cobb-Douglas function, with the participation of parameter B; Y is the per capita income of the regional agent and P corresponds to the vector of prices. Restrictions for P, G and S are, respectively:

$$Y_P = P_P U_P \tag{2}$$
$$Y_G = P_G U_G \tag{3}$$
$$Y_S = P_S U_S \tag{4}$$

Thus, the share of each one of the three components of the final demand is given by:

$$\frac{Y_i}{Y} = \frac{\Phi_i^{-1} B_i}{\sum_j \Phi_j^{-1} B_j} \tag{5}$$

Wherein, subscript i can represent P, G or S; B_j is the Cobb-Douglas function parameter; Φ_i is the elasticity of expenditure concerning utility function U_i wherein $\Phi 1$ is set for the subfunctions of the private agent utility (U_p), government (U_g) and of global savings (U_s). Thus, the demand system (5) can be rewritten for P, G and S as:

$$\frac{Y_P}{Y} = \left(\frac{\Phi_P}{\Phi}\right)^{-1} B_P \tag{6}$$
$$\frac{Y_G}{Y} = \Phi B_G \tag{7}$$
$$\frac{Y_S}{Y} = \Phi B_S \tag{8}$$

Or in the form of a percentage change, as used in GTAP modeling:

$$y_P - y = -(\Phi_P - \Phi) + b_p \tag{9}$$
$$y_G - y = \Phi + b_G \tag{10}$$
$$y_S - y = \Phi + b_S \tag{11}$$

In GTAP nomenclature equations (9)-(11) take the form:

$$\mathrm{yp(r)} - \mathrm{y(r)} = -[\mathrm{uepriv(r)} - \mathrm{uelas(r)}] + \mathrm{dppriv(r)} \tag{12}$$
$$\mathrm{yg(r)} - \mathrm{y(r)} = \mathrm{uelas(r)} + \mathrm{dpgov(r)} \tag{13}$$
$$\mathrm{ysave(r)} - \mathrm{y(r)} = \mathrm{uelas(r)} + \mathrm{dpsave(r)} \tag{14}$$

The parameter $'\mathrm{uelas(r)}'$ represents income elasticity, which is defined as the mean weight of elasticities of the private agent, government and global savings' incomes. However,

since income elasticities of the government and global savings are fixed, changes in $'\text{uelas(r)}'$ depend only on changes in the elasticity of cost per private agent utility (uepriv(r)):

$$\text{uelas(r)} = \text{XSHRPRIV(r)} * \text{uepriv(r)} - \text{dpav(r)} \quad (15)$$

Where dpav(r) is the parameter for changes in the mean distribution of the share of the three components of the final demand:

$$\text{dpav(r)} = \text{XSHRPRIV(r)} * \text{dppriv(r)} + \text{XSHRGOV(r)} * \text{dpgov(r)} + \text{XSHRSAVE(r)} * \text{dpsave(r)} \quad (16)$$

where XSHRPRIV(r), XSHRGOV(r) and XSHRSAVE(r) are the shares of the private agent, the government and global savings in regional income, respectively - dppriv(r), dpgov(r) and dpsave(r) represent the consumption distribution parameter of these three components in the final demand, at this same order, which is equivalent to parameter *B* of the Cobb-Douglas function of the regional agent.

Producers' behavior aims at maximizing their profit in a perfectly competitive market structure, whose price reflects the marginal cost of associated industries and constant returns to scale. The production process demands production factors: land, capital, skilled and unskilled labor, which "wages" (VOA) are paid to. In addition to the buying and selling relationships among producers (VDFA), output is domestically sold to both the private agent (VDPA) and the government (VDGA. Producers also interact with the international sector by buying imported goods (VIFA) and by selling exported goods (VXMD).

2.2 Database and Empirical Strategy

This paper used the GTAP model base 10 supported by the year of 2014, which had 65 productive sectors and 141 countries/regions. Table 1 shows GTAP's sectoral and regional aggregation. The 65 sectors were aggregated into twelve categories: i) agriculture, ii) livestock, iii) extraction, iv) processed food, v) textiles, vi) light manufacturing, vii) pharmaceuticals, viii) heavy manufacturing, ix) utilities and construction, x) transportation and communication, xi) healthcare and social services[5] , and xii) other services. The 141 countries/regions were aggregated into: Brazil; Brazil's twelve main partners in health-related sectors' imports (United States, Germany, China, Switzerland, Italy, France, Japan, United Kingdom, Ireland, Belgium, India and Mexico – in this very order) - which altogether account for 80% of Brazil's total imports by the 65 sectors recorded in 2014 - and the 128 other countries/regions aggregated to the region called "rest of the world".

