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IMPACT OF SUBSTITUTING THE OF EXPORTED AGRICULTURAL PRODUCTS FOR DOMESTIC PROCESSING ON BRAZILIAN ECONOMY

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ABSTRACT

This study examined the potential economic growth caused by substituting the export of the agrifood fresh products industry for domestic processing. We used an interregional input-output system measured for 2013. Results showed that this substitution led to a R$ 4.86 billion increase in the national GPV. Moreover, given the industrial concentration in the Southeast region of the country, this substitution can contribute to increased economic inequality among the Federation Units. This theoretical exercise, besides contributing to the literature on the importance of adding value to production by processing agricultural commodities, may help guide policies aimed at promoting economic growth.

Keywords: Value Added; Regional Interdependence; Input-Output.

INTRODUCTION

Between 1980 and 1990, globalization sparked income growth in emerging markets, stimulating world consumption, and consequently increasing the need for raw materials. This phenomenon was responsible for the appreciation of primary products in the international market, contributing to stimulating Brazilian production and export of commodities. The Brazilian export of such products became even greater following the commodities boom of the 2000s (BAFFES et al., 2009; BLACK, 2015; WORD BANK,2002).

Favorable climate conditions and the availability of natural resources are comparative advantages that favor the competitive production of agricultural commodities in Brazil (EMBRAPA, 2018). The low production cost of a given basket of products—such as soybeans, sugarcane, and corn—combined with the high level of efficiency, resulting from the modernization process of agriculture that began in the 1970s, guarantee Brazil competitiveness in international trade (BARROS & MACHADO, 2014).

According to the Center of International Development of Harvard University (CID, 2019), in 2016, Brazilian agricultural exports corresponded to 36.5% of the total exports, 24% of which went to China, mainly soybean, sugar, and coffee. Besides the growth in global demand, incentives for the export of primary products, like preferential trade agreements and even the implementation of laws that stimulate the export of non-industrialized products, such as the Kandir Law, and more recently, the strong depreciation of the national currency, have intensified this scenario of product exports with low value added.

Despite Brazil playing an important role in the export of agricultural raw materials, the country has a small market share in the international trade of processed agricultural products. According to the Brazilian Food Industry Association (ABIA, 2019), the country processes about 58% of total agricultural production, of which approximately 80% is consumed by the domestic market. Belik (1994) recalls the significant restructuring process undergone by the agrifood industry in the mid-1970s, as it began to incorporate all the technological, process, and organizational advances developed and adopted by the processing industry, aiming to meet the needs of a more urban and demanding consumer.

Processing commodities domestically generate greater value added, which is distributed as profit to companies and as income to workers, contributing to economic growth (SIDONIO et al., 2013). Furtuoso and Guilhoto (2003, p. 804) argue that "the development of agribusiness is the most efficient way for Brazil to add value on the agricultural product produced, providing new markets that enable export expansion, income generation, and taxes for the country."

For Macedo and Nishizaki Júnior (2017), the food sector, related to the agricultural sector, is the one that can most easily generate economic growth and business development for Brazil. According to the authors, the food market stimulates the dynamism of parallel production or distribution markets, whether domestic or external. Consequently, expanding the food market generates jobs, besides moving other sectors economically and generating more taxes.

Unlike the import substitution policies widely discussed in Brazil and in the world (ADEWALE, 2017; OLPER et al., 2017, OLPER et al., 2014), this article proposes the discussion of a policy to replace Brazilian exports of natural products through their internal processing. In this paper, it is only proposed to increase the processing of products up to the limit of the idle capacity of the Brazilian industry, without the need for new investments. However, its results shed light on a possible change in the country's export policy, prioritizing the exports of elaborated products. This policy, in addition to increasing domestic value added, also makes room for the use of imported inputs and the consequent internationalization of the Brazilian food industry, contributing to Brazil's participation in global value chains.

Serrano et al. (2015) also analyzed the internationalization of the food industry in Spain. For the authors the food industry elaborates products with a certain degree of sophistication, thereby having relatively high value added and income elasticity greater than one. In addition, the trade intensification of industrial products in the food and drink industry is important in the process of internationalization of the food industry.

Given this context, this article analyzes the impact that substituting the export of fresh agrifood products for domestic processing has on the level and redistribution of economic activity in Brazil, per Federation Unit. To do so, we performed an input-output analysis, which allows the evaluation of the impacts on gross production value (GPV) and changes in exports and value-added (VA) of each Brazilian federation unit.

RESEARCH MOTIVATION

Brazil ranks 22nd among the world's largest exporters. In 2017, the country's main exports consisted of agricultural commodities such as soybean (US$ 25.9 billion) and sugar (US$ 11.4 billion), as well as mineral commodities such as iron ore (US$ 20.1 billion) and crude oil (US$ 17.4 billion). Its main trade partners are China (US$ 48 billion), the United States (US$ 25.1 billion), Argentina (US$ 17.8 billion), the Netherlands (US$ 7.57 billion), and Germany (US$ 6.18 billion) (OEC, 2019).

According to data from the Observatory of Economic Complexity (OEC, 2019), the national economy has been experiencing a favorable scenario for agricultural commodity exports. Such a scenario may, however, undergo adverse changes that affect, in the short term, the competitiveness of national production, such as import taxation on primary products by trading partners, impacts on trade agreements, and devaluation on the national currency, among others. The greater the diversification in the export portfolio of a given country, the lower its possibility of suffering from international volatility (HADDAD et al., 2011; McMILLAN et al., 2014).

