ÁREA 6 - CRESCIMENTO, DESENVOLVIMENTO ECONÔMICO E INSTITUIÇÕES

STRUCTURAL CHANGE IN THE BRAZILIAN ECONOMY: a structural decomposition analysis for 2000-2014

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ABSTRACT
The paper aims to analyze the features of the Brazilian structural change process in the period from 2000 to 2014. More specifically, we investigate the intensity and nature of the deindustrialization process in sub-periods of the whole period under consideration. To overcome some limitations of the indicators used by the later literature (the sectoral gross output, value-added and employment shares), we apply an I-O structural decomposition methodology that takes the effect of relative prices explicitly to examine the contributions of different factors to the growth of total gross output and its composition. We utilize a series of I-O Matrices valued at constant prices constructed by the GIC-UFRJ for the period 2000-2014, based on partial information from the Brazilian SNA and I-O matrix official statistics. Moreover, in our analysis, we regroup the whole set of extractive and manufacturing sectors into four industry groups according to the classification proposed by the GIC-UFRJ: processed agricultural commodities, traditional industry, industrial commodities, and innovative industry. Such classification allows us to interpret some distinctive characteristics of the Brazilian's productive structure since it captures specific features of the competition and technological flow patterns prevailing in the Brazilian economy in the period. The I-O structural decomposition analysis of the database described leads us to develop a different perspective in the debate about the Brazilian deindustrialization process. According to this perspective, this process is less intense and continuous than literature characterizes it. In particular, we show that it is more significantly intense in the sub-period after the 2008 world crises and in the case of the traditional and innovative industries groups.
KEY-WORDS: Brazilian economy. Structural Change and Deindustrialization. Input-output model. Structural decomposition analysis. Relative prices.

RESUMO
O artigo tem como objetivo analisar as características do processo de mudança estrutural na economia brasileira no período de 2000 a 2014. Mais especificamente, investigamos a intensidade e a natureza do processo de desindustrialização para todo o período e para sub-períodos. Para tanto, examinamos os efeitos da mudança estrutural nas fontes de mudança estrutural na economia brasileira. Para superar algumas limitações dos indicadores utilizados pela literatura especializada (valor bruto da produção, valor agregado e ocupações), aplicamos uma metodologia de decomposição estrutural que considera explicitamente o efeito de preços relativos para examinar as contribuições de diferentes fatores crescimento da produção bruta total e sua composição. Utilizamos uma série de Matrizes Insumo-Produto (MIP), nominadas a preços constantes, construídas pelo GIC-UFRJ para o período 2000-2014, com base em informações parciais das estatísticas oficiais do Sistema de Contas Nacionais e da MIP. Reagrupamos todo o conjunto de setores extrativista e manufatureiro em quatro grupos industriais de acordo com a classificação proposta pelo GIC-UFRJ: commodities agrícolas processadas, indústria tradicional, commodities industriais e indústria inovativa. Tal classificação permite interpretar algumas características distintivas da estrutura produtiva brasileira, uma vez que captura os padrões de concorrência e fluxo tecnológico prevalecentes na economia no período. A decomposição estrutural nos leva a desenvolver uma perspectiva sobre a desindustrialização brasileira, em especial porque incorpora o efeito dos preços relativos. De acordo com essa perspectiva, esse processo é menos intenso e contínuo do que a literatura caracteriza. Em particular, mostramos que é mais significativo no subperíodo após a crise mundial de 2008 e no caso dos setores da indústria tradicional e inovativa.
PALAVRAS-CHAVE: Economia Brasileira. Mudança Estrutural e Desindustrialização. Insumo-produto. Decomposição estrutural. Preços relativos.
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1 INTRODUCTION

Since the 2000s, many studies dedicated particular attention to analyzing the evolution of the productive structure of the Brazilian economy. One of the main topics of discussion is the existence and intensity of a process of deindustrialization and regressive specialization. Most of this literature uses the fall in manufacturing industries', gross output, value added and employment shares as indicators in the characterization of these processes. However, these indicators have some critical limitations when utilized for this purpose and cannot be used alone in this type of investigation. We argue that an analysis based on the indicators gains accuracy by the explicit use of an Input-Output (I-O) analytical framework.

This paper aims to analyze the process of structural change in the Brazilian economy in the period between 2000 and 2015. More specifically, our investigation deals with the existence, nature, and intensity of the processes of deindustrialization and regressive specialization in such a period. To better characterize these processes, we subdivide the whole period into three subperiods: 2000-2003; 2003-2008; 2010-2014. Concerning the I-O analytical framework, we specifically apply an I-O structural decomposition methodology that takes the effect of relative prices explicitly to examine the contributions of different factors to the growth of total gross output and its composition. In our work, we utilize a series of I-O Matrices valued at constant prices constructed by GIC-UFRJ for the period 2000-2015, based on partial information from the Brazilian SNA and I-O matrix official statistics.

By using this database, it is possible to take into account relative price effects, an essential feature of the Brazilian and others developing economies. We argue that the exclusion of relative price effect contributes to the debate about deindustrialization and regressive specialization by increasing the accuracy of the analysis of the factors affecting the productive structure of the Brazilian economy. Moreover, in our analysis, we regroup the whole set of extractive and manufacturing sectors into four industry groups according to the classification proposed by GIC-UFRJ: processed agricultural commodities, traditional industry, industrial commodities, and innovative industry. Such classification allows us to interpret some distinctive characteristics of the Brazilian productive structure since it captures specific features of competition and technological flow patterns prevailing in Brazil.

Besides this introduction, this paper has more four sections. Section 2 provides an overview of the Brazilian economy considering a macroeconomic overview and some structural analysis. Section 3 describes methodological issues, as the data, input-output model and structural decomposition. In section 4 we analyze the results of our structural decomposition analysis. Finally, the last section presents some final remarks.

2 A BRIEF REVIEW OF THE INTERPRETATIONS OF THE PROCESS OF STRUCTURAL CHANGE IN THE BRAZILIAN ECONOMY

Two concepts are usually used to understand and characterize the deindustrialization process. First, we have the classic concept of deindustrialization based on Rowthorn & Wells (1987) among others, that define deindustrialization as the continuous fall in manufacturing employment share. Secondly, there is the modern one, suggested by Tregenna (2009) for example, where a country would be deindustrializing if manufacturing value added share decreases comparing to other sectors, especially the services sector.

However, there are some criticisms regarding the use of these indicators to characterize deindustrialization. In using employment as a measure, it is not possible to do sectoral change analysis regarding production (Silva & Lourenço, 2016). As the standard way to calculate the value added is by the difference between the gross output and the intermediate inputs, it is also affected by prices and quantities. Thus, deindustrialization analysis using value added data may be associated only to a change in relative prices (terms of trade) of the manufacturing industry to the general GDP deflator (Silva & Lourenço, 2016).

Also, Medeiros, Freitas, & Passoni (2018) discuss that analyzing deindustrialization by the shares of value added and employment is misleading because they argue that as the economic activity may affect the participation of manufacturing industries. It happens especially because the investment-output ratio e pro-cyclical, and the participation of industries intensive in capital goods must rise in the ascendant part of the cycle and reduce in the valley.

To overcome those limitations, the authors suggest that the structural change in the economy is analyzing a combination of three elements. The first one is the comparison of value added (and employment) of innovative industry group n total value added (and employment). The second one analyzes competitive indicators such as market share of domestic exports on world exports by industry and the market share of imports in total supply. The last one is the density of the interindustry relations as captured by the input-output linkages indicators.

This work concentrates its analysis on the last point, using the input-output approach. Some studies use input-output indicators to analyze the existence of structural change of the Brazilian economy. Most of this studies use Rasmussen linkage indicators and key sectors to verify if there are changes in the backward and forward linkages. Some of them are Morceiro (2012), Pires, Teixeira and, Rocha (2015), Marconi, Rocha, & Magacho (2016). The first three ones concentrate their analysis up to 2009 because there was a change in the national system accounts that realized only in 2016 the input-output table (IBGE, 2016). They found that there was a was a reduction in technical coefficients, not only for the manufacturing industry but also for all economic sectors. Also, a common result is that although the manufacturing industry is reducing its linkages in the economy, this sector continues to be very important because they have high linkage effects, having the capability to stimulate other sectors.

For a more recent period, Passoni & Freitas (2017) shows that between 2010 and 2014 the manufacturing activities are still very important to the productive structure, but this important is more significant in the traditional industry. Also, they show based on the power and sensitivity of dispersion indicators and its composition there was no significant change in the Brazilian economy between 2010 and 2014. Medeiros, Freitas and, Passoni (2018) analyze these linkage indicators between a larger period, 2000 and 2014, but focused on the innovative industry. They show that there were small changes between 2000 and 2014, but exists an increasing tendency between 2000 and 2008 and a declining trend in the period from 2010 to 2014.

Structural decomposition analysis (SDA) is also another input-output methodology used to identify the structural change in the Brazilian economy. Neves (2013), Persona and Oliveira (2016) and Magacho, McCombie and Guilhoto (2018) use this methodology with the objective to verify the hypothesis of deindustrialization and regressive specialization. Because of the structural data availability, this studies analysis the Brazilian economy up to 2009. They use different databases and methods to construct a deflated IOT series. They use cell-specific deflators, double deflation, and accumulated quantum indices respectively.

All three works argue that the final demand is the source of change that contributes the most to the changes in gross output in the period. Persona & Oliveira (2016) found out that technological change (changes on national technical coefficients) had a negative influence on employment (more expressively), value added, gross product and growth. The authors associate this change with technological innovation, changes in products composition, changes in relative prices and trade pattern. As this study ended in 2009, this must also be an effect of the negative performance in the Brazilian economy at this time. According to them, the hypothesis of regressive specialization is correct, as changes of gross output and value added were related to industries based on natural resources and reduction of manufacturing sectors intensive in scale and technology importance.

Neves (2013) argues that there is not strong evidence of a marked process of deindustrialization between 2000 and 2008, whether from the perspective of occupations or under the gross output. The author bases his argument on the idea that the manufacturing industry had the greatest contribution among all industries. However, as far as the trade pattern is concerned, there is import penetration in the manufacturing industry, especially more marked in the medium-low and medium-high technology sectors. In addition, there is a negative contribution of the technological change to the gross output in volume in the period, which is mitigated by the change in relative prices.

Magacho, McCombie and Guilhoto (2018) found that the technological change had a positive effect on the period, but the substitution of national inputs mitigate its result. The results suggest that there is a penetration of imported inputs, and this is essential to understand the Brazilian growth in the period analyzed. In a sectoral perspective, the authors observe that substitution of national inputs is more pronounced in high- and medium-high-technology manufacturing sectors.

Although Persona and Oliveira (2016) and Magacho, McCombie, and Guilhoto (2018) deflate the IOT to consider the effects of the exchange rates' volatility and relative price changes and analyze prices effect and quantity separately, we argue that both methods is not enough to include with relative prices changes in the structural decomposition analysis. In both methods, there is a missing step that must consider the deflator in each sector concerning the total gross output. This step guarantees the additivity over industries because there are changes in the relation of both deflators. Besides that, these studies do not include the role of relative prices inside the SDA explicitly.