The empirical strategy started from observation of increase in federal government's spending due to the COVID-19 pandemic scenario. According to the Transparency Portal, the amount transferred by the federal government to the Ministry of Health to face the emergency arising from the new coronavirus totaled 39,299,135,197. 90 billion Reais in 2020, it is equivalent to increase by 1.19%[6] in government's spending (BRASIL, 2020b). Thus, 1.19% increase (shock) in the government's demand for goods and services was simulated based on the *dpgov* parameter in the GTAP model (equations 13 and 16).

[5] The human health and social care sector include the provision of healthcare-related services provided by medical and other health professionals in hospitals and in other facilities, residential healthcare activities, and social care activities indirectly related to health.

[6] This value was reached by proportionality by taking into consideration that the total amount spent by the federal government on the pandemic totaled 524.02 billion Reais, which is equivalent to 15.85% of the public spending.

Since the government's utility is modeled by a Cobb-Douglas function, the expansion of its demand (expenditures) is distributed among sectors based on their share in total government consumption (equation 13), both internally - via domestic production - and abroad - via imports from their trading partners. Increase in the government's demand also increased its share in the total final demand of regional agent in a manner proportional to the applied shock, according to equation (16).

Two limitations of the GTAP model for the present evaluation need to be highlighted. The first one refers to the modeling of the final demand by the regional agent - in per capita terms -, i.e., the government's demand is not an equivalent representation of the total demand of the countries, which is underestimated in terms of value. However, since the focus of the current study is not an exact nominal evaluation of the effects of increased demand by the federal government, but rather the evaluation of the direction taken by these effects of governments' participation in purchase processes inside and outside the economy, it is possible stating that this limitation is not an obstacle to our analysis. The second limitation concerns the fact that it is not possible applying a shock to the increase in the government's demand for a specific sector. However, it should be noticed that expenditures on the healthcare sector are equivalent to 41.31[7]% of the total government's consumption by summing the domestic and international consumption, based on the GTAP10 database.

According to GTAP 10 data, Brazilian government's expenditures are mainly directed to the domestic market, which accounts for 99.95% of the total spent; imported products only accounted for 0.045% of it. Table 2 shows the composition of Brazilian government's consumption between domestic and imported sectors, based on the sector classification shown in Table 1.

The government's domestic spending is focused on the service sector, mainly on "other services" (57.18%), which include financial services, public administration and national defense, education, among others; healthcare services and social assistance (41.34%), and the utilities and construction sectors (1.39%); other sectors account for 0.08% of the total spending. Government's imports are distributed among "other services" (81.86%), heavy manufacturing (10.73%), textiles (3.08%), pharmaceuticals (1.72%), healthcare services (1.38%) and other sectors (1.23%). It is noteworthy that government imports of the textile and pharmaceutical products sectors exceed the domestic consumption in these sectors. The value recorded for imports by heavy manufacturing sectors (22.98 million dollars) is close to the total spent on domestic purchases by these sectors (25.70 million dollars).

Table 1 - Regional and Sector Classification

Regional Classification	Sector Classification
Brazil **Main Brazilian partners of healthcare products' imports:** United States, Germany, China, Switzerland, Italy, France, Japan, United Kingdom, Ireland, Belgium, India and Mexico. **Rest of World:** Australia, New Zealand, Canada, Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Norway, Bulgaria, Croatia, Romania, Israel, Hong Kong, Korea, Mongolia, Taiwan, Brunei Darussalam,	**Agriculture:** Raw rice (pdr), wheat and rye (wht), other grains (gro), vegetables and fruits (v_f), oilseeds (osd), sugar cane and beets (c_b), vegetable fibers (pfb), other crops (ocr), processed rice (pcr). **Livestock:** animal husbandry (ctl), other animal products (oap), raw milk (rmk), other animal products (wol), meat: cattle, sheep, goat horse (cmt), other meat products (omt). **Extraction:** forestry, logging (frs), fishing, hunting, kinetic restocking (fsh), coal (coa), petroleum (oil), gas (gas), other extractions (oxt). **Processed foods:** vegetable oils (vol), dairy products (mil), sugar (sgr), other foods (ofd), beverages and tobacco (b_t). Textiles**:** textiles (tex), clothing (wap).