Moreover, the processing of fresh products and subsequent export of the industrialized product can improve Brazil's position in the Global Value Chains (GVC), since the country's insertion in the GVC is timid due to the low import content embedded in exports (OCDE, 2018). This behavior is expected in countries specialized in exporting primary products; as these products are in the early stages of the production chain, there is no room to include imports in their exports.

The role of Brazil in GVCs is the subject of several studies such as those by Araújo Jr. et al. (2018) e HERMIDA and XAVIER (2018). The country stands out in the export of primary or semi-elaborated products, mainly concerning trade with the European Union and China. Any change to a new scenario in which Brazil gains relevance in the export of elaborated products goes through several challenges outside the scope of this research, mainly related to technological changes, logistics, international quality certifications, and trade restrictions due to commercial agreements. However, in the medium and long term, the domestic processing of agricultural commodities and their transformation into industrialized foods can be strategic for Brazil regarding the generation of domestic value added (FURTUOSO & GUILHOTO, 2003) and diversification in the export portfolio (CIRERA et al., 2015; HADDAD et al., 2011; McINTYRE et al., 2018).

We propose to analyze an economic growth strategy based on the substitution of agricultural exports for domestic processing and their impact on Brazilian economic activity. To do so, we must understand the productive structure of the country and how the linkages between the productive sectors behave. Consequently, we adopted an input-output analysis, presented in the next section.

INPUT-OUTPUT ANALYSIS

By using the input-output analysis, we can produce an "economic photograph" of a region and thereby identify the relationship between its economic sectors (GUILHOTO, 2011). Consequently, one can measure the degree of sectoral and regional interdependence in an economy (MILLER and BLAIR, 2009).

The input-output matrix allows performance comparisons between public policies in different sectors and/or regions. We can identify the linkage between productive sectors and understand the impact on the production of specific sectors, according to variations in demand (PEIXOTO et al., 2013).

The input-output models consist in fixed coefficients, which describe the inputs from other sectors per unit of production of the receiving sector. These coefficients reflect the cost of production. Although the input-output model considers the economy with fixed coefficients, we can apply different methods to analyze technology changes. The main approaches consist of static demand-driven IO, dynamic macroeconometric IO models, and computable general equilibrium (CGE) models. In this study, we cannot consider technological advances because we will increase de production using the idle structure. (Forbes et al., 2007 and Wiebe et al., 2018)

LEONTIEF MODEL

Input-output analysis can be performed using the Leontief model (1951), in which one can measure the impact on production resulting from variations in final demand (MILLER & BLAIR, 2009), according to the Equation 1:

$$X=AX+Y \qquad (1)$$

Where X represents a vector ($nx1$) with the value of sector production; A is a matrix (nxn) with the technical coefficients of production and *Y* is a vector ($nx1$) with the values of sector final demand. The final demand vector is treated as exogenous to the system. Thus, vector X is established by vector Y multiplied by Leontief inverse (MILLER & BLAIR, 2009). According to the Equations 2 and 3:

$$X = LY \tag{2}$$

$$L = (I - A)^{-1} \tag{3}$$

Where *L* represents the Leontief inverse matrix (nxn), which shows the direct and indirect production coefficients. Variations in production needed to meet changes in final demand can be obtained by the Equation 4:

$$\Delta X = (I - A)^{-1} \Delta Y \tag{4}$$

GHOSH MODEL

Leontief's model can calculate backward linkages, that is, it captures the vertical effects. Input-output analysis can be also conducted using the model proposed by Ghosh (1958).

Leontief's traditional input-output model addresses demand-driven economic relations, whereas Gosh's model looks at the economy from the supply side. According to Bekchanov et al. (2012), the Gosh model allows for estimating the intersectoral allocation of primary and intermediate inputs.

The model is built from the Equation 5:

$$x^T = i'Z + v' \tag{5}$$

Where x^T is a vector (1xn) representing the gross production for each sector, and *v'* is a vector (1xn) representing value added. Symbol (T) refers to the use of transposed vectors. Term *Z* can also be expressed by $Z = \hat{x}B$, where B is a matrix (nxn) of technical coefficients, obtained by the Equation 6:

$$B = \hat{x}^{-1}Z \tag{6}$$

Hence, the Ghosh model can be defined by the Equations 7 and 8:

$$x^{t} = v'(I - B)^{-1} \quad (7)$$

$$G = (I - B)^{-1} \quad (8)$$

Where *G* is the Ghosh inverse matrix (nxn). The components of the Gosh matrix (g_{ij}) present the total production required from sector *j* to absorb a unit of primary inputs (monetarily represented by value added) of sector *i* (BEKCHANOV et al. 2012).

The primary hypothesis of the Gosh Model is that the outputs in b_{ij} are economically stable; that is, if sector *i* output is doubled, sector *i* sales for all other sectors that buy from sector *i* will also be doubled. Instead of fixed purchase coefficients, as in Leontief's model, we have fixed sales coefficients (MILLER and BLAIR, 2009).

That is a strong hypothesis. For Miller and Blair (2009), Ghosh had in mind an economy with excess demand, in which any increase in supply (sales) from one sector would be fully absorbed by the other economy sectors (purchasers). This is an uncommon scenario. According to Saath and Fachinello (2018), however, the food production sector presents a growing demand worldwide, driven mainly by population growth and increased income, contributing to the scenario proposed by Ghosh.

Dietzenbacher (1997) reinterpreted the Ghosh model, considering it as a "price model" rather than a "quantity model," that is, as a cost-pushed input-output model of primary inputs (value added). However, Gross Production Value - GPV increases, whether in the traditional interpretation of the Ghosh model (1958) or the reinterpretation by Dietzenbacher (1997), can be seen as economic benefits achieved by the region under analysis.