Neves (2013) overcome those limitations and construct a database that guarantees the additivity over industries and include the role of relative prices inside the SDA. Besides that, the way the author analyzes the role of relative prices is not the most accurate one once he analysis each effect separately. The role of relative prices has it meaning when analyzed in a global way inside the decomposition.

In other to overcome this limitation, the novelty of this work is to present an SDA analysis that disentangles the changes in gross output in its volume changes and relative prices properly. Also, a new feature is that we use a more recent database that covers 15 years (2000-2014) that allow us to understand what happened in the Brazilian productive structure after 2009. We argue that the process of deindustrialization have to have its focus those sectors that have the innovation capacity, primarily because it stimulates technological flows.

3 METHODOLOGY

3.1 Data and aggregation

We utilize a series of I-O Matrices valued at relative constant prices of 2010, constructed by the GIC-UFRJ for the period 2000-2015. The I-O matrices at current and prices of the previous year is constructed based on partial information from the Brazilian SNA and I-O matrix official statistics (IBGE, 2015; 2016), published by Passoni and Freitas (2018a; 2018b).

Since our goal is to include the relative prices change in the context of SDA in the Brazilian case, we use also I-O tables valued at **constant relative prices,** as proposed in Casler (2006), Dietzenbacher and Temurshoev (2012), Hillinger (2002) and Reich (2008) and constructed by (Passoni & Freitas, 2018b).

In the procedure done by Passoni and Freitas (2018b), they deflate the whole series of estimated matrices at current and last year prices by the price index of total gross-output. Using this data is possible to isolate the contribution of relative price changes. For that chained prices indices were constructed using cell-specific deflators to put all the I-O Tables at the base year, in this case, 2010. At the decomposition we present in this work, this data is related to what we will call *'volume effect*,' that expresses the change in production of the specific good or service in question. In this way, they purge the inflation effect and the IOT a series that Passoni and Freitas (2018b) presents is compatible over time.

To obtain deflated IOT additivity another step is necessary. Passoni and Freitas (2018b) also adjusted the previous series for relative prices to obtain a series at *constant relative prices*, as suggested by Balk & Reich, 2008; Dietzenbacher & Temurshoev, 2012; Diewert, 2015; Reich, 2008. They make this adjustment though dividing each relative price (cell-specific deflators) by the total gross output deflator. It guarantees consistent deflated input-output tables. This step allows isolation of the variation of one commodity price relative to the other commodities, caused by the forces of supply and demand on each commodity market. So, we will name this price adjustment as *'relative prices effect*.'

We observe that relative price changes have a meaningful impact when doing sectoral analysis in the period analyzed in this study. Although, most of the studies of the Brazilian process of deindustrialization do not analyze this aspect, and this may influence the observed results.

Relative to the data used, the decomposition procedures were calculated based on 91 commodities by 42 sectors. This disaggregation level is the most disaggregated data possible for an IOT large series of Brazilian national accounts[1] For organization and disclosure of results, we regroup the whole set of extractive and manufacturing sectors into four industry groups according to the classification proposed by GIC-UFRJ

- *Processed agricultural commodities (PAC):* sectors intensive in natural and energy resources, being generally associated with agribusiness and homogeneous products of high tonnage;
- *Industrial Commodities (IC)*: natural resource intensive activities related to mineral extractive industry, metallurgy and basic chemistry;
- *Traditional industry (IT)*: industries that produce goods with less technological content, with few requirements regarding productive scale; production of wage goods, inputs, industrial parts and complements, and manufactured consumer goods;
- *Innovative industry (IN)*: more sophisticated activities in technology and organization terms on the production process that most contribute to the technology diffusion process in the economy;

The description of the sectors that contain this classification is in the appendix.

As suggested by Medeiros, Freitas, & Passoni (2018), this classification is better than others based only on the technological intensity of products (such as OECD intensity classification). It captures supply factors, such as the global pattern of competition and technological flow and also aspects related to demand, as the technological intensity of demanding manufacturing and extractive goods. Such classification allows us to interpret some distinctive characteristics of the Brazilian productive structure and has essential meaning when analyzing the process of deindustrialization.

3.2 I-O model in the context of relative prices

The gross output ($\mathbf{x}$) in the I-O model is:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A_n})^{-1}\mathbf{f_n} \qquad (1)$$

where $\mathbf{A_n}$ $(n \times n)$ is the matrix of domestic technical coefficients; $(\mathbf{I} - \mathbf{A_n})^{-1}$ $(n \times n)$ is the Inverse Leontief Matrix, and $\mathbf{f_n}$ is the domestic final demand $(n \times 1)$, and n is the number of sectors in the model.

In the Brazilian IOT $\mathbf{A_n}$ and $\mathbf{f_n}$ are obtained from the Use Table of national products at basic prices, which contains the information of intermediate demand of commodities by sector and final demand of commodities $(n \times k,$ with k commodities). To transform this information according to the industry technology model we use a market share matrix ($\mathbf{D}$) to transform demand of commodities into the demand of sectors. This matrix is defined as follows:

$$\mathbf{D} = \mathbf{V}\hat{\mathbf{q}} \qquad (2)$$

where $\mathbf{V}$ is the transposed matrix production $(n \times k)$ and $\mathbf{q}$ the gross output value by commodity $(k \times 1)$.

Let $\mathbf{U_n}$ be the flow matrix of intermediate demand for national products at basic prices. Thus, we obtain the commodity by sector matrix of national technical coefficients $\mathbf{B_n}$, as follows:

$$\mathbf{B_n} = \mathbf{U_n}\hat{\mathbf{x}}^{-1} \qquad (3).$$

Next, by premultiplying $\mathbf{B_n}$ by $\mathbf{D}$ we obtain $\mathbf{A_n}$:

$$\mathbf{A_n} = \mathbf{D}.\mathbf{B_n} \qquad (4).$$

Likewise, we obtain the vector of final demand by sector ($\mathbf{f_n}$) by premultiplying the vector of final demand by commodities ($\mathbf{d_{F_n}}$) by $\mathbf{D}$ such as:

$$\mathbf{f_n} = \mathbf{D}.\left(\mathbf{d_{F_n}}\right) \qquad (5).$$

[1] For more details of this procedure, see Passoni and Freitas (2018a).

Using (4) and (5) we present gross output as:

$$\mathbf{x} = \mathbf{D}.\mathbf{B_n}\mathbf{x} + \mathbf{D}.\mathbf{d_{F_n}} \quad (6).$$

We can express sectoral gross output as follows, to capture the changes in volume and prices,

$$\mathbf{x} = \hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} \quad (7)$$

with $\hat{\mathbf{x}}^{\mathbf{p}}$ represents the *relative price effect* and $\mathbf{x}^{\mathbf{v}}$ is gross output *volume*. The changes in the prices here represents the *relative price effect*, mentioned in the previous section, and we define $\hat{\mathbf{x}}^{\mathbf{p}} = x_j^p/p$, where x_j^p is the price index of the sector *j* and *p* the price index of total gross output deflator.

As we aim to capture the influence of relative prices in the IO model components, we rewrite all variables disaggregating relative price and volume terms. The elements of the $\mathbf{U_n}$ matrix becomes:

$$u_{n_{ij}} = \frac{u_{n_{ij}}^{p}}{p} \times u_{n_{ij}}^{v} \quad (8)$$

Where $u_{n_{ij}}^{p}$ is the relative price of commodity *i* used as an input by industry *j*, and $u_{n_{ij}}^{v}$ is the volume measure of commodity *i* used as an input by industry *j*.

Using (7) and (8) in (3) , the elements of $\mathbf{B_n}$ are given by:

$$b_{n_{ij}} = \frac{\frac{u_{n_{ij}}^{p}}{p}}{\frac{x_j^p}{p}} \times \frac{u_{n_{ij}}^{v}}{x_j^v} = \frac{u_{n_{ij}}^{p}}{p_{x_j}} \times \frac{u_{n_{ij}}^{v}}{x_j^v} \quad (9).$$

Let us define the elements of matrices $\mathbf{B_n^p} = \left[b_{n_{ij}}^{p}\right]$ and $\mathbf{B_n^v} = \left[b_{n_{ij}}^{v}\right]$ as follows:

$$b_{n_{ij}}^{p} = \frac{u_{n_{ij}}^{p}}{p_{x_j}} \text{ and } b_{n_{ij}}^{v} = \frac{u_{n_{ij}}^{v}}{x_j^v} \quad (10)$$

Thus, using the symbol $\otimes$ to denote the Hadamard product, the $\mathbf{B_n}$ matrix can be expressed in the following way:

$$\mathbf{B_n} = \mathbf{B_n^p} \otimes \mathbf{B_n^v} \quad (11)$$

where, $\mathbf{B_n^p}$ is the matrix of relative price indices, and $\mathbf{B_n^v}$ is the matrix of national technical coefficients measured in volume terms, both related to the commodity by industry national technical coefficient matrix.

As to the final demand, let us define the commodity relative price of the final demand vector ($\mathbf{d_{F_n}^p}$):

$$\mathbf{d_{F_n}^p} = d_{F_{nj}}^{p}/p \quad (12).$$

Next, we can decompose the final demand vector in its relative price and volume components, obtaining the expression below:

$$\mathbf{d_{F_n}} = \mathbf{d_{F_n}^p}\mathbf{d_{F_n}^v} \quad (13)$$

where $\mathbf{d_{F_n}}^{\mathbf{v}}$ represents the volume final demand vector.