[7]It was calculated by adding the government's total consumption in the "healthcare and welfare services" sector under the government's total consumption in all sectors, domestically and abroad.

Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, Bangladesh, Nepal, Pakistan, Sri Lanka, Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Uruguay, Venezuela, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Dominican Republic, Jamaica, Trinidad and Tobago, Albania, Belarus, Russian Federation, Ukraine, Kazakhstan, Tajikistan, Armenia, Azerbaijan, Georgia, Bahrain, Iran, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Egypt, Morocco, Tunisia, Benin, Burkina Faso, Cameroon, Ivory Coast, Ghana, Guinea, Nigeria, Senegal, Togo, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Uganda, Zambia, Zimbabwe, Botswana, South Africa, Puerto Rico (PRI), Caribbean, Rest of North America, Rest of South America, Rest of Central America, Remainder of EFTA, Remainder of Asia, Remainder of East Asia, Remainder of Southeast Asia, Remainder of South Asia, Remainder of West Asia, Remainder of North Africa, Remainder of West Africa, Remainder of East Africa, Remainder of South Central Africa, Remainder of Eastern Europe, Remainder of Europe, Remainder of former Soviet Republics, Remainder of Oceania, Remainder of the European Union, Remainder of the World.	**Light manufacturing:** leather products (lea), lumber and wood products (lum), paper and stationery products (ppp), metal products (fmp), motor vehicles (mvh), other transport equipment (otn), other manufacturing (omf). **Pharmaceuticals:** manufacture of pharmaceutical products (bhp). **Heavy manufacturing:** refined petroleum and coke (p_c), chemicals (chm), rubber and plastics products manufacturing (rpp), non-metallic minerals (nmm), iron and steel (i_s), non-ferrous metals (nfm), electronic equipment (ele), electrical equipment (eeq), other machinery and equipment (ome). **Utilities and construction:** electricity (ely), gas distribution (gdt), water (collection, treatment, and distribution) (wtr), construction (cns). **Transport and communication:** trade (tdr), accommodation, food and services (afs), other transport (otp), shipping (wtp), air transport (atp), warehousing and support activities (whs), communication (cmn). **Health and social care services:** human health and social care (hht). **Other services**: financial services (ofi), insurance (ins), real estate activities (rsa), other business services (obs), recreation and other services (ros), public administration and defense (osg), education (edu), human health (hht), housing (dwe).

Source: Elaborated based on data in the GTAP 10 database.

Table 2- Sectoral composition of Brazilian government's expenditures between domestic and imported sectors - amounts in millions of dollars (US$) and percentages (%)

	National		Imported	
	US$	%	US$	%
Agriculture	9.39	0.00	0.00	0.00
Livestock	41.18	0.01	0.01	0.00
Extraction	0.16	0.00	0.00	0.00
Processed Food	1.99	0.00	0.36	0.17
Textiles	4.32	0.00	6.60	3.08
Light Manufacturing	18.90	0.00	1.78	0.83
Pharmaceuticals	0.90	0.00	3.68	1.72
Heavy Manufacturing	25.70	0.01	22.98	10.73
Utilities and construction	6,613.95	1.39	0.00	0.00
Transportation and communication	349.91	0.07	0.47	0.22
Health and social care services	196,539.91	41.34	2.96	1.38
Other Services	271,955.63	57.18	175.24	81.86
Total	475,561.92	100.00	214.07	100.00

Source: elaborated by the authors based on GTAP 10 data.

3. Results and Discussion

Results' presentation encompasses variation in production (Table 3), imports (Table 4), exports (Table 5), and in the trade balance (Table 6) in the Brazilian economy due to issues

faced by its main partner countries in imports for health-related sectors, as well as by the rest of the world.

Table 3 shows that the 1.19% increase in the demand by the Brazilian federal government led to increase in production, mainly in the sectors where the government has large participation, such as the case of positive variation in healthcare and social assistance services production (0.59%), and in the production of other services (0.10%) and pharmaceutical products (0.07%) - pharmaceutical products directly result from increase in healthcare services' production. The other sectors present participation loss in national production.