INTERREGIONAL MODELS

Input-output analysis can also be performed in interregional terms. To perform an interregional product input analysis, also known as Isard model (ISARD, 1951), we must obtain a large volume of information, official or estimated, depending on availability, especially regarding interregional trade flows (GUILHOTO et al., 2019).

Figure 1 presents the general interregional input-output matrix. Its main characteristic is the identification of trade (exports and imports) that takes place between regions, that is, the movement of goods destined for intermediate consumption or final demand (SOUZA, 2014).

Figure 1 | Generic Interregional Input-Output Matrix

	Sectors – Region L	Sectors – Region M	L	M	
Sectors – Region L	LL Intermediate Inputs	LM Intermediate Inputs	DF LL	DF LM	Gross Production L
Sectors – Region M	ML Intermediate Inputs	MM Intermediate Inputs	DF ML	DF MM	Gross Production M
	Foreign Imports (M)	Foreign Imports (M)	M	M	M
	Net Indirect Taxes (IIL)	Net Indirect Taxes (IIL)	IIL	IIL	IIL
	Value Added (VA)	Value Added (VA)			
	Gross Production – Region L	Gross Production – Region M			

Source: Adapted from Guilhoto (2011)

In matrix form, technical coefficients can be represented by the Equation 9:

$$A = \begin{bmatrix} A^{LL} & A^{LM} \\ A^{ML} & A^{MM} \end{bmatrix} \qquad (9)$$

Where the intraregional technical coefficients for region L are defined by the Equation 10:

$$A^{LL} = Z^{LL} \, (\widehat{X^{L}})^{-1} \qquad (10)$$

And the interregional technical coefficients for region L by the Equation 11:

$$A^{LM} = Z^{LM} \, (\widehat{X^{M}})^{-1} \qquad (11)$$

Region M uses a similar reasoning. Thus, as in the single region model, the interregional input-output system can be represented by the Equation 12:

$$(I - A)X = Y \qquad (12)$$

Consequently, the interregional input-output system can be described by the Equation 13:

$$X = (I - A)^{-1} \, Y \qquad (13)$$

Similarly, an interregional input-output system can also be described from the supply side, using the Ghosh model (1958) as the Equation 14:

$$G = (I - B)^{-1} \tag{14}$$

KEY SECTOR MEASUREMENT

From an input-output matrix, we can calculate the sectoral linkage of the economy and the interrelations between sectors. Rasmussen-Hirschman forward and backward indexes are examples of such indicators. Forward linkage indexes can determine how much a sector is demanded by others, whereas backward linkage indexes inform how much a sector demands from the others. In analyzing these indexes, one can point to which sectors can be regarded as "key economic sectors" (BORGH, 2013).

For Guilhoto (2009), considering L_{*j} as the sum of L_{ij} elements of a typical column of the Leontief inverse matrix, taking L* as the average of all L elements, and *n* the number of elements on column j, the backward linkage index can be calculated according to the Equation 15:

$$XILT = \frac{\left[\frac{L_{*j}}{n}\right]}{L^{*}} \tag{15}$$

The Leontief inverse matrix is not recommended for calculating the forward linkage index due to how L_{ij} coefficients are built (MILLER and BLAIR, 2009). To construct this indicator, we used the Ghosh matrix given by $G = (I - B)^{-1}$. Taking G* as the average of G elements and Gi* as the sum of elements from a typical G row, one can obtain the forward linkage index by Equation 16:

$$ILF = \frac{\left[\frac{G_{i*}}{n}\right]}{G^{*}} \tag{16}$$

After describing the methodology used to achieve the proposed objectives, the next section will describe the database used.

DATABASE

We used an interregional input-output system measured for 2013 in this study. The system was built using the Supply and Use Interregional Tables (SUIT) method, described by Guilhoto et al. (2019), which combines estimated data and official data from surveys, such as the regional census conducted by the Brazilian Institute of Geography and Statistics (IBGE).

According to Guilhoto et al. (2019), the SUIT method can be used to construct interregional input-output systems for all countries that present National Supply and Use Tables and the necessary subnational information for regionalization.

Besides the interregional input-output matrix, we also used a national input-output matrix for 2013, estimated by the Guilhoto and Sesso Filho method, which can be found in the works by Guilhoto and Sesso Filho (2005, 2010) made available by the Center for Regional and Urban Economics at USP (NEREUS), also with 68 sectors and 128 products.

EMPIRICAL STRATEGY

The interregional matrix available for this study is for 2013. We built the national matrix to the same year to avoid incompatibility of results. Moreover, as the input-output analysis is performed using technical coefficients, the time lag is less problematic since the technological, productive structure is relatively more rigid compared with the absolute values (MILLER and BLAIR, 2009).

The steps for estimating the results are as follows:

(1) Using the national matrix: we first estimated the Leontief inverse matrix $(I - A)^{-1}$, as described in Section 2.1; from there, we estimated the basic input-output indicators, such as production multiplier, and forward and backward linkage indexes. It aimed to build a ranking of the sectors and identify the national importance of the Agriculture and Other Food Products sectors. We used the “Other Food Products” sector for analysis because it is the largest purchaser in the agricultural products sector (IBGE, 2020), mainly due to its production of animal feed. Animal feed production is the main product derived from soybean, which in turn is the country’s main raw agricultural export product.