Finally, for the market-share matrix, the approach was somewhat different. First, the volume market share ($\mathbf{D}^{\mathbf{v}}$) was calculated using *constant prices* data:

$$\mathbf{D}^{\mathbf{v}} = \mathbf{V}^{\mathbf{v}}\widehat{\mathbf{q}^{\mathbf{v}}} \quad (14).$$

Since there is not a direct relative prices deflator to D ($\mathbf{D}^{\mathbf{p}}$) that guarantees consistent aggregation, we calculate it by the cell-by-cell Hadamard division ($\oslash$) of market share matrix calculated using constant relative prices data ($\mathbf{D}$) and constant relative prices data ($\mathbf{D}^{\mathbf{v}}$).

$$\mathbf{D}^{\mathbf{p}} = \mathbf{D} \oslash \mathbf{D}^{\mathbf{v}} \quad (15).$$

Doing so, we represent **D as:**

$$\mathbf{D} = \mathbf{D}^{\mathbf{p}} \otimes \mathbf{D}^{\mathbf{v}} \quad (16).$$

Back to equation (6), we have now:

$$\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} = (\mathbf{D}^{\mathbf{p}} \otimes \mathbf{D}^{\mathbf{v}})\left(\mathbf{B_n^p} \otimes \mathbf{B_n^v}\right)\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} + (\mathbf{D}^{\mathbf{p}} \otimes \mathbf{D}^{\mathbf{v}}).\left(\mathbf{d_{F_n}^p}\mathbf{d_{F_n}^v}\right) \quad (17)$$

Solving the last equation for the vector of gross output in volume terms we obtain

$$\mathbf{x^v} = \left[\mathbf{I} - \left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}(\mathbf{D^p} \otimes \mathbf{D^v})\left(\mathbf{B_n^p} \otimes \mathbf{B_n^v}\right)\hat{\mathbf{x}}^{\mathbf{p}}\right)\right]^{-1}\hat{\mathbf{x}}^{\mathbf{p}^{-1}}(\mathbf{D^p} \otimes \mathbf{D^v}).\left(\mathbf{d^p_{F_n}}\,\mathbf{d^v_{F_n}}\right) \quad (18).$$

To simplify the above equation, we denote $\widetilde{\mathbf{A}}_{\mathbf{n}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}(\mathbf{D^p} \otimes \mathbf{D^v})\left(\mathbf{B_n^p} \otimes \mathbf{B_n^v}\right)\hat{\mathbf{x}}^{\mathbf{p}}$, $\tilde{\mathbf{Z}} = \left[\mathbf{I} - \widetilde{\mathbf{A}}_{\mathbf{n}}\right]^{-1}$, and $\tilde{\mathbf{f}}_{\mathbf{n}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}(\mathbf{D^p} \otimes \mathbf{D^v}).\left(\mathbf{d^p_{F_n}}\,\mathbf{d^v_{F_n}}\right)$, that are the matrix of national coefficients, Leontief matrix and final demand vector weighted by total relative prices. In this way,

$$\mathbf{x^v} = \left(\mathbf{I} - \widetilde{\mathbf{A}}_{\mathbf{n}}\right)^{-1}\tilde{\mathbf{f}}_{\mathbf{n}} = \tilde{\mathbf{Z}}\tilde{\mathbf{f}}_{\mathbf{n}} \quad (19).$$

This equation is interesting because it allows us to identify the volume contribution to changes in gross output (the *volume effect*), leaving aside the relative price contribution.

3.3 A proposed indicator of the share of industries in gross output

Before doing the decomposition itself, we propose an indicator that compares the sectoral growth share of each industry group with the total economy. With this, we can see if each industry is growing above or below the total gross output. Notably, we are interested in analyzing the performance of the innovative industry group concerning the economy, as it is the industry that can stimulate technological flow in the economy.

If we consider τ as the share of each extractive and manufacturing industry group (x_G^v) in the total gross output volume (x^v), as in:

$$\tau = \frac{x_G^v}{x^v} \quad (20)$$

with G as industrial commodities, processed agricultural commodities, traditional industry and innovative industry.

We can measure the growth rate of τ (g_τ) using the growth rates of x_G^v and x^v:

$$g_{x_G^v} = \frac{x_{G_1}^v - x_{G_0}^v}{x_{G_0}^v} \text{ and } g_{x^v} = \frac{x_1^v - x_0^v}{x_0^v} \quad (21)$$

in this way:

$$g_\tau = \frac{g_{x_G^v} - g_{x^v}}{1 + g_{x^v}} \quad (22).$$

If $g_\tau < 1$ it means that the group growth rate is lower than the total gross output in volume. In this sense, it contributes to the decline in the share and will indicate that the participation of each group is falling in the period. The previous equations (34), (35) and (36) are also calculated using the total gross output. The comparison between them also gives the importance of taking apart the relative price effect.

3.4 Structural decomposition

The structural decomposition analysis (SDA) approach is a technique that disaggregates the change of some economic aspect into various components contributions - disaggregating an identity into several components (Miller & Blair, 2009). Any economic variable can be decomposed into its elements, enabling a better understanding of the variation between two periods.

The variable of interest, in this paper, is the change in Brazilian gross output ($\mathbf{x}$) between 2000 and 2015, and three subperiods: 2000-2003, 2003-2008 and 2010-2015. With it, we propose a two-level decomposition. The first one disaggregates the change of gross output presented in equation (7) in changes in total volume ($\mathbf{x^v}$) and total relative prices ($\mathbf{x^p}$).

The decomposition follows Dietzenbacher & Los (1998) and Miller & Blair (2009), using the average of the two extreme decomposition situations. Denote '0' and '1' as superscripts for the initial and final, respectively. So, the gross output change (**$\Delta\mathbf{x}$**) of equation (7), then, becomes:

$$\boldsymbol{\Delta}\mathbf{x} = \hat{\mathbf{x}}_1^{\mathbf{p}}\hat{\mathbf{x}}_1^{\mathbf{v}} - \hat{\mathbf{x}}_0^{\mathbf{p}}\hat{\mathbf{x}}_0^{\mathbf{v}} \tag{23}$$

$$\underbrace{\boldsymbol{\Delta}\mathbf{x}}_{\textit{total gross output change}} = \underbrace{\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}} + \hat{\mathbf{x}}_0^{\mathbf{p}}\right)\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}}}_{\textit{volume change}} + \underbrace{\frac{1}{2}\boldsymbol{\Delta}\hat{\mathbf{x}}^{\mathbf{p}}\left(\hat{\mathbf{x}}_1^{\mathbf{v}} + \hat{\mathbf{x}}_0^{\mathbf{v}}\right)}_{\textit{relative prices changes}} \tag{24}$$

We express all the decomposition's results regarding its contribution to total gross output growth. To obtain this contribution, we must divide each variable in (19) concerning initial gross output x_0.

For its turn, the second level decomposition departs from changes of total volume ($\mathbf{x}^{\mathbf{v}}$).

In this second level, we separate volume contribution from the relative prices contribution to $\mathbf{x}^{\mathbf{v}}$ growth. The volume contribution corresponds to the variation of volume variables $\mathbf{D}^{\mathbf{v}}$, $\mathbf{B}_{\mathbf{n}}^{\mathbf{v}}$, and, $\mathbf{d}_{\mathbf{F_n}}^{\mathbf{v}}$. The price contribution corresponds to the changes in $\hat{\mathbf{x}}^{\mathbf{p}}$**,** $\mathbf{B}_{\mathbf{n}}^{\mathbf{p}}$, and $\mathbf{d}_{\mathbf{F_n}}^{\mathbf{p}}$**.**

To this decomposition, we apply the difference between all the variables at the final and at the initial point in (17) to find $\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}}$ and its *volume* and *price effect contribution*. So, we have:

$$\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}} = \boldsymbol{\Delta}\left(\tilde{\mathbf{Z}}\tilde{\mathbf{f}}_{\mathbf{n}}\right) \tag{25}$$

After the methodological procedures, presented in the appendix, the structural decomposition results in the following equation:

$$\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}} = \left[\underbrace{\left(\breve{\mathbf{A}}_{\mathbf{n}}^{\mathbf{v}} + \breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{v}} + \breve{\mathbf{D}}^{\mathbf{v}}\right)}_{\textbf{volume contribution }(\boldsymbol{\upsilon})} + \underbrace{\left(\breve{\mathbf{x}^{\mathbf{p}}} + \breve{\mathbf{A}}_{\mathbf{n}}^{\mathbf{p}} + \breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{p}} + \breve{\mathbf{D}}^{\mathbf{p}}\right)}_{\textbf{relative prices contribution }(\boldsymbol{\rho})} + \breve{\boldsymbol{s}}\right] \tag{26}$$

where $[\breve{...}]$ represents the changes between the final and initial period inside the $\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}}$ for each variable assigned. At this point, we define $\mathbf{f}_{\mathbf{n}}$ as being the final demand excluded inventories ($\boldsymbol{s}$). We do this because inventories do not have economic meaning as it used as a residual account on SNA. To obtain the contribution to gross output, we must divide each variable in (21) concerning initial gross output x_0.

So, the volume contribution is the sum of the volume changes in the national intermediate demand $\breve{\mathbf{A}}_{\mathbf{n}}^{\mathbf{v}}$, the final demand $\breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{v}}$ and the market share contribution $\breve{\mathbf{D}}^{\mathbf{v}}$. The price contribution takes into account the effect of total relative prices, the change in the relative prices inside national intermediate inputs coefficients, final demand and market share matrix.

We must notice that $\breve{\mathbf{A}}_{\mathbf{n}}^{\mathbf{v}}/\breve{\mathbf{A}}_{\mathbf{n}}^{\mathbf{p}}$ and $\breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{v}}/\breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{p}}$ contributions, in fact, represents the change in $\mathbf{B}_{\mathbf{n}}^{\mathbf{v}}/\mathbf{B}_{\mathbf{n}}^{\mathbf{p}}$ and $\mathbf{d}_{\mathbf{Fn}}^{\mathbf{v}}/\mathbf{d}_{\mathbf{Fn}}^{\mathbf{p}}$, but weighted by the market share matrix. Inside $\breve{\mathbf{D}}^{\mathbf{v}}/\breve{\mathbf{D}}^{\mathbf{p}}$ we include the changes of the volume market share matrix, weighted by $\mathbf{A}_{\mathbf{n}}$ and $\mathbf{f}_{\mathbf{n}}$. We present the equations definitions in the Appendix.

- *Volume contribution (υ) and sources of change*

All the previous procedure was done to isolate the changes in the Brazilian gross output related to volume.

In this section, we analyze the volume contribution to gross output in volume, expressed at (26). In other to better identify the factors that contribute to changes in output, we propose the following sources of change: trade pattern, technological change, and final demand. The changes in the trade pattern reflect the effect of penetration/substation of inputs or final goods and services. The technological change's contribution shows the consequence of a change in the \`production recipe´. The last factor is the final demand's contribution that displays the effect of the variations of final demand in the gross output.

To capture all these effects, we express all national variables in total demand and imported demand. The changes in matrix $\mathbf{A}_{\mathbf{n}}$ is due to variations in the technology itself ($\mathbf{A}$) or also on the trade pattern of imported inputs, we calculate national technological coefficients as a difference between total technical coefficients ($\mathbf{A}$) and imported technical coefficients ($\mathbf{A}_{\mathbf{m}}$), as:

$$\mathbf{A_n} = \mathbf{A} - \mathbf{A_m} \qquad (27).$$

As observed in (10) and (11), $\mathbf{A}$ and $\mathbf{A_m}$ are:

$$\mathbf{A} = (\mathbf{D^p} \otimes \mathbf{D^v}).(\mathbf{B^p} \otimes \mathbf{B^v}) \qquad (28)$$

$$\mathbf{A_m} = (\mathbf{D^p} \otimes \mathbf{D^v}).\left(\mathbf{B_m^p} \otimes \mathbf{B_m^v}\right) \qquad (29).$$

In this sense, variations in $\mathbf{A}$ will express the contribution to technological change, and the contribution of $\mathbf{A_m}$ shows the changes in the trade pattern of inputs in the Brazilian economy. Note that as Brazilian SNA express the inputs information in a commodity-by-sector level, we observe these changes in $\mathbf{B}$ and $\mathbf{B_m}$ changes.

However, the change in the technology itself may demand more imported inputs than was previously necessary. An increase/decrease in total imports this way may not be related to a change in trade pattern, such as penetration or substation of imports, but only reflects the technological needs for production. To isolate this effect, as Schuschny (2005) and Kupfer, Freitas, & Young (2003) propose, we estimate an auxiliary matrix of imported technological coefficients.

