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ARTICLE

Sector dynamics and productive specialization in the Brazilian manufacturing industry between 1998 and 2014

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ABSTRACT

The deindustrialization process in Brazil has been widely discussed in the economic literature. However, should the entire manufacturing industry be seen as a loser in this development process? And what would be the factors associated with the structural transformations of the Brazilian industry? This article analyzes the losers and winners of the Brazilian development process between 1998 and 2014, a period marked by profound economic transformations. The work uses an innovative approach, considering data from 200 classes of the manufacturing industry and a new strategy of grouping the more and less dynamic sectors. The results highlight: i) particularly favored sectors, such as the processing of agricultural commodities and the consumer goods sectors (such as the manufacture of computers, telephone sets, air conditioners, automobiles, television sets, among others); (ii) particularly fragile sectors, such as the textile and chemical industry segments.

KEYWORDS | Structural Transformation; Factor Analysis; Cluster Analysis; Manufacture

JEL-CODES | O14; O33; O10.

Dinâmica setorial e especialização produtiva da indústria de transformação brasileira entre 1998 e 2014

Resumo

O processo de desindustrialização no Brasil tem sido amplamente discutido na literatura econômica. Contudo, seria o caso de considerarmos toda a indústria como perdedora desse processo de desenvolvimento? E quais seriam os fatores associados às transformações estruturais da indústria brasileira? Este artigo analisa os setores perdedores e ganhadores do processo de desenvolvimento brasileiro entre 1998 e 2014, período marcado por profundas transformações econômicas. O trabalho utiliza uma abordagem bastante desagregada, incluindo dados de 200 classes da indústria de transformação e uma nova estratégia de agrupamento dos setores mais e menos dinâmicos. Os resultados destacam: setores especialmente favorecidos, como o processamento de *commodities* agrícolas e os setores de bens de consumo (como a fabricação de computadores, aparelhos telefônicos, aparelhos de ar-condicionado, automóveis, aparelhos de televisão, entre outros); e setores especialmente fragilizados, como os segmentos têxteis e da indústria química.

Palavras-chave | Especialização Produtiva; Manufatura; Análise Fatorial; Análise de *Cluster*; Mudança Estrutural

Códigos-JEL | O14; O33; O10

1. Introduction

The increase in commodity prices during the 2000s stimulated the debate on economic development and the strategy of productive specialization in primary goods (PEREZ, 2013; ROCHA, 2015; FISHLOW, 2013). According to Lazzarini *et al.* (2013), the Brazilian production and exportation of commodities did not represent a loss – some sort of natural-resources curse – to Brazil, but the opposite: an important strategic differential for the Brazilian economy. Such argument was corroborated by Rocha (2015) and Fishlow (2013), who argue that the production and exploitation of commodities have been increasingly R&D-intensive, which differs from the former specialization in primary products based solely on comparative advantages.

However, although the production and exportation of commodities is a competitive advantage, other studies argue that this sector has a reduced ability to directly streamline all economic activities and generate long-term economic development (UNCTAD, 2016). The reason for it being the fact that the sector has more isolated chains, with fewer connections with other sectors, alongside the fact that it has fewer technological externalities compared to highly technology-intensive sectors.[1] In addition, commodity production and exportation would stimulate volatile growth cycles due to frequent oscillations in commodity prices. Given these points, some authors show concerns about the fact that Brazilian growth is specialized in industries with low technological content (ROCHA, 2007).

In view of the divergences in the debate on economic growth, the discussion around productive specialization is essential for the structuralist theory of development and technological innovation (CARVALHO; KUPFER, 2011). Lewis' groundbreaking work (1954) states that the classical approach is inadequate for development theory, because in underdeveloped countries there is a duality that can be represented by a two-sector model, with a dynamic exporting segment and a traditional subsistence and low-productivity sector. Economic development would be the process of expansion of the modern sector and contraction of the traditional sector until the economy ceased to be dualistic (heterogeneous).

In recent literature, several studies, such as Diao *et al.* (2017) and Hausmann *et al.* (2014),[2] have shown that productive specialization in some sectors would determine higher growth rates than specialization in others, as it had been stated

1 See OECD (2011), Haussmann et al. (2014), Diao et al. (2017) and Hirschman (1958).

2 The focus of these authors is the productive specialization of the export agenda.

by Prebish (1949), Chenery (1979) and Lewis (1954). Nevertheless, existing divergences in the debate about the importance of the productive structure for the economic development process call for more empirical studies on the dynamics and impact of changes in the composition of the productive sectors (UNCTAD, 2016). The first step would be to identify the most relevant changes in the productive structure.