(2) Using the interregional matrix for the 27 FUs:

(i) We first estimated the Leontief inverse matrix $(I - A)^{-1}$, as described in Section 2.1.

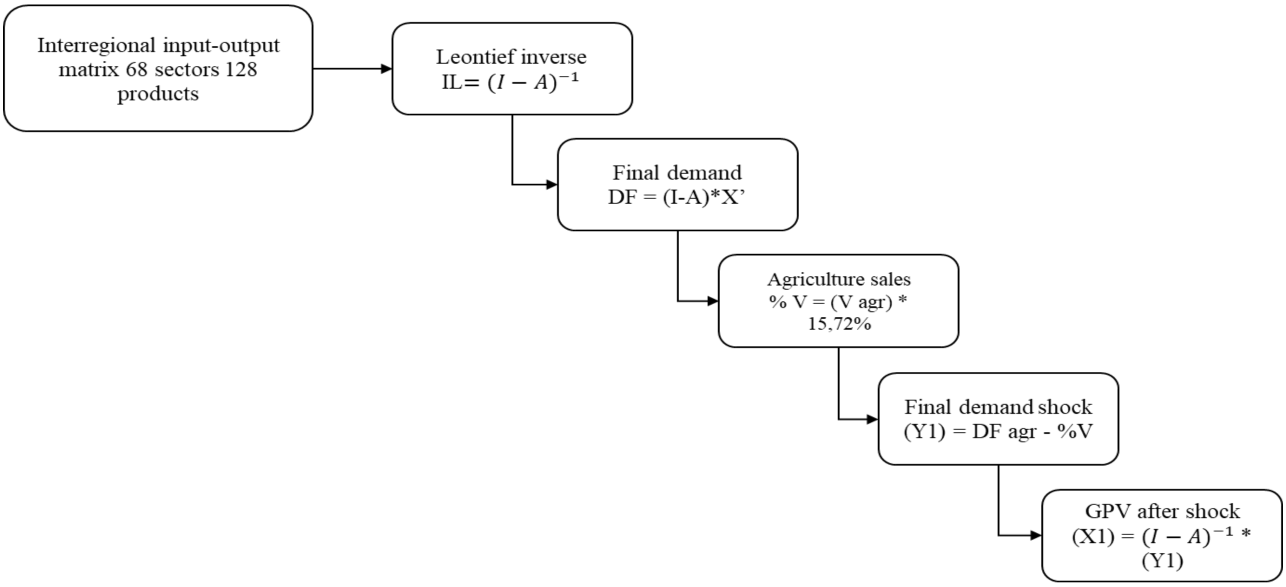
(ii) Demand-side shocks were calculated as follows (Figure 2):

(a) We listed the values of total sales from the agriculture sector (V agr) to the "Other Food Products" sector for each FU, obtained by the interregional Z-matrix;

(b) Next, we multiplied the values obtained in (a) by the percentage of idle capacity of the processing industry in 2013 (15.72%,[1]);

(c) We subtracted the value obtained in (b) from the final demand (exports) of the agriculture sector, and computed a new gross production value (X1) according to Equation 13, simulating a reduction in the exports of agriculture (DF agr), exactly in the amount of the processing capacity of the Other Food Products industry;

Figure 2 | Steps for calculating demand-side shocks based on the interregional input-output matrix



Source: the authors (2022)

(iii) Next, we estimated the Ghosh inverse matrix, according to Equation 14;

(iv) Supply-side shocks were scaled as follows:

1 We used the idle capacity of the processing industry due to the lack of specific information about the "Other Food Products" industry. Statistics for the processing industry can be found at: https://www.portaldaindustria.com.br/estatisticas/

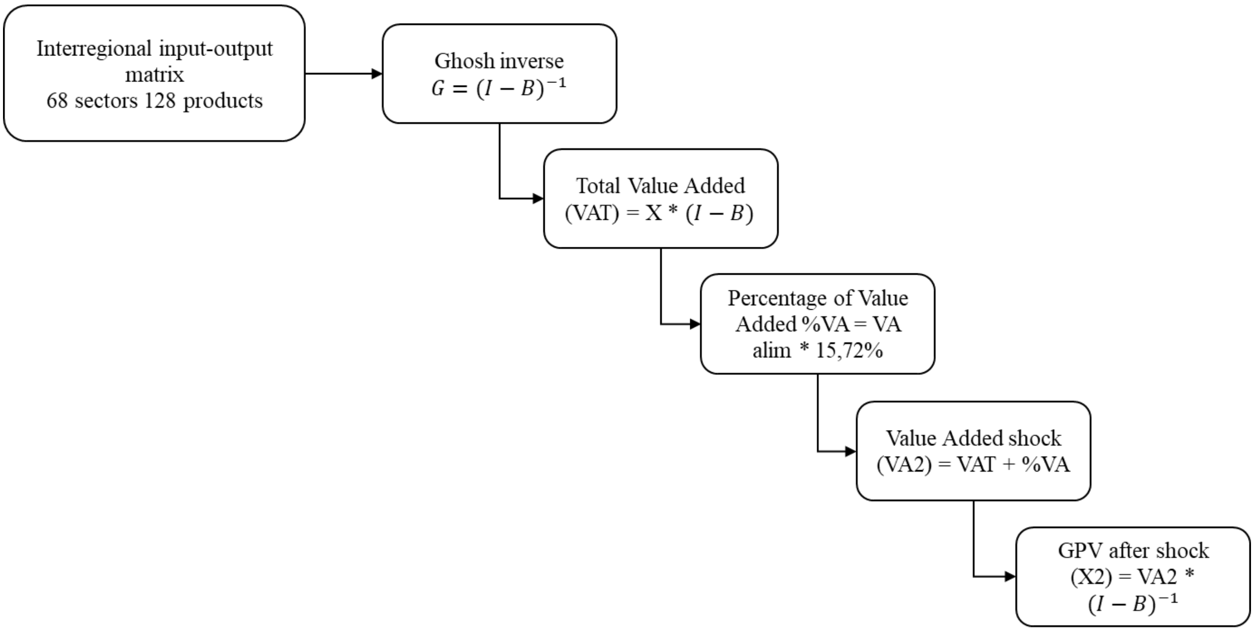
(a) We multiplied the percentage of idle capacity of the processing industry (15.72%) for 2013 by the value added of the "Other Food Products" sector (VA alim), per Federation Unit;