The basic idea of this hypothesis is disaggregating the changes in $\mathbf{B_m^v}$ that are influenced by the changes in the technology and the one which is due exclusively to the trade pattern. As technological requirements are better analyzed considering only the volume, we calculate this auxiliary matrix of imported technological coefficients ($\breve{\mathbf{B}}_\mathbf{m}^\mathbf{v}$) supposing that it grows proportionally based on the rate of growth of technical coefficients in volume (t_{ij}^v), denoted as

$$t_{\mathrm{ij}}^{\mathrm{v}} = \frac{b_{ij_1}^v}{b_{ij_0}^v} - 1 \qquad (30)$$

where $\mathrm{T}_{\mathrm{ij}}^{\mathrm{v}}$ is the technological growth related to the input produced by product *i* and used by sector *j* between the final and initial period.

We calculate the auxiliary matrix of imported technical coefficients ($\breve{\mathbf{B}}_\mathbf{m0}^\mathbf{v}$) by multiplying each element of the imported technological coefficient at the initial period ($b_{m_{ij_0}}^v$) by $1 + t_{ij}^v$:

$$\breve{b}_{m_{ij_0}}^v = \frac{b_{ij_1}^v}{b_{ij_0}^v} \times b_{m_{ij_0}}^v \qquad (31)$$

where $\breve{\mathbf{B}}_\mathbf{m0}^\mathbf{v} = \left[\breve{b}_{m_{ij_0}}^v\right]$ and $\mathbf{B_{m_0}^v} = \left[b_{m_{ij_0}}^v\right]$.

The difference between $\breve{\mathbf{B}}_\mathbf{m0}^\mathbf{v} - \mathbf{B_{m_0}^v}$ shows only the change on imported inputs that changed only because of the technic of production.

The other part, $\mathbf{B_{m_1}^v} - \breve{\mathbf{B}}_\mathbf{m0}^\mathbf{v}$shows in fact if there was a substitution or penetration of imports, reflecting a change in competitive imports. When we insert this information into the structural decomposition, we express the changes in $\mathbf{B}$ (commodity-by-sector) matrices in the $\mathbf{A}$ matrices (sector-by-sector). In this way, we rearrange the volume contribution of national technical coefficients $\breve{\mathbf{A}}_\mathbf{n}^\mathbf{v}$ as:

$$\breve{\mathbf{A}}_\mathbf{n}^\mathbf{v} = \underbrace{-\left(\breve{\mathbf{A}}_\mathbf{m_1}^\mathbf{v} - \breve{\breve{\mathbf{A}}}_\mathbf{m_0}^\mathbf{v}\right)}_{\substack{\text{Intemediate}\\ \text{trade pattern}}} + \underbrace{\left[\breve{\mathbf{A}} - \left(\breve{\breve{\mathbf{A}}}_\mathbf{m_0}^\mathbf{v} - \breve{\mathbf{A}}_\mathbf{m_1}^\mathbf{v}\right)\right]}_{\substack{\text{National}\\ \text{Technological change}}} \qquad (32)$$

where the first part of the previous equation represents the changes in the intermediate trade pattern and the second one represents the contribution of national technological change.

We do the disaggregation of national final demand in total and imported, excluded inventories, as expressed at:

$$\mathbf{f_{nd}} = \mathbf{f_d} - \mathbf{f_{md}} \qquad (33)$$

where, as observed on (14):

$$\mathbf{f_d} = \mathbf{D}.\left(\mathbf{d_F^p d_F^v}\right) \qquad (34)$$

$$\mathbf{f_{md}} = \mathbf{D}.\left(\mathbf{d_{F_m}^p d_{F_m}^v}\right) \qquad (35).$$

The changes in $\mathbf{f_{md}}$ represent the trade pattern effect on final demand, which means the penetration or substitution of imports associated with final goods and services on the economy.

We disaggregate final demand in consumption (c), which includes private and government consumption, gross fixed capital formation (k), and external demand (e), which represents exports.

Putting together all the previous elements, the *volume contribution* to gross output in volume, when analyzed by the sources of change, is expressed as:

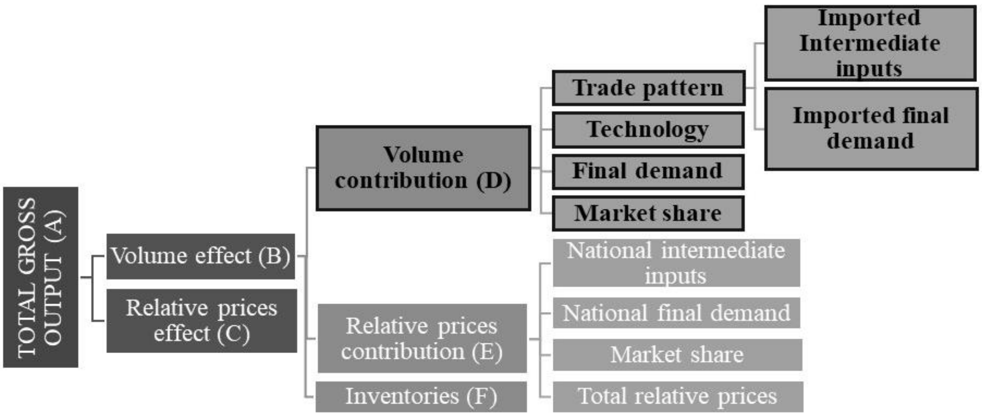
$$\boldsymbol{\upsilon} = \underbrace{\left[-\left(\breve{\mathbf{A}}^{\mathbf{v}}_{\mathbf{m}_1} - \breve{\breve{\boldsymbol{A}}}^{\mathbf{v}}_{\mathbf{m}_0}\right) - \breve{\mathbf{c}}^{\mathbf{v}}_{\mathbf{m}} - \breve{\mathbf{k}}^{\mathbf{v}}_{\mathbf{m}} - \breve{\mathbf{e}}^{\mathbf{v}}_{\mathbf{m}}\right]}_{\textbf{trade pattern}} + \underbrace{\left(\breve{\mathbf{A}} - \left(\breve{\breve{\boldsymbol{A}}}^{\mathbf{v}}_{\mathbf{m}_0} - \breve{\mathbf{A}}^{\mathbf{v}}_{\mathbf{m}_1}\right)\right)}_{\textbf{national technology}} + \underbrace{\breve{\mathbf{c}}^{\mathbf{v}} - \breve{\mathbf{k}}^{\mathbf{v}} - \breve{\mathbf{e}}^{\mathbf{v}}}_{\textbf{final demand}} + \underbrace{\boldsymbol{\Delta}\mathbf{D}^{\mathbf{v}}}_{\textbf{\textit{market share}}} \tag{36}$$

To obtain the contribution to gross output, we must divide each variable in (31) to initial gross output x_0.

The changes in technology are related to column-specific changes, as a simplification (Miller & Blair, 2009). As each column of $\mathbf{A}$ shows the way of production of each sector (the 'sector's production recipe'), the change column by column extracts the effect of input changes in each sector of the economy. So, this changes in technological coefficients will show the changes in input needs for the production in each sector. It is related to the *'fabrication effect,'* and determinate the type of inputs that the production of each sector depends on the most (i.e., if the technology depends more intensive in high-technologic or labor-skilled inputs).

This way of rearranging the information allows characterizing the changes in the Brazilian economy structure. Figure 4 shows an alternative form to visualize the decompositions.

Figure 1 – Structural decomposition diagram



Source: Author's elaboration.

Although the decomposition is done to total gross output ($\boldsymbol{\Delta}\mathbf{x}$) and $\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}}$**,** only the volume contribution to $\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}}$ (highlighted in Figure 4) is going to be analyzed on the following section with the results.

One way to present decomposition is as the rate of growth of gross output, after normalizing (dividing) by the total initial gross output. In this case, we must have to pre-multiply *volume (*υ*)* and *price contribution (ρ)* by sectoral relative prices. This step is necessary for the proper aggregation between sectors. After this, it is possible to normalize to obtain the sectoral growth's contribution. The following section presents results of these decompositions.

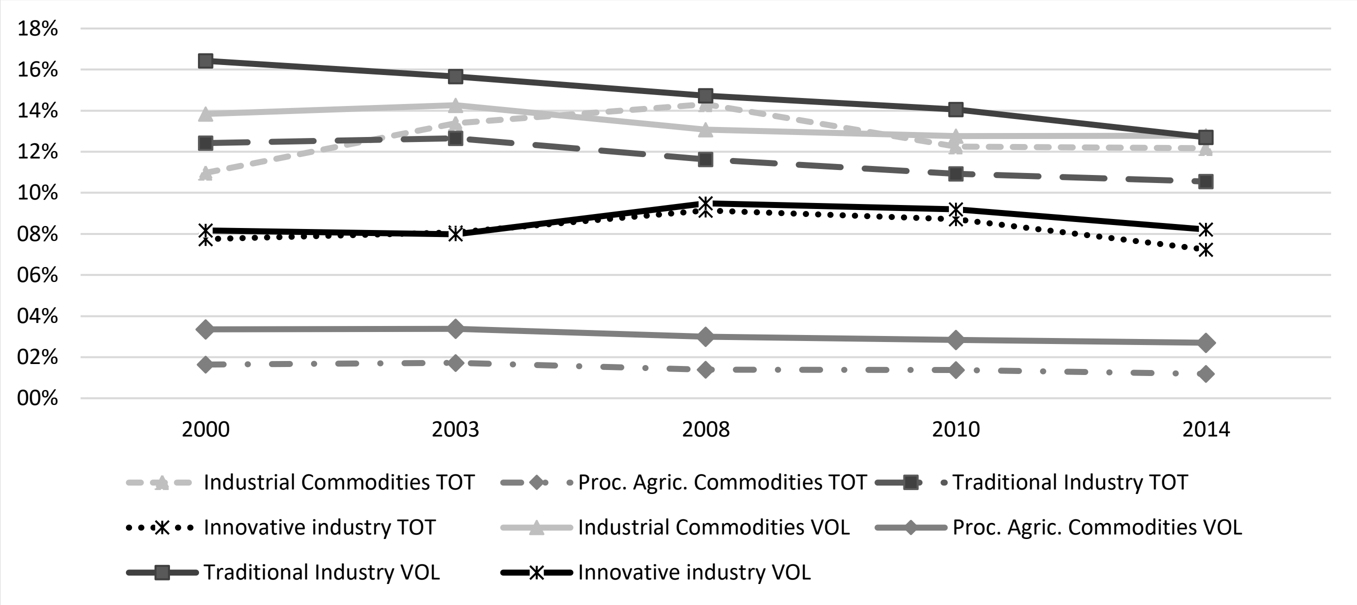
4 RESULTS

Before presenting the decomposition itself, we present the manufacturing and extractive industries share on total gross output in Figure 5. We present two different share series one Total (TOT), related to $\mathbf{x}$, and other in volume (VOL), corresponds to $\mathbf{x}^{\mathbf{v}}$. This figure helps us to visualize the benefits of desegregating volume and relative prices.