Increase in the demand by the federal government and the production reallocation necessary to meet such a demand, mainly for healthcare services supply, have effects on imports and exports (Tables 4 and 5, respectively). The greatest variation in imports takes place in the pharmaceuticals (0.37%), utilities and construction (0.15%), textiles (0.11%), and light manufacturing (0.10%) sectors, with emphasis on the fact that the pharmaceutical subsector is closely connected to the healthcare sector, both in the domestic and international economy (Andrade *et al*, 2011; Gava, Miyamoto, and Coleti, 2016). On the other hand, exports can present reduction in all sectors, except for the extractive sector (0.11%), which works as input production-source abroad.

Besides leading to reorientation of the national economy, increase in the government's demand affects the economy of other countries. Production (Table 3) and exports (Table 5) in the agrifood and industrial sectors has increased both in Brazil's main health-related products' trading partners and in the rest of the world; except for decreased production and exports in the textile sectors in Ireland and India, and for the light and heavy manufacturing sectors, in Ireland.

The trade balance (Table 6) derives from the difference between variation in countries' exports and imports values; it is expressed in millions of dollars. Brazil is the only country presenting trade balance deficit (-715.59) mainly due to the heavy (-268.40) and light (-194.49) manufacturing sectors. Only the Brazilian extractive sector showed surplus (99.27) – the recorded result is linked to increase in world imports in this sector - except for Ireland and Mexico (Table 4). The negative trade balance is in compliance with studies that have emphasized the Brazilian vulnerability and international dependence, consequently, CEIS vulnerability (Furtado, 1961, 1964; Gadelha, 2003, 2004, 2006; Gadelha *et al*., 2021).

The trade balance of other countries is positive, mainly the United States (210.92) and China (78.18) trade balance. Among the negative sectoral balances concerning the main exporting countries to the healthcare sectors in Brazil one finds i) Ireland's deficit in the pharmaceutical products sector's trade balance, which is opposite to that observed for other Brazilian trade partners and for the rest of the world, and ii) China's trade deficit in the textiles sector, which is justified by the intensification of Chinese production industrial sectors based on higher added value products, which gave way to other Asian countries in sectors accounting for lower added value, such as textiles (Gaulier, Lemoine and Unal-Kesenci, 2007).

4. Concluding remarks

The aim of the present study was to contribute to the debate on healthcare in Brazil based on the analysis about the impact of increase in the Brazilian federal government's demand (consumption) for goods and services based on the GTAP model - as it has been happening due to the COVID-19 pandemic.

Increase in the government's demand implied in increase in the production of the domestic healthcare service sectors and in its associated sectors, such as pharmaceuticals. Overall, there was increase in imports by health-related sectors (pharmaceuticals, manufactures) worldwide, as well as decrease in exports by most sectors, and this process had negative effect on the trade balance and, consequently, increased Brazil's international

vulnerability. These results draw attention to CEIS' international dependence and vulnerability, a fact that makes it unfeasible to meet the government's domestic demand for such products. On the other hand, the main trading partners in terms of healthcare-related products' imports have been benefiting from increase in their exports and in their trade balances.

Table 3 - Production variation (% values)

qo	Brazil	United States	Germany	China	Switzerland	Italy	France	Japan	United Kingdom	Ireland	Belgium	India	Mexico	Rest of the World
Agriculture	-0.14	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Livestock	-0.19	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Extraction	-0.08	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Processed Food	-0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles	-0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00
Light Manufacturing	-0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00
Pharmaceuticals	0.07	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00
Heavy Manufacturing	-0.20	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00
Utilities and construction	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Transportation and communication	-0.16	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Health and social care services	0.59	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
Other Services	0.10	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00

Source: based on GTAP results.

Table 4 - Variation in imports (% values)

qiw	Brazil	United States	Germany	China	Switzerland	Italy	France	Japan	United Kingdom	Ireland	Belgium	India	Mexico	Rest of the World
Agriculture	-0.04	-0.00	-0.00	-0.02	-0.00	-0.00	-0.00	-0.01	-0.00	0.00	0.00	0.00	-0.00	-0.00
Livestock	0.03	-0.01	0.00	-0.01	-0.00	-0.00	-0.00	-0.02	-0.00	0.00	0.00	0.00	0.00	-0.02
Extraction	-0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00
Processed Food	0.00	-0.00	-0.00	-0.01	-0.00	0.00	-0.00	-0.00	-0.00	0.01	0.00	-0.01	-0.00	-0.00
Textiles	0.11	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
Light Manufacturing	0.10	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Pharmaceuticals	0.37	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00
Heavy Manufacturing	0.04	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Utilities and construction	0.15	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
Transportation and communication	-0.04	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
Health and social care services	-0.04	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00
Other Services	0.08	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

Source: based on GTAP results.