(b) Next, we added the values obtained in (a) to the total value added of the "Other Food Products" (TVA).

(c) We used the values obtained in (b) to simulate a new gross production value (X2) according to Equation 7 if the idle capacity of the "Other Food Products" industry was fully used.

Figure 3 shows the steps performed to calculate supply-side shocks.

Figure 3 | Steps for calculating supply-side shocks based on the interregional input-output matrix



Source: the authors (2022)

(3) Finally, we calculated the difference between the new Gross Production Values obtained in each simulation (difference = X2 - X1) to evaluate the net impact on the Gross Production Value - GPV of ceasing agricultural exports and using this production as a raw material, meeting the idle capacity of the industry. We used only the industry's idle capacity volume, so that the increase in the internal processing of agricultural commodities would only use the current productive structure, without the need for new investments. In this strategy, considering the linearity of the Leontief production function, it is assumed that 15% more inputs generate 15% more Value Added.

RESULTS AND DISCUSSIONS

We first present some results regarding the agriculture and other food products sectors, using the 2013 national input-output matrix to evaluate the chaining of both sectors with the remaining economic sectors at a national level. Which helps to understand, at the national level, the impact of substituting agricultural exports by domestic processing of the other food products industry.

Tables 1 and 2 summarize the Rasmussen-Hirschman linkage indexes. Table 1 ranks the top ten sectors with the highest backward linkages, plus the agriculture sector in the last row for comparison. These are “purchasing” sectors, that is, they stand out for purchasing goods and services from other sectors, thus being driving sectors of the economy.

The agriculture sector ranked 45th, with 0.908 backward linkage indexes. In fact, the agriculture sector is not an important “purchasing” sector for the other activities. Brazilian agricultural production fulfills some classic roles (see Johnston & Mellor (1961)) for economic development, mainly, supplying raw materials and food, however it is not very efficient in generating market. The Other Food Products sector ranks 5th (1.263), which indicates a linkage index above average, placing this sector as a driving sector. Importantly, the main suppliers for the Other Food Products sector are the agriculture and livestock sectors.

Table 1 | Top ten sectors with backward linkage indices greater than the unit, compared to agriculture – Year 2013

Sector	BLI	Ranking
Oil refining and coking plants	1.367	1
Slaughtering and meat products, including dairy and fishery products	1.365	2
Sugar manufacturing and refining	1.301	3
Biofuel manufacturing	1.282	4
Other food products	**1.263**	**5**
Extraction of non-ferrous metallic minerals, including beneficiation	1.247	6
Non-ferrous metallurgy and metal casting	1.24	7
Manufacture of cars, trucks and buses, except parts	1.212	8
Manufacture of cleaning products, cosmetics/perfumery and personal hygiene products	1.186	9
Production of pig iron/alloy, steel and seamless steel pipes	1.173	10
Agriculture, including agricultural and post-harvest support	**0.908**	**45**

Source: Research data

Table 2 ranks the top ten sectors with the highest forward linkages, plus the Other Food Products and agriculture sectors in the last two rows for comparison. The first three main sectors in this group are the Television, radio and cinema activities (1.876), Printing and playback of recordings (1.556) and the Oil and gas extraction sector (1.543). The agriculture sector ranked 37th with a 0.954 forward linkage index, whereas the Other Food Products ranked 48th, indicating that both sectors lack strong linkages with other sectors as "sellers" in the national economy.

Table 2 | Top ten sectors with forward linkage indices greater than the unit, compared to agriculture – Year 2013

Sector	FLI	Ranking
Television, radio, film and sound and image recording/editing activities	1.876	1
Printing and playback of recordings	1.556	2
Oil and gas extraction, including support activities	1.543	3
Manufacture of organic and inorganic chemicals, resins and elastomers	1.473	4
Extraction of coal and non-metallic minerals	1.458	5
Maintenance, repair and installation of machinery and equipment	1.423	6
Non-real estate rentals and intellectual property asset management	1.421	7
Legal, accounting, consulting, and corporate headquarters activities	1.42	8
Other professional, scientific and technical activities	1.417	9
Waterborne transport	1.407	10
Other food products	**0.764**	**48**
Agriculture, including agricultural and post-harvest support	**0.954**	**37**

Source: Research data

We must also highlight the importance of the **Other Food Products sector** as a purchaser of inputs from other economic sectors, suggesting that stimulus to this sector can be an important driver of economic growth. Moreover, the agriculture sector is an important seller of inputs, mainly for the food and Other Food Products sector.

By summing the columns of the Leontief inverse, we obtain the production multipliers, which reveal the impact on GPV resulting from changes in the final demand of a given sector. Table 3 presents the ten sectors with the highest production multipliers in the national economy. It can be noted that 4 of the 5 main industries in the GPV ranking are processors of agricultural inputs.