As can be seen on the graph, it is possible to observe the relative price effect by the difference between bold (VOL) and dotted (TOT) line.

The industries TI and IC have more changes in their relative prices among the periods. This change usually increases their participation in total gross output. This graph also indicates that the process of deindustrialization in Brazil is less intense and continuous as literature characterize it, due to relative price effects. The reduction of these industries share on gross output may be associated with other questions than deindustrialization itself, i.e., by the economic performance.

Figure 2 – Total and volume extractive and manufacturing industries share on gross output



Source: Author's elaboration based on the SNA/IBGE and I-O Tables/GIC-UFRJ.

Analyzing the growth rate of IN volume's share as presented in Table 1, we see that its participation had positive growth during 2000-2014 and 2003-2008. In both periods, this extractive and manufacturing group was the only one that its growth was higher than the gross output in volume. The weak economic performance in 2000-2003 is maybe the cause of the negative growth of the share of this industry group. These both facts are connected with the relationship between investment-output ratio and its connection with the macroeconomic performance of the economy.

Table 1 –Accumulated growth of industries' share in volume and total gross output for Brazil, 2000-2014 and selected periods (in %)

Industries	Volume participation				Total participation			
	2000-2014	2000-2003	2003-2008	2010-2014	2000-2014	2000-2003	2003-2008	2010-2014
Industrial Commodities	-7.60	2.73	-10.60	-0.81	47.17	22.57	40.16	-0.75
Processed Agricultural Commodities	-19.49	0.27	-13.40	-5.87	53.66	14.01	43.33	-36.81
Traditional Industry	-22.65	-5.01	-8.25	-10.53	12.39	-8.74	11.17	-1.77
Innovative industry	0.69	-2.64	15.95	-11.52	4.44	-2.41	-0.41	10.18

Source: Author's elaboration based on the SNA/IBGE and I-O Tables/GIC-UFRJ and Passoni & Freitas (2018a, 2018b).

The positive growth share of IN in 2003-2008 and 2000-2014 happened because there was an increase in the investment-output ratio in these periods (MEDEIROS, FREITAS, PASSONI, 2018), that lead new productive capacity and new investments. Comparing what happened in 2000-2014 and 2010-2014, with an IN annual volume contribution to total gross output of 2.98pp and 3.06pp (Table 2) and gross output growth of 2.85% and 2.33%, what must justify the growth of all industries groups, but especially the innovative industry is the reduction of its importance in the Brazilian economy. As mentioned by Medeiros, Freitas, and Passoni (2018), there was a declining trend of backward and forward linkages in the Brazilian economy between 2010 and 2014.

Table 1 also helps us to visualize the importance of taking the relative prices apart from the analysis of deindustrialization. Analyzing the same indicator for the total share, we see the share of the industries increasing in the periods. The difference between them shows the effect of the changes in relative prices, that is more pronounced with the IC and PAC, but also by the opposite sign and magnitude in the innovative industry.

Both previous helps to see the importance of relative prices on structural analysis, and its importance in a more explicit way if we see when analyzing the growth. By doing the decomposition analysis, is possible to verify if the changes on gross output are due to reasons that the literature generally associates with deindustrialization, as the loss of competitiveness of the domestic market, seen by trade pattern, or by the economic deceleration.

In Table 2 we see the decomposition analysis for 2000 and 2014 and selected periods, for the whole economy. The first level of the decomposition disaggregates the total gross output change (A) in the volume effect (B) and Relative price effect (C). The relative price effect's contribution is very low for the aggregate, but for a sectoral analysis, its importance is more apparent.

Table 2 – Annual volume contribution to gross output growth for Brazil, 2000-2014 and selected periods (in pp)

Periods	Total Gross output change (A)	Volume effect (B)				Relative prices effect (C)
		Volume contribution (D)	Relative Prices contribution (E)	Inventories (F)	Total (B=D+E+F)	
2000-2014	2.85%	2.98	-0.13	0.01	2.86	-0.01
2000-2003	1.44%	1.07	0.47	-0.12	1.42	0.02
2003-2008	4.57%	4.55	-0.37	0.37	4.54	0.02
2010-2014	2.33%	3.06	-0.58	-0.17	2.31	0.02

Source: Author's elaboration based on the SNA/IBGE and I-O Tables/GIC-UFRJ and Passoni & Freitas (2018a, 2018b).

The second level disaggregation is for the volume effect (B), disaggregated in the volume contribution (D), relative prices contribution (E) and inventories. The relative prices contribution has a substantial effect not only at the disaggregated level but also in the aggregate one. It usually tends to underestimate the volume contribution or the changes due to real factors. As mentioned at the methodology, only the *volume contribution* (D) to gross output in volume is going to be analyzed the results.

Table 3 is presented the volume contribution to gross output in a sectoral perspective, and also for the aggregate. Among all subperiods, 2003-2008 had the highest accumulated volume contribution, due to the intense period's economic activity. We can explain this performance by favorable external conditions and an active internal macroeconomic policy, founded on the growth of public expenditures (consumption and investment) and credit expansion for household's consumption and investment (Serrano & Summa, 2012). Also, there was an improvement in the labor market and gains in real wages, and with inflation was under control, and there was an improvement in income distribution and poverty indicators.

The most important source of change to volume contribution in all subperiods is the final demand. The domestic demand represents the higher participation on final's demand contribution, except for 2000-2003. The external demand was significant in this period because Brazilian economic activity was very week due the high-interest rates adopted after the balance-of-payments crisis and presented a depreciation of exchange rate.

When analyzing the disaggregated data, we see that IC and TI ins the ones that contributed the most to the external demand (0.08pp and 0.06pp). A fact that helps us to understand it is the share of exports of IC increased its share in total Brazilian exports (9%) and also in world's market (40%) at 2000-2003 (MEDEIROS, FREITAS, PASSONI, 2018). In the case of TI, although it has a significant contribution (0.06pp), the share of exports in total national exports (-5%) and the world's exports (-12%) fallen this period. It indicates that besides this decline, this sector for this period is also significant to gross output.

The technological change due to the variation of national technical coefficients had a positive impact in 2000-2014 and 2010-2014. This effect is more marked in the Services, although IC also has significant participation. In 2010-2014 the proportion of this effect (at about 30% of total volume contribution) was the higher among all periods and had the higher annual contribution (0.51pp).

Table 3 – Annual volume contribution to gross output volume change for Brazil, 2000-2015 and selected periods

Sectors	Trade pattern				Technological change			Final demand				Market share	Total
	Inter	Final		Subtotal	Matrix A	Imports	Subtotal						
		Cons	GFCF					Cons	GFCF	Ext	Subtotal		
2000-2014													
Agriculture, fishing and related	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.07	0.01	0.08	0.15	0.00	0.14
Industrial Commodities	-0.10	-0.02	-0.01	-0.14	0.04	-0.01	0.03	0.18	0.09	0.14	0.41	0.01	0.32
Processed Agricultural Commodities	-0.02	-0.01	0.00	-0.03	-0.01	0.00	-0.01	0.02	0.01	0.02	0.05	0.00	0.02
Traditional Industry	-0.05	-0.05	-0.01	-0.11	-0.01	0.00	-0.01	0.18	0.05	0.05	0.28	-0.01	0.15
Innovative industry	-0.05	-0.05	-0.05	-0.15	0.01	-0.01	0.01	0.20	0.15	0.03	0.38	-0.01	0.23
Services	-0.15	-0.08	-0.03	-0.26	0.12	-0.01	0.11	1.61	0.43	0.21	2.24	0.02	2.11
Total	**-0.37**	**-0.22**	**-0.11**	**-0.69**	**0.15**	**-0.03**	**0.13**	**2.25**	**0.74**	**0.52**	**3.51**	**0.02**	**2.96**
2000-2003													
Agriculture, fishing and related	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.06
Industrial Commodities	0.03	0.00	0.00	0.03	0.01	0.00	0.01	-0.01	-0.01	0.08	0.05	0.02	0.11
Processed Agricultural Commodities	-0.04	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	-0.04
Traditional Industry	-0.01	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.04	-0.01	0.06	0.02	0.00	0.00
Innovative industry	-0.01	0.00	0.00	-0.01	-0.01	0.01	0.00	-0.01	-0.01	0.02	0.00	0.00	-0.02
Services	-0.04	0.00	0.00	-0.05	-0.04	0.01	-0.03	0.17	-0.03	0.07	0.20	0.01	0.13
Total	**-0.08**	**0.02**	**0.00**	**-0.06**	**-0.06**	**0.02**	**-0.05**	**0.10**	**-0.06**	**0.28**	**0.33**	**0.03**	**0.25**
2003-2008													
Agriculture, fishing and related	0.00	-0.01	0.00	-0.02	0.01	0.00	0.01	0.14	0.02	0.08	0.24	0.00	0.24
Industrial Commodities	-0.43	-0.04	-0.04	-0.52	-0.05	0.01	-0.04	0.34	0.26	0.34	0.93	-0.02	0.35
Processed Agricultural Commodities	0.02	-0.01	0.00	0.01	-0.01	0.00	-0.01	0.05	0.02	0.02	0.09	0.02	0.10
Traditional Industry	-0.09	-0.07	-0.03	-0.19	-0.04	0.00	-0.04	0.41	0.13	0.14	0.68	0.01	0.45
Innovative industry	-0.08	-0.09	-0.15	-0.32	-0.02	0.00	-0.02	0.42	0.52	0.25	1.19	0.00	0.84
Services	-0.25	-0.10	-0.06	-0.41	0.08	-0.01	0.07	2.54	0.85	0.68	4.07	0.01	3.73
Total	**-0.84**	**-0.32**	**-0.30**	**-1.45**	**-0.03**	**-0.01**	**-0.03**	**3.90**	**1.79**	**1.50**	**7.19**	**0.01**	**5.72**
2010-2014													
Agriculture, fishing and related	0.00	0.00	0.00	-0.01	0.01	0.00	0.01	0.08	0.00	0.06	0.14	0.00	0.14
Industrial Commodities	-0.02	-0.01	0.00	-0.03	0.14	-0.04	0.10	0.28	0.06	0.03	0.36	-0.01	0.42
Processed Agricultural Commodities	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.02	0.01	0.00	0.03	0.00	0.02
Traditional Industry	-0.02	-0.03	0.00	-0.05	0.04	-0.02	0.02	0.19	0.03	-0.01	0.20	-0.04	0.14
Innovative industry	-0.01	-0.01	0.00	-0.02	0.06	-0.03	0.03	0.15	0.04	-0.03	0.17	-0.01	0.17
Services	-0.04	-0.06	0.00	-0.09	0.41	-0.05	0.36	1.46	0.35	0.06	1.87	0.02	2.15
Total	**-0.09**	**-0.11**	**0.00**	**-0.20**	**0.65**	**-0.14**	**0.51**	**2.16**	**0.49**	**0.11**	**2.76**	**-0.05**	**3.03**

Note: In final demand trade pattern we opted to exclude the contributions of exports and government consumption because their final demand import (and its contribution) is not significant. To see their contribution, see Appendix C.
Source: Author's elaboration based in the SNA/IBGE and I-O Tables/GIC-UFRJ and Passoni & Freitas (2018a, 2018b).