Table 5 - Exports variation (% values)

qxw	Brazil	United States	Germany	China	Switzerland	Italy	France	Japan	United Kingdom	Ireland	Belgium	India	Mexico	Rest of the World
Agriculture	-0.16	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Livestock	-0.40	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.02	0.02	0.02	0.03	0.01	0.02
Extraction	0.11	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.00	-0.01	-0.00	-0.01	-0.00	-0.00
Processed Food	-0.31	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01
Textiles	-0.67	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00
Light Manufacturing	-0.52	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	-0.00	0.00	0.00	0.00	0.00
Pharmaceuticals	-0.55	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.01
Heavy Manufacturing	-0.44	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00
Utilities and construction	-0.42	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.00	0.00	0.00
Transportation and communication	-0.34	0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00
Health and social care services	-0.45	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00
Other Services	-0.41	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Source: based on GTAP results.

Table 6 - Variation in the trade balance (values expressed in millions of dollars)

DTBALi	Brazil	United States	Germany	China	Switzerland	Italy	France	Japan	United Kingdom	Ireland	Belgium	India	Mexico	Rest of the World
Agriculture	-42.89	8.22	0.61	9.92	0.12	0.94	2.02	0.75	0.41	0.00	0.04	1.53	0.84	19.15
Livestock	-60.97	8.48	3.71	3.63	0.25	1.40	2.57	2.07	1.44	0.83	1.03	1.59	0.30	36.00
Extraction	99.27	-2.11	5.02	8.17	-0.20	3.02	1.76	10.79	0.60	0.17	0.46	6.17	-3.24	-127.96
Processed Food	-60.74	8.34	3.97	2.82	0.59	1.83	4.86	1.57	2.94	0.05	0.12	0.95	0.74	35.05
Textiles	-16.38	7.52	1.42	-2.58	0.20	0.59	0.94	1.53	1.77	0.08	0.31	-1.71	0.19	6.74
Light Manufacturing	-194.49	58.45	8.69	20.82	1.92	4.51	9.52	10.50	10.77	0.13	1.84	-0.21	2.64	70.07
Pharmaceuticals	-38.09	11.00	2.72	2.02	0.41	1.36	2.31	1.00	2.55	-0.32	1.27	0.42	0.72	12.39
Heavy Manufacturing	-268.40	78.50	0.82	25.13	1.49	1.87	7.82	12.87	9.65	-1.86	1.87	5.62	9.79	124.48
Utilities and construction	-5.94	0.46	0.17	0.31	0.13	0.29	0.25	0.44	0.32	0.04	0.08	-0.07	0.01	3.52
Transportation and communication	-21.85	6.33	0.14	2.22	-0.27	0.49	0.41	0.26	1.80	-0.41	-1.10	-2.42	0.14	-9.93
Health and social care services	-1.25	0.18	0.08	0.16	0.01	-0.00	0.07	0.08	0.20	-0.00	0.00	-0.04	0.03	0.47
Other Services	-103.86	25.55	5.88	5.56	1.73	2.58	4.52	3.38	9.85	1.53	1.70	-0.61	0.46	41.73
Total	-715.59	210.92	33.23	78.18	6.38	18.88	37.05	45.24	42.30	0.24	7.62	11.22	12.62	211.71

Source: based on GTAP results.

Brazil's vulnerability and international dependence reflects its production pattern and international insertion, which is featured as exporter of primary products and as dependent on foreign manufacturing, from textile products, such as masks (N95), to products with high technological content, such as medical devices and medicines. Thus, although SUS has continuous supply of healthcare services, the country lacks productive security for SUS' operation.

The challenge of structuring CEIS is posed by the capabilities of the private sector, as well as by universities, research and development institutions and public development banks. The State acts systemically by means of emergency and structuring actions that have short-term effect on SUS' response capacity and, mid- and long-term effect on the broader perspective of reindustrialization. This process makes it possible reducing or changing the dependence on imported equipment and inputs, ensuring greater balance in this sector's trade balance and better conditions for the development of public healthcare policies. Besides, CEIS organization is configured as opportunity to boost the development of the productive forces and, consequently, the growth of the Brazilian economy, given its role as job position and income generator.

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