Table 3 | Top ten sectors with the highest production multiplier – Year 2013

Sector	GPV impact	Ranking
Oil refining and coking plants	2.46	1
Slaughtering and meat products, including dairy and fishery products	2.456	2
Sugar manufacturing and refining	2.341	3
Biofuel manufacturing	2.307	4
Other food products	**2.272**	**5**
Extraction of non-ferrous metallic minerals, including beneficiation	2.243	6
Non-ferrous metallurgy and metal casting	2.23	7
Manufacture of cars, trucks and buses, except parts	2.18	8
Manufacture of cleaning products, cosmetics/perfumery and personal hygiene products	2.134	9
Production of pig iron/alloy, steel and seamless steel pipes	2.11	10
Agriculture, including agricultural and post-harvest support	**1.633**	**45**

Source: Research data

According to the direct and indirect production multipliers, applying a shock of R$ 1 million reais to the final demand of the **Slaughtering and Meat Products** sector generates an impact of R$ 2.45 million reais on the national GPV. The **Agriculture sector** ranks 45th, with a multiplier of 1.63. In turn, the **Other Food Products sector** ranks 5th with a multiplier of 2.272, suggesting a great impact of this sector on the GPV when shock is applied to its final demand.

Although the results presented refer to the aggregate national economy, Brazil is a country with continental dimensions and a diversified productive structure (GUILHOTO et al., 2019). Hence, an interregional input-output system consisting of the 27 Federal Units can present more detailed results, not only regarding intersectoral linkages but also of the existing regional interdependence among the FUs.

In case of variations in final demand, the production multipliers show what the impact on GPV is. When it comes to an interregional system, however, one can identify the GPV spillovers from each FU to the others, depending on the interdependence between the productive structures.

Table 4 presents the average percentage for all sectors of the intraregional production multiplier (which remains in the FU) and the percentage that spillover to the other FUs (interregional). This analysis shows how independent each region can be from the others regarding input purchase.

Table 4 | Production multiplier – average percentage per FU – Year 2013

	Region/State	FU	Production Multiplier (Average %)	
			Intrarregional	Interregional
MIDWEST	Mato Grosso	MT	74	26
	Goiás	GO	76	24
	Mato Grosso do Sul	MS	79	21
	Federal District	DF	79	21
SOUTH	Paraná	PR	80	20
	Rio Grande do Sul	RS	79	21
	Santa Catarina	SC	81	19
SOUTHEAST	Espírito Santo	ES	80	20
	Minas Gerais	MG	80	20
	Rio de Janeiro	RJ	85	15
	São Paulo	SP	89	11
NORTHEAST	Alagoas	AL	77	23
	Bahia	BA	79	21
	Ceará	CE	82	18
	Maranhão	MA	82	18
	Piauí	PI	72	28
	Pernambuco	PE	82	18
	Paraíba	PB	75	25
	Rio Grande do Norte	RN	78	22
	Sergipe	SE	82	18
NORTH	Acre	AC	73	27
	Amazonas	AM	78	22
	Amapá	AP	75	25
	Pará	PA	75	25
	Rondônia	RO	75	25
	Roraima	RR	79	21
	Tocantins	TO	71	29

Source: Research data

São Paulo holds the highest percentage of intraregional production multiplier (89%), and thus can be considered as the most self-sufficient in input purchase among the Brazilian states. In second place we have the state of Rio de Janeiro, with 85%. At the other end, with the lowest percentage of intraregional production multiplier is the state of Tocantins (71%).

According to Guilhoto et al. (2017), São Paulo and Rio de Janeiro have a diversity of industries and services, which contributes to the multiplier effect remaining in these states, since it allows for most inputs to be procured from local agents. Tocantins, on the other hand, lacks these elements, having its production structure restricted to primary products, and consequently, most of its inputs need to be procured from other FUs.

We calculated the percentages of production multipliers only for the agriculture and other food products sector (Table 5). In the Agriculture sector, São Paulo and Pará stand out with an intraregional production multiplier of 91%, as well as the state of Amazonas with 90%, indicating that much of what is produced by the sector in these states remains within the states. But these percentages can have different explanations. For the state of São Paulo, its position as a major input consumer, since it holds the country's most important industrial park, explains the high intraregional percentage.

Table 5 | Production multiplier for the agriculture and other food products sectors – average percentage per FU – Year 2013

Region	Region/State	FU	Production Multiplier – Agriculture sector (%)		Production Multiplier – Other food products sector (%)	
			Intrarregional	Interregional	Intrarregional	Interregional
MIDWEST	Mato Grosso	MT	62	38	65	35
	Goiás	GO	71	29	65	35
	Mato Grosso do Sul	MS	68	32	72	28
	Federal District	DF	72	28	69	31
SOUTH	Paraná	PR	80	20	73	27
	Rio Grande do Sul	RS	81	19	73	27
	Santa Catarina	SC	79	21	68	32
SOUTHEAST	Espírito Santo	ES	84	16	63	37
	Minas Gerais	MG	77	23	71	29
	Rio de Janeiro	RJ	88	12	70	30
	São Paulo	SP	91	9	76	24
NORTHEAST	Alagoas	AL	70	30	65	35
	Bahia	BA	84	16	74	26
	Ceará	CE	88	12	63	37
	Maranhão	MA	85	15	73	27
	Piauí	PI	63	37	63	37
	Pernambuco	PE	85	15	67	33
	Paraíba	PB	83	17	59	41
	Rio Grande do Norte	RN	75	25	62	38
	Sergipe	SE	86	14	71	29
NORTH	Acre	AC	79	21	62	38
	Amazonas	AM	90	10	61	39
	Amapá	AP	86	14	59	41
	Pará	PA	91	9	68	32
	Rondônia	RO	73	27	61	39
	Roraima	RR	72	28	76	24
	Tocantins	TO	66	34	62	38

Source: Research data

In the case of Pará and Amazonas, their distance from the country's major consumer market means that inputs for agricultural products are mostly purchased domestically, as the shipping cost can render long distance trade unfeasible. On the other hand, the states of Mato Grosso and Piauí have an intraregional production multiplier of 62% and 63%, respectively, for the agriculture sector, which shows a considerable production spillover from these states to the other regions.