The effect of non-competitive imports is minimal in almost all periods, and for 2000-2014 and 2010-2014 they were negative (-0.03pp and -0.14pp).

In 2000-2003, the total technological change had a negative contribution of 0.05pp. This effect is probably related to the effects of trade liberalization that took place in the 1990's and still had an impact on this period. Also, we can see this adverse effect is common in a sectoral perspective. In 2003-2008 we also saw a negative contribution of technological change, but its sectoral composition is different. All extractive and manufacturing sectors had a negative contribution to the total gross output, indicating that the 'recipe of production' contributes in a negative way for the gross output.

There is *penetration of imports* on *intermediate inputs* in total market supply for all subperiods. It represents a loss of competitiveness of national market against the imported suppliers. Also, this effect is more marked in the ones where the economic growth is higher, like 2000-2014 (-0.37pp) and 2003-2008 (-0.84pp). Besides that, is in 2000-2003 that this effect represents the higher proportion among all sources of change, representing almost -30% of 0.24pp. These may be in function of the low economic dynamic in this subperiod.

Also, we see the process of penetration of imports in the final demand. This fact is common among almost all sub-periods, except for 2000-2003 where there is a substitution of imported for national goods supply. We attribute this different pattern to exchange rate depreciation, and also to the weak performance in the economy.

In a sectoral level, there is penetration of imports for intermediate inputs and final demand for most sectors in 2000-2014, 2000-2003 and 2003-2008 for all industries groups. Besides that, some sectors have their penetration of imports higher in intermediate demand than in the final demand. These sectors are IC and Services. The opposite to this happens with TI (more concentrated in consumption) and IN (concentrated in GFCF), where the final demand penetration is higher. In 2000-2014, the IN was the one which had the higher penetration of imports between extractive and manufacturing industries, and in its case, this happened in a more significant proportion because final goods (-0.09pp compared to -0.04pp of intermediate inputs).

In 2003-2008 we can say that there is a substantial effect of penetration of imports in consumption and GFCF, with a negative contribution of -0.40pp and -0.32pp. In 2010-2014 we visualized that the effect of weak economic activity leads to a null contribution of this effect for gross fixed capital formation. This fact is different in general from other sectors, which generally had their penetration of imports of intermediate inputs higher than final demand. It happens because there is a dependency on imported final goods, such as machinery and equipment.

5 FINAL REMARKS

This paper contributes to the debate of deindustrialization because it considers explicitly the role of relative price effects and how it affects this debate. We showed that taking apart relative prices effects guarantee accuracy on results. Also, the proposed I-O structural decomposition analysis is an alternative way to see the changes in the Brazilian productive structure. As well we use a new database that allows us to contribute with more recent information.

The hypothesis of the process of regressive specialization may be affected by relative prices. Relative price effect has an impact on IC, mainly because of the rising tendency of international commodities prices that started in 2003 and intensified in the following year (Lima e Silva, Prado, & Torracca, 2016). Without taking apart the effects of relative prices, it generally influences in a positivity way its contribution to output growth. So, if analyzed the total effect, its participation on gross output is overestimated.

Among all manufacturing industries, when disaggregated the contribution to volume effect is considered, the *Traditional* and *Innovative industry*'s final demand are the industries which had importance on the period of high growth. It happens because there is a positive relationship between the trend rate of GDP growth and the investment-output ratio.

So, when there is economic growth (deceleration) the participation of manufacturing industries may rise (follow) because there is an increase (decrease) demand for manufacturing products (capital goods). In periods of weak growth, the positive disaggregated gross output in volume growth is generally due to services sectors, that contraposes the weak manufacturing and extractive performance.

According to this perspective, such deindustrialization process is less intense and continuous than it is usually characterized in the literature when considering relative prices effect and analyzing the volume change in volume gross contributions in a broader perspective.

Besides that, we see that something happened before 2010, that even with a considerable average of growth, the innovative industry has grown on a low path compared to the total gross output in volume. This is also seen by other authors, like Medeiros, Freitas, and Passoni (2018) and must indicate that there is some evidence that these industry group is losing its capacity to stimulate the economy. Also, another fact that may justify this fact is that is the reasons that explain the economic growth in the period, not marked by the trajectory of GFCF.

Also, the intense process of penetration of imports on market's inputs and final goods demand is not favorable for the Brazilian economy. This seems recurrently by all periods, just changing its intensity because of the economic activity. These are some preliminary results, and a more in-depth analysis considering the sources of capital goods in the GFCF may contribute to understanding the role of investment and the innovative industry for the productive structure.

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APPENDIX A

I-O model on the context of relative prices

To solve the I-O model on the context of relative prices, we substitute we part form the following equation:

$$\mathbf{x} = \mathbf{A_n}\mathbf{x} + \mathbf{f_n}$$

By doing the substitution of $\mathbf{x} = \hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}}$ we have:

$$\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} = \mathbf{A_n}\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} + \mathbf{f_n}$$

Solving for $\mathbf{x}^{\mathbf{v}}$ by premultiplying the previous equation for $\hat{\mathbf{x}}^{\mathbf{p}^{-1}}$

$$\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{A_n}\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{f_n}$$

$$\mathbf{x}^{\mathbf{v}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{A_n}\hat{\mathbf{x}}^{\mathbf{p}}\mathbf{x}^{\mathbf{v}} + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{f_n}$$

To simplify the previous equation, we define $\mathbf{A_n^*} = \mathbf{A_n}\hat{\mathbf{x}}^{\mathbf{p}}$

$$\mathbf{x}^{\mathbf{v}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{A_n^*}\mathbf{x}^{\mathbf{v}} + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{f_n}$$

and also $\widetilde{\mathbf{A_n}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{A_n^*}$ and $\widetilde{\mathbf{f_n}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{f_n}$**.** So, we have:

$$\mathbf{x}^{\mathbf{v}} = \widetilde{\mathbf{A_n}}\mathbf{x}^{\mathbf{v}} + \widetilde{\mathbf{f_n}}$$

Solving for x^v, we have: $\mathbf{x}^{\mathbf{v}} = \left(\mathbf{I} - \widetilde{\mathbf{A_n}}\right)^{-1}\widetilde{\mathbf{f_n}}$, where $\tilde{\mathbf{Z}} = \left(\mathbf{I} - \widetilde{\mathbf{A_n}}\right)^{-1}$ is the Leontief matrix taking account relative prices effect In this way we can express the gross output in volume as: $\mathbf{x}^{\mathbf{v}} = \tilde{\mathbf{Z}}\widetilde{\mathbf{f_n}}$

Structural decomposition

We find the changes in the gross output in volume between the final and initial period in the following way:

$$\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}} = \mathbf{x}_1^{\mathbf{v}} - \mathbf{x}_0^{\mathbf{v}}$$

$$\boldsymbol{\Delta}\mathbf{x}^{\mathbf{v}} = \boldsymbol{\Delta}\left(\tilde{\mathbf{Z}}\widetilde{\mathbf{f_n}}\right)$$

As suggested by Dietzenbacher & Los (1998) and Miller & Blair (2009), we calculate the decomposition of the previous equation by the mean of the two extreme cases:

$$\Delta\mathbf{x^v} = \frac{1}{2}\Delta\tilde{\mathbf{Z}}\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\Delta\tilde{\mathbf{f}}_{\mathbf{n}}$$

As we want to desegregate the variations of the Leontief matrix, we also have to the decomposition for $\Delta\tilde{\mathbf{Z}}$. As suggested by Miller & Blair (2009), it becomes:

$$\Delta\tilde{\mathbf{Z}} = \tilde{\mathbf{Z}}_1\Delta\widetilde{\mathbf{A}_{\mathbf{n}}}\tilde{\mathbf{Z}}_0$$

Also, we want to take a deep look at the determinants of $\Delta\widetilde{\mathbf{A}_{\mathbf{n}}}$, so we also do the decomposition for it. Remembering that $\widetilde{\mathbf{A}_{\mathbf{n}}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{A}^*_{\mathbf{n}}$, so we have

$$\Delta\widetilde{\mathbf{A}_{\mathbf{n}}} = \frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{A}^*_{\mathbf{n}_1} + \mathbf{A}^*_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\Delta\mathbf{A}^*_{\mathbf{n}}$$

As we defined $\mathbf{A}^*_{\mathbf{n}} = \mathbf{A}_{\mathbf{n}}\hat{\mathbf{x}}^{\mathbf{p}}$, its variation $\Delta\mathbf{A}^*_{\mathbf{n}}$ is calculated as:

$$\Delta\mathbf{A}^*_{\mathbf{n}} = \frac{1}{2}\Delta\mathbf{A}_{\mathbf{n}}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0\right) + \frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}$$

If we substitute $\Delta\mathbf{A}^*_{\mathbf{n}}$ and $\Delta\widetilde{\mathbf{A}_{\mathbf{n}}}$ inside $\Delta\tilde{\mathbf{Z}}$, we will have

$$\Delta\tilde{\mathbf{Z}} = \tilde{\mathbf{Z}}_1\left(\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{A}^*_{\mathbf{n}_1} + \mathbf{A}^*_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\left[\frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}\right] + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\left[\frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}\right]\right)\tilde{\mathbf{Z}}_0$$

For the modified final demand, defined as $\tilde{\mathbf{f}}_{\mathbf{n}} = \hat{\mathbf{x}}^{\mathbf{p}^{-1}}\mathbf{f}_{\mathbf{n}}$, its variation is found by:

$$\Delta\tilde{\mathbf{f}}_{\mathbf{n}} = \frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{f}_{\mathbf{n}_1} + \mathbf{f}_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\Delta\mathbf{f}_{\mathbf{n}}$$

Replacing $\Delta\tilde{\mathbf{Z}}$ and $\Delta\tilde{\mathbf{f}}_{\mathbf{n}}$ inside $\Delta\mathbf{x^v}$, we find:

$$\begin{aligned}\Delta\mathbf{x^v} = \frac{1}{2}\Bigg[\tilde{\mathbf{Z}}_1\left(\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{A}^*_{\mathbf{n}_1} + \mathbf{A}^*_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\left[\frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}\right]\right.\\ \left. + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\left[\frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}\right]\right)\tilde{\mathbf{Z}}_0\Bigg]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right)\\ + \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{f}_{\mathbf{n}_1} + \mathbf{f}_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\Delta\mathbf{f}_{\mathbf{n}}\right]\end{aligned}$$

Reorganizing the previous equation to capture the contribution of national technical coefficients $\breve{\mathbf{A}}_{\mathbf{n}}$, the contribution of national final demand $\breve{\mathbf{f}}_{\mathbf{n}}$ and the total relative prices $\breve{\hat{\mathbf{x}}}^{\mathbf{p}}$ and the contribution from inventories, we have:

$$\Delta\mathbf{x^v} = \breve{\mathbf{A}}_{\mathbf{n}} + \breve{\mathbf{f}}_{\mathbf{n}} + \breve{\hat{\mathbf{x}}}^{\mathbf{p}} + \breve{\mathbf{s}}$$

with:

$$\breve{\mathbf{A}}_{\mathbf{n}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\left[\frac{1}{2}\Delta\mathbf{A}_{\mathbf{n}}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0\right)\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right)$$

$$\breve{\mathbf{f}}_{\mathbf{n}} = \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\Delta\mathbf{f}_{\mathbf{n}}\right]$$

$$\begin{aligned}\breve{\hat{\mathbf{x}}}^{\mathbf{p}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}_1 + \hat{\mathbf{x}}^{\mathbf{p}^{-1}}_0\right)\left[\frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right) + \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{A}^*_{\mathbf{n}_1} + \mathbf{A}^*_{\mathbf{n}_0}\right)\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right)\\ + \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}^{-1}}\right)\left(\mathbf{f}_{\mathbf{n}_1} + \mathbf{f}_{\mathbf{n}_0}\right)\right]\end{aligned}$$

Each variable from the above equation has the contributions of volume and relative prices. The properly disaggregation is done to isolate the volume effect, and the relative prices effect.

Remembering from sections 3.2 and 3.3,

$$\mathbf{A}_{\mathbf{n}} = \left(\mathbf{D^p} \otimes \mathbf{D^v}\right)\left(\mathbf{B^p_n} \otimes \mathbf{B^v_n}\right)$$

$$\mathbf{f}_{\mathbf{n}} = \left(\mathbf{D^p} \otimes \mathbf{D^v}\right).\left(\mathbf{d^p_{F_n}}\mathbf{d^v_{F_n}}\right)$$

So, we disaggregate the changes in $\breve{\boldsymbol{A}}_{\mathbf{n}}$ in the contributions of four components: $\mathbf{D^p}$, $\mathbf{D^v}$, $\mathbf{B^p_n}$, $\mathbf{B^v_n}$. Also, the contribution of $\breve{\boldsymbol{f}}_{\mathbf{n}}$ is disaggregated in the contribution of $\mathbf{D^p}, \mathbf{D^v}, \mathbf{d^p_{F_n}}, \mathbf{d^v_{F_n}}$. As we want to observe the trade pattern of national demand, we disaggregate that national demand in total and imported final demand, specific for variables expressed in volume.

Gross output's volume change is rearranged to capture the *volume ($\boldsymbol{\upsilon}$)* and *relative price contribution ($\boldsymbol{\rho}$)*. If we divide each change by total gross output in the initial period (x_0), we have the contribution of each factor to total gross output

$$\frac{\Delta\mathbf{x^v}}{x_0} = \frac{\boldsymbol{\upsilon}}{x_0} + \frac{\boldsymbol{\rho}}{x_0} + \frac{\breve{\mathbf{s}}}{x_0}$$

In the following sections, we present the elements that form each variable presented in Figure 4 in the text.

VOLUME EFFECT

- **National input coefficients**

  We express the changes in the matrix of national coefficients ($\breve{\mathbf{A}}_{\mathbf{n}}{}^{\mathbf{v}}$) by the difference of total ($\breve{\mathbf{A}}^{\mathbf{v}}$) and imported coefficients ($\breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{v}}$).

$$\breve{\mathbf{A}}_{\mathbf{n}}{}^{\mathbf{v}} = \breve{\mathbf{A}}^{\mathbf{v}} - \breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{v}}$$

Notice that we denote $\mathbf{A}_{\mathbf{n}}^{\mathbf{v}}$, $\mathbf{A}^{\mathbf{v}}$, $\mathbf{A}_{\mathbf{m}}^{\mathbf{v}}$, but as IBGE express the transitional matrix in the dimension commodity-by-sector, it, in fact, represents the chance in $\mathbf{B}_{\mathbf{n}}^{\mathbf{v}}$, $\mathbf{B}^{\mathbf{v}}$, $\mathbf{B}_{\mathbf{m}}^{\mathbf{v}}$.

$$\breve{\mathbf{A}}^{\mathbf{v}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[(\mathbf{D}_1 + \mathbf{D}_0)\left(\frac{1}{2}\left((\mathbf{B}^{\mathbf{p}}{}_1 + \mathbf{B}^{\mathbf{p}}{}_0) \otimes \Delta\mathbf{B}^{\mathbf{v}}\right)\right)\right]\right](\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0)\right]\right]\tilde{\mathbf{Z}}_0\right](\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0})$$

$$\breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{v}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[(\mathbf{D}_1 + \mathbf{D}_0)\left(\frac{1}{2}\left((\mathbf{B}_{\mathbf{m}_1}^{\mathbf{p}} + \mathbf{B}_{\mathbf{m}_0}^{\mathbf{p}}) \otimes \Delta\mathbf{B}_{\mathbf{m}}^{\mathbf{v}}\right)\right)\right]\right](\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0)\right]\right]\tilde{\mathbf{Z}}_0\right](\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0})$$

Disaggregating $\breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{v}}$ to capture disaggregate the contribution of competitive imports (trade pattern) and the imports that are induced by technological change, we have:

$$\breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{v}} = \underbrace{\breve{\mathbf{A}}_{\mathbf{m}_1}{}^{\mathbf{v}} - \breve{\breve{\mathbf{A}}}_{\mathbf{m}_0}{}^{\mathbf{v}}}_{\textit{trade pattern}} - \underbrace{\left(\breve{\mathbf{A}}_{\mathbf{m}_0}{}^{\mathbf{v}} - \breve{\breve{\mathbf{A}}}_{\mathbf{m}_0}{}^{\mathbf{v}}\right)}_{\textit{technogical change}}$$

$$\breve{\mathbf{A}}_{\mathbf{m}_t}{}^{\mathbf{v}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[(\mathbf{D}_1 + \mathbf{D}_0)\left(\frac{1}{2}\left((\mathbf{B}_{\mathbf{m}_1}^{\mathbf{p}} + \mathbf{B}_{\mathbf{m}_0}^{\mathbf{p}}) \otimes \mathbf{B}_{\mathbf{m}_t}^{\mathbf{v}}\right)\right)\right]\right](\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0)\right]\right]\tilde{\mathbf{Z}}_0\right](\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0})$$

$$\breve{\breve{\mathbf{A}}}_{\mathbf{m}_0}{}^{\mathbf{v}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[(\mathbf{D}_1 + \mathbf{D}_0)\left(\frac{1}{2}\left((\mathbf{B}_{\mathbf{m}_1}^{\mathbf{p}} + \mathbf{B}_{\mathbf{m}_0}^{\mathbf{p}}) \otimes \breve{\mathbf{B}}_{\mathbf{m}_0}^{\mathbf{v}}\right)\right)\right]\right](\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0)\right]\right]\tilde{\mathbf{Z}}_0\right](\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0})$$

- **Final demand**

National final demand is formed by the sum of the contributions of each demand component, disaggregated in consumption (*c*), which includes private and government consumption, gross fixed capital formation (*k*), and external demand (*e*).

$$\breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{v}} = \breve{\mathbf{f}}_{\mathbf{c}_{\mathbf{n}}}^{\mathbf{v}} + \breve{\mathbf{f}}_{\mathbf{k}_{\mathbf{n}}}^{\mathbf{v}} + \breve{\mathbf{f}}_{\mathbf{e}_{\mathbf{n}}}^{\mathbf{v}}$$

The above relations are calculated by the difference of total final demand and imported final demand, for each h final demand component.

$$\breve{\mathbf{f}}_{\mathbf{h}_{\mathbf{n}}}^{\mathbf{v}} = \breve{\mathbf{f}}_{\mathbf{h}}^{\mathbf{v}} - \breve{\mathbf{f}}_{\mathbf{h}_{\mathbf{m}}}^{\mathbf{v}}$$

Notice that we denote $\breve{\mathbf{f}}_{\mathbf{h}_{\mathbf{n}}}^{\mathbf{v}}$,$\breve{\mathbf{f}}_{\mathbf{h}}^{\mathbf{v}}$, $\breve{\mathbf{f}}_{\mathbf{h}_{\mathbf{m}}}^{\mathbf{v}}$, but as the transitional matrix are expressed in the dimension commodity-by-sector, it, in fact, represents the chance in $\mathbf{d}_{\mathbf{h}_{\mathbf{n}}}^{\mathbf{v}}$, $\mathbf{d}_{\mathbf{h}}^{\mathbf{v}}$, $\mathbf{d}_{\mathbf{f}_{\mathbf{m}}}{}^{\mathbf{v}}$. The decompositions for these variables are:

$$\breve{\mathbf{f}}_{\mathbf{h}}^{\mathbf{v}} = \frac{1}{2}(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0)\left[\frac{1}{2}(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1})\left[\frac{1}{2}\left[(\mathbf{D}_1 + \mathbf{D}_0)\left(\frac{1}{2}\left((\hat{\mathbf{d}}_{\mathbf{h}_1}^{\mathbf{p}} + \hat{\mathbf{d}}_{\mathbf{h}_0}^{\mathbf{p}})\Delta\mathbf{d}_{\mathbf{h}}^{\mathbf{v}}\right)\right)\right]\right]\right]$$

$$\breve{\mathbf{f}}_{\mathbf{h}_{\mathbf{m}}}^{\mathbf{v}} = \frac{1}{2}(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0)\left[\frac{1}{2}(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1})\left[\frac{1}{2}\left[(\mathbf{D}_1 + \mathbf{D}_0)\left(\frac{1}{2}\left((\hat{\mathbf{d}}_{\mathbf{h}_{\mathbf{m}_1}}^{\mathbf{p}} + \hat{\mathbf{d}}_{\mathbf{h}_{\mathbf{m}_0}}^{\mathbf{p}})\Delta\mathbf{d}_{\mathbf{h}_{\mathbf{m}}}^{\mathbf{v}}\right)\right)\right]\right]\right]$$

- **Market share matrix**

As all the transitional matrix are expressed at commodity-by-sector dimension, the variation of the Market share matrix includes its variation sized by all the variables on the model (change on intermediate and final demand, excluded inventories). As this matrix does not have an essential economic meaning, its change is not open by national and imported.

$$\breve{\mathbf{D}}^{\mathbf{v}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[\frac{1}{2}\left((\mathbf{D}_1^{\mathbf{p}} + \mathbf{D}_0^{\mathbf{p}}) \otimes \Delta\mathbf{D}^{\mathbf{v}}\right)(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0})\right]\right](\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0)\right]\right]\tilde{\mathbf{Z}}_0\right](\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0})$$
$$+ \frac{1}{2}(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0)\left[\frac{1}{2}(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1})\left[\frac{1}{2}\left[\left(\frac{1}{2}\left((\mathbf{D}_1^{\mathbf{p}} + \mathbf{D}_0^{\mathbf{p}}) \otimes \Delta\mathbf{D}^{\mathbf{v}}\right)\right)(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0})\right]\right]\right]$$