São Paulo and Roraima hold the highest intraregional values of production multipliers for the Other Food Products sector (76%). With different economic profiles, these two states have the highest input self-sufficiency in this sector for different reasons. The first is due to its great capacity to procure inputs domestically, given its industrial diversity, the latter due to its lack of regional integration, mainly for geographical reasons. Paraíba and Amapá, in turn, present the lowest percentages of intraregional production multiplier (59% each). Considering the percentage of spillover to other Brazilian regions, these states appear to be the least self-sufficient regarding the other food products sectors.

EXPANSION OF AGRICULTURAL PRODUCT PROCESSING

Brazil is a heterogeneous country, and the productive structure in each FU is quite different. Hence, we analyzed the substitution of agricultural exports by domestic processing for each FU, which allows identifying the different effects this strategy had in each region.

Table 6 shows the simulation results of substituting agriculture exports by increased production (value added) in the other food products sector, as described in Section 4. Paraná and Santa Catarina showed the highest GPV reduction due to the decrease in exports, given their intense grain exports due to natural (edaphoclimatic) and structural factors, such as ports. Both Paraná and Santa Catarina have important ports for shipping grains abroad.

Table 6 | Exports exchanged from the Agriculture sector by applying value added into Other Food Products sector – Year 2013 (millions)

	Region/State	FU	GPV after export reduction in Agriculture sector	GPV after VA application in Other Food Products sector	Average
MIDWEST	Mato Grosso	MT	-330.93	182.92	-148.01
	Goiás	GO	-562.46	847.33	284.87
	Mato Grosso do Sul	MS	-103.56	133.85	30.29
	Federal District	DF	-24.69	66.71	42.01
SOUTH	Paraná	PR	-1170.78	1465.11	294.34
	Rio Grande do Sul	RS	-1134.64	1050.02	-84.62
	Santa Catarina	SC	-130.34	445.79	315.46
SOUTHEAST	Espírito Santo	ES	-24.16	168.68	144.52
	Minas Gerais	MG	-673.45	928.07	254.63
	Rio de Janeiro	RJ	-12.25	162.38	150.13
	São Paulo	SP	-414.53	2862.43	2447.89
NORTHEAST	Alagoas	AL	-8.09	88.52	80.43
	Bahia	BA	-400.07	313.66	-86.41
	Ceará	CE	-21.98	413.34	391.36
	Maranhão	MA	-25.54	55.28	29.74
	Piauí	PI	-53.05	47.35	-5.70
	Pernambuco	PE	-8.70	328.76	320.07
	Paraíba	PB	-4.47	94.14	89.67
	Rio Grande do Norte	RN	-4.5	105.17	100.81
	Sergipe	SE	-9.37	78.97	69.60
NORTH	Acre	AC	-3.94	15.12	11.18
	Amazonas	AM	-14.81	55.46	40.65
	Amapá	AP	-0.77	13.28	12.50
	Pará	PA	-110.04	155.14	45.10
	Rondônia	RO	-17.31	44.21	26.90
	Roraima	RR	-1.42	6.41	4.99
	Tocantins	TO	-29.04	24.92	-4.12
	Brazil		**-5,294.75**	**10,153.03**	**4,858.29**

Source: Research data

São Paulo, Paraná and Santa Catarina had the most significant GPV increase due to positive shock in the value added of the Other Food Products sector. For São Paulo, this may result from the importance of the state to the national industry, since in 2013 it was responsible for 32% of everything produced in the country, according to IBGE. As for the states of Paraná and Santa Catarina, this increase may be explained by the production of animal feed, an important component of the Other Food Products sector, given the states' importance in poultry and pork production.

By calculating the difference between the decrease in GPV, due to the reduction in agricultural exports, and he increase in GPV, due to the VA increase of the other food products sectors, we have the net result of the scenario proposed in this study. São Paulo holds the largest positive difference, R$ 2.45 billion reais in GPV, which may stem from the state being the largest industrial hub in the country and, consequently, concentrating a large part of the food processing industry and other related industries, such as packaging and transportation. Thus, what the state loses from reducing agricultural exports is more than offset by the VA increase of the other food sector and the indirect impact of related sectors.

Mato Grosso, Bahia, Rio Grande do Sul, Piauí, and Tocantins presented a negative net value. Note that the states of Mato Grosso, Tocantins, Piauí, and Bahia are agricultural frontiers, with the last three making up the so-called MATOPIBA region[2], in which processing volumes, mainly feed, are significantly low about to the huge agricultural production and export. They are recent agribusiness frontiers, lacking time to potentially transform themselves into agro-industrial frontiers[3]. Moreover, Mato Grosso is the state with the highest agricultural GPV, representing 14% of the total agriculture of Brazil GPV and the 5th highest in agricultural VA, responsible for 10.22% of the country's total agricultural VA. Consequently, the reduction of agricultural exports resulted in a proportionally greater negative effect than its processing, since the industrial structure used for grain processing lacks the same concentration as agriculture.