Putting together all the previous elements, the *volume contribution* to gross output in volume, when analyzed by the sources of change, is expressed as

$$\boldsymbol{\upsilon} = \underbrace{\left[-\left(\breve{\mathbf{A}}_{\mathbf{m}_1}^{\mathbf{v}} - \breve{\breve{A}}_{\mathbf{m}_0}^{\mathbf{v}}\right) - \breve{\mathbf{c}}_{\mathbf{m}}^{\mathbf{v}} - \breve{\mathbf{k}}_{\mathbf{m}}^{\mathbf{v}} - \breve{\mathbf{e}}_{\mathbf{m}}^{\mathbf{v}}\right]}_{\text{trade pattern}} + \underbrace{\left(\breve{\mathbf{A}} - \left(\breve{\breve{A}}_{\mathbf{m}_0}^{\mathbf{v}} - \breve{\mathbf{A}}_{\mathbf{m}_1}^{\mathbf{v}}\right)\right)}_{\text{national technology}} + \underbrace{\breve{\mathbf{c}}^{\mathbf{v}} - \breve{\mathbf{k}}^{\mathbf{v}} - \breve{\mathbf{e}}^{\mathbf{v}}}_{\substack{\text{final}\\ \text{demand}}} + \underbrace{\breve{\mathbf{D}}^{\mathbf{v}}}_{\substack{\text{market}\\ \text{share}}}$$

PRICE EFFECT (ρ)

- **Total prices**

  Represents the effect of total relative prices ($\hat{\mathbf{x}}^{\mathbf{p}}$) in volume contribution to gross output in volume.

$$\breve{\widetilde{\mathbf{x}}}^{\mathbf{p}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\Delta\hat{\mathbf{x}}^{\mathbf{p}}\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right) + \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}-1}\right)\left(\mathbf{A}^*_{\mathbf{n}_1} + \mathbf{A}^*_{\mathbf{n}_0}\right)\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\Delta\left(\hat{\mathbf{x}}^{\mathbf{p}-1}\right)\left(\mathbf{f}_{\mathbf{n}_1} + \mathbf{f}_{\mathbf{n}_0}\right)\right]$$

- **National input coefficients prices ($\breve{A}_n{}^p$)**

It corresponds to the contribution of relative price changes in $\mathbf{A_n}$ relative to changes in $\mathbf{B_n^p}$**,** weighted by the market share matrix. It is obtained by difference from the changes in relative prices in total and imported technical coefficients:

$$\breve{\mathbf{A}}_{\mathbf{n}}{}^{\mathbf{p}} = \breve{\mathbf{A}}^{\mathbf{p}} - \breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{p}}$$

$$\breve{\mathbf{A}}^{\mathbf{p}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[\left(\mathbf{D}_1 + \mathbf{D}_0\right)\left(\frac{1}{2}\left(\Delta\mathbf{B}^{\mathbf{p}} \otimes \left(\mathbf{B^v}_1 + \mathbf{B^v}_0\right)\right)\right)\right]\right]\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0\right)\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right)$$

$$\breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{p}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[\left(\mathbf{D}_1 + \mathbf{D}_0\right)\left(\frac{1}{2}\left(\Delta\mathbf{B}_{\mathbf{m}}^{\mathbf{p}} \otimes \left(\mathbf{B}_{\mathbf{m}_1}^{\mathbf{v}} + \mathbf{B}_{\mathbf{m}_0}^{\mathbf{v}}\right)\right)\right)\right]\right]\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0\right)\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right)$$

- **Final demand prices**

National final demand relative price effect is formed by the sum of the contributions of each demand component, disaggregated in consumption (*c*), which includes private and government consumption, gross fixed capital formation (*k*), and external demand (*e*).

$$\breve{\mathbf{f}}_{\mathbf{n}}^{\mathbf{p}} = \breve{\mathbf{f}}_{\mathbf{c_n}}^{\mathbf{p}} + \breve{\mathbf{f}}_{\mathbf{k_n}}^{\mathbf{p}} + \breve{\mathbf{f}}_{\mathbf{e_n}}^{\mathbf{p}}$$

The above relations are calculated by the difference of total final demand and imported final demand, for each h final demand component.

$$\breve{\mathbf{f}}_{\mathbf{h_n}}^{\mathbf{p}} = \breve{\mathbf{f}}_{\mathbf{h}}^{\mathbf{p}} - \breve{\mathbf{f}}_{\mathbf{h_m}}^{\mathbf{p}}$$

Notice that we denote $\breve{\mathbf{f}}_{\mathbf{h_n}}^{\mathbf{p}}, \breve{\mathbf{f}}_{\mathbf{h}}^{\mathbf{p}}, \breve{\mathbf{f}}_{\mathbf{h_m}}^{\mathbf{p}}$**,** but as the transitional matrix are expressed in the dimension commodity-by-sector, it, in fact, represents the chance in $\mathbf{d}_{\mathbf{h_n}}^{\mathbf{p}}$, $\mathbf{d}_{\mathbf{h}}^{\mathbf{p}}$, $\mathbf{d}_{\mathbf{f_m}}{}^{\mathbf{p}}$**.** The decompositions for these variables are:

$$\breve{\mathbf{f}}_{\mathbf{h}}^{\mathbf{p}} = \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\left[\frac{1}{2}\left[\left(\mathbf{D}_1 + \mathbf{D}_0\right)\left(\frac{1}{2}\left(\Delta\hat{\mathbf{d}}_{\mathbf{h}}^{\mathbf{p}}\left(\mathbf{d}_{\mathbf{h}_1}^{\mathbf{v}} + \mathbf{d}_{\mathbf{h}_0}^{\mathbf{v}}\right)\right)\right)\right]\right]\right]$$

$$\breve{\mathbf{f}}_{\mathbf{h_m}}^{\mathbf{p}} = \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\left[\frac{1}{2}\left[\left(\mathbf{D}_1 + \mathbf{D}_0\right)\left(\frac{1}{2}\left(\Delta\hat{\mathbf{d}}_{\mathbf{h_m}}^{\mathbf{p}}\left(\mathbf{d}_{\mathbf{h_m}_1}^{\mathbf{v}} + \mathbf{d}_{\mathbf{h_m}_0}^{\mathbf{v}}\right)\right)\right)\right]\right]\right]$$

- **Market share matrix prices**

Corresponds the changes in the market share matrix related to prices, weighted by intermediate and final demand

$$\breve{\mathbf{D}}^{\mathbf{p}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\left[\frac{1}{2}\left[\frac{1}{2}\left(\left(\Delta\mathbf{D}^{\mathbf{p}} \otimes \left(\mathbf{D}_1^{\mathbf{v}} + \mathbf{D}_0^{\mathbf{v}}\right)\right)\right)\left(\mathbf{A}_{\mathbf{n}_1} + \mathbf{A}_{\mathbf{n}_0}\right)\right]\right]\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0\right)\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right) + \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\left[\frac{1}{2}\left[\left(\frac{1}{2}\left(\Delta\mathbf{D}^{\mathbf{p}} \otimes \left(\mathbf{D}_1^{\mathbf{v}} + \mathbf{D}_0^{\mathbf{v}}\right)\right)\right)\left(\tilde{\mathbf{f}}_{\mathbf{n}_1} + \tilde{\mathbf{f}}_{\mathbf{n}_0}\right)\right]\right]\right]$$

Putting together all the previous elements we express the *relative prices contribution* to gross output in volume as:

$$\boldsymbol{\rho} = \breve{\widetilde{\mathbf{x}}}^{\mathbf{p}} + \breve{\mathbf{f}}_{\mathbf{c_n}}^{\mathbf{p}} + \breve{\mathbf{f}}_{\mathbf{k_n}}^{\mathbf{p}} + \breve{\mathbf{f}}_{\mathbf{e_n}}^{\mathbf{p}} + \left(\breve{\mathbf{A}}^{\mathbf{p}} - \breve{\mathbf{A}}_{\mathbf{m}}{}^{\mathbf{p}}\right) + \breve{\mathbf{D}}^{\mathbf{p}}$$

***INVENTORIES* ($\Delta\mathbf{s}$)**

To make an empirical adjustment, we calculate inventories' contribution separately. The first element is from the induced part from intermediate demand and the other from the direct final demand.

$$\breve{\mathbf{s}} = \frac{1}{2}\left[\tilde{\mathbf{Z}}_1\left[\frac{1}{2}\left(\hat{\mathbf{x}}_1^{\mathbf{p}-1} + \hat{\mathbf{x}}_0^{\mathbf{p}-1}\right)\left[\frac{1}{2}\Delta\mathbf{A}_{\mathbf{n}}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1 + \hat{\mathbf{x}}^{\mathbf{p}}{}_0\right)\right]\right]\tilde{\mathbf{Z}}_0\right]\left(\tilde{\mathbf{s}}_1 + \tilde{\mathbf{s}}_0\right) + \frac{1}{2}\left(\tilde{\mathbf{Z}}_1 + \tilde{\mathbf{Z}}_0\right)\left[\frac{1}{2}\left(\hat{\mathbf{x}}^{\mathbf{p}}{}_1^{-1} + \hat{\mathbf{x}}^{\mathbf{p}}{}_0^{-1}\right)\Delta\mathbf{s}\right]$$

Appendix B

Table 1— Sector correspondence aggregation[1]

6 Sectors	42 Sectors
Agriculture, fishing and related	Agriculture, forestry, livestock and fisheries
Industrial Commodities	Extraction of oil and gas, including support activities Extraction of iron ore, including processing and agglomeration Other mining and quarrying Oil refining and coking plants Manufacture of biofuels Manufacture of other organic and inorganic chemicals, resins and elastomers Cement and other non-metallic mineral products Manufacture of steel and its derivatives Metallurgy of nonferrous metals Metal products - exclusive machinery and equipment
Processed Agricultural Commodities	Manufacture of tobacco products Manufacture of wood products Manufacture of pulp, paper and paper products
Traditional Industry	Food and drinks Manufacture of textiles Manufacture of wearing apparel and accessories Manufacture of footwear and leather goods Printing and reproduction of recordings Perfumery hygiene and cleaning Manufacture of pesticides, disinfectants, paints and various chemicals Rubber & Plastics Furniture and products of various industries & Machinery and equipment[2]
Innovative industry	Pharmaceutical products Furniture and products of various industries & Machinery and equipment[2] Household appliances and electronic material Automobiles trucks and buses Parts and accessories for motor vehicles Other transportation equipment
Services	Electricity generation and distribution gas water sewage and urban cleaning Construction Trade Accommodation and food services Transporting warehousing and mail Information services Financial intermediation insurance and supplementary pension and related services Real estate activities and rentals Business and family services and maintenance services Public administration, defense and social security Public education Private education Public health Private health

Notes:

[1] A modified version of the translator presented by Passoni and Freitas (2018a)

[2] As is not possible to desegregate the aggregated Sector "Furniture and products of various industries & Machinery and equipment," it was applied a proportion of 19.82% for the ***Traditional industry***. It represents the *Furniture and products of various industries*' production proportion in the aggregated sector when the disagreed information is provided, for the year 2010. The proportion applied for ***Innovative Industry*** is 80.18%.