Regarding the Southern Brazilian states, Rio Grande do Sul has a high export volume, especially soybean; however, compared with Santa Catarina and Paraná, the state presents a lower processing volume. Rio Grande do Sul has a tobacco industrial park, one of the products that make up the agriculture sector, but that does not participate in the other food products

2 The MATOPIBA is an acronym for the states of Maranhao, Tocantins, Piauí and Bahia. Its region is composed by 336 municipalities in four border states: 143 from Maranhão, 130 from Tocantins, 33 from Piauí and 30 for Bahia. Their territory belonging to the Cerrado biome, where agriculture based on modern, high productivity technologies is developed. Nowadays MATOPIBA is an important agricultural frontier. For more information visit: https://www.embrapa.br/gite/projetos/matopiba/matopiba.html.

3 See more details in Dalmas, Staduto, Willers, 2007.

sector (sector where the shock was applied).

The greatest negative differences in these states can also be explained by the spillover of production multipliers (Table 5). Mato Grosso, Piauí and Tocantins are among the lowest percentages of intraregional multipliers in the "Other food products" sector, which indicates that most inputs used by these sectors are acquired outside these states, thus positive impacts on the sector will spillover to other regions.

Moreover, the states presenting a negative difference have their GPV mostly composed by agriculture, compared with the other FUs. These states are also exporters of agricultural products, so any variation in exports will be of great impact, without proportional compensation for the internal agricultural processing.

When considering the net result for the country (Table 6), the decrease in GPV resulting from the reduction in agricultural exports totals R$ 5.29 billion. In turn, the increase in GPV resulting from the increase in value added of the other food products sector is R$ 10.15 billion. Importantly, this scenario projected no expansion of the agricultural product processing sector, since it only considered the idle capacity already existing in the industry.

We found that the reduction in agricultural GPV was more than offset by the gain in GPV from the increased value added on the other food products sector, with a net positive result of R$ 4.86 billion. This suggests that public policies of this nature can positively impact the national economy and consequently regional development.

However, the industrial structure of Brazil, mainly concentrated in the Southeastern states, can contribute such policies to enhance further the economic inequality between states since those that gain the most are the wealthiest states. Hence, a more equitable economic result can be obtained by first implementing incentives to decentralize the national productive structure.

CONCLUSIONS

Based on input-output analysis, this study evaluated the impact of substituting the export of fresh products from the agro-industry for domestic processing, thus allowing a greater generation of value-added, contributing to the economic growth of the country.

It allowed analyzing the chaining power of the sector, initially for the national economy aggregate. Among the main "purchasing" sectors, the other food products sector ranks 5th, being one of the main sectors to boost economy, while the agriculture sector ranks 45th among "purchasing" sectors and 37th among "selling" sectors. In aggregate terms, this suggests that policies aiming to encourage the "Other Food Products" sector would significantly impact the economic growth of the country compared to policies encouraging only agricultural production and exports.

To achieve the proposed objectives, we simulated a scenario of partially suppressed agricultural exports and increased supply of other food products. Sectors that buy inputs from the "Other Food Products" sector were assumed to increase their purchases in fixed proportions.

We used the average percentage of idle capacity of the manufacturing industry as a reference, corresponding to 15.72% for the studied year. It was thus unnecessary to evaluate the expansion of manufacturing plants. Our results show that the substitution would be satisfactory nationwide, pointing to a positive balance of R$ 4.86 billion in gross production value.

Except for the states of Mato Grosso, Bahia, Rio Grande do Sul, Piauí, and Tocantins, which presented a negative GPV balance, all other FUs had a positive balance. Losses from the decreased agricultural exports were more than offset by the increase in "other food products" supply.

This suggests that the decrease in GPV in Mato Grosso, Bahia, Piauí, and Tocantins occurs because these states are expanding their agricultural frontier, with the last three making up called MATOPIBA, where for agricultural production, has been employed an intensive technological model to achieve higher productivity; however, they are still in the early stages of agroindustrialization. Hence, most of their agricultural processing takes place outside their borders, so that the gains from processing do not offset the losses from reduced exports.

Although the state of Rio Grande do Sul is one of the largest soybean exporters, the regionalization of the agroindustrial activities in other states results in low value addition to primary products in this state.

The proposed scenario showed that substituting agricultural exports by domestically processing products with higher value added can have significant effects for the national economic activity. However, the increase in national wealth is accompanied by increased economic inequality among the FUs, since the Southeastern states, already considered the richest in the country, show the biggest estimated gains. This is because the industrial structure used for processing agricultural products is largely concentrated in the Southeast region.

This theoretical exercise assumed two hypotheses: 1) based on Ghosh model, in which purchase coefficients are fixed, that is, increases in the supply of a producing sector must be absorbed in fixed proportions by the purchasing sectors; 2) in which supply increases will be fully absorbed by the domestic and foreign markets without price variations.

Another point to be addressed is that it is not within the scope of the paper to deal with the challenges faced by Brazil, if the internalization of the process of the agricultural products reflects in a change in the country's exports policy. For this, technological changes, quality standard certifications and commercial agreements will be necessary. It can cause a negative impact in the benefits pointed out by this research and that may be the subject of further research.

However, these results may shed light on this issue, sparking new research on the importance of reducing dependence on fresh agricultural exports and using the food production sector as a strategy for national economic growth. Moreover, it draws attention to the concentration of the national productive structure, which can enhance economic inequalities.

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