As highlighted by Tregenna (2016), it is necessary to diagnose structural changes not only intersectorally (which will not be done in this study[3]), but also to go further and point out which sectors have been shrinking (the subject of this paper). This, because the industrial sector is not homogeneous; high-technology and high-productivity manufacturing sectors, productive links, high wages and high level of education of workers coexist with low-productivity industrial activities, low wages and low technological levels.

A major limitation of previous studies, however, is the fact that most of them concentrate on aggregate production functions, which exclude production heterogeneity, i.e., the productive structure disaggregated in many sectors, from their analysis. This study analyzes the process of structural change and productive specialization in the Brazilian manufacturing industry, relating it to the Brazilian context of the reference period – 1998-2014. The research is based on the dynamics of 200 classes of the manufacturing industry, enabling a more accurate identification of the losing and winning sectors of the Brazilian development process in the period. The key objective is to identify patterns of structural change in the Brazilian manufacturing and to answer the following questions: which sectors have been most impacted by the process of deindustrialization? Which sectors show high dynamism? What are the reasons for productive specialization?

To achieve the proposed objectives, the following structure of analysis is presented: review of the literature that discusses aspects of structural change and highlights sectoral alterations of manufacturing; research material and methods, underlining the data sources used and the methods of factor and cluster analysis; research results, highlighting the creation of a sector dynamics ranking, which lists the 200 sectors surveyed according to their economic dynamics in the period, and the segmentation of the sectors that presented a similar profile of dynamism; and research conclusions.

3 See Maia (2018) for a deep understanding of this topic.

2. Structural change and economic development

In its classical format, structural change is analyzed from the changes in labor and the value added by the decomposition of the economy between its three macro-sectors – agriculture, industry and services (CLARK, 1957; KUZNETS, 1966, 1973; BAUMOL, 1967).[4] Agriculture, the dominant sector in the early stage of development, rapidly lost share to the secondary sector in developed countries due to the industrialization process that followed the Industrial Revolution (1820-1870). For Madisson (1987), mankind lived in a "Malthusian trap" up to the eighteenth century, in which production grew at the same rate of the population. Only after 1870 was this trap broken and production began to expand, mainly because of the shift from the primary to the secondary sector. From the 1960s and 1970s onwards, advanced industrialized countries began to observe a swift expansion of the service sector, which exceeded the relevance of the secondary sector in number of employees (MILLS, 1979). This process came to be known in the literature as deindustrialization (ROWTHORN; COUTTS, 2004).[5]

The importance of the industry for the economy has been reported in the economic literature for a long time. Two classical works in defense of industrialization were Hamilton (1791) and List (1841). Both defended protecting the nascent industry in the United States, in the case of Hamilton, and Germany, for List. This protection was necessary to stimulate the development of industrial sectors, which would be safeguarded against foreign competition for a certain period, until manufacturing flourished and became competitive without further need of protection or subsidies. Under this argument, many countries – both developed[6] and underdeveloped[7] – protected their market with a view to developing their manufacturing sector (OCAMPO, 2002; CHANG, 2002, 2009; BATISTA JUNIOR., 2000).

In the 1950s, the CEPAL school was an important reference in the debate on the deterioration of trade relations and the defense of the substitution-based industrialization process in Latin America. Prebisch (1949) criticized the international

4 According to Kuznets (1973), the main aspect of structural change includes the passage from agriculture to the other sectors and, subsequently, from industry to services.

5 Developing countries, in turn, started this deindustrialization process only in the 1990s (KIM; LEE, 2014).

6 According to Chang (2002) and Ocampo (2002), the developed countries used wide commercial protections during their industrialization process, and now that they have a market of high productivity, high technology and competitiveness, they try to impose liberalism to developing countries.

7 Chang (2009) argues that, just as he protects his son from exposing himself to the labor market as soon as he reaches adulthood, preferring him to attend college prior to working, so as to be more prepared, the same should occur with the emerging industries of a country, or a new sector of the economy.

trade models that advocated the international division of labor, attributing to the periphery the role of producing food and raw materials for the countries of advanced industrialization. The author defended industrialization as a strategy to increase productivity and economic development in Latin American countries. According to him, the increase in the average income of the population would only be achieved in two ways: by increasing the productivity of the economy; and by improving trade terms, i.e., via the relative valuation of a country's exporting activity in relation to its imports.

For other authors, the modern industrial sector does not have the same relevance as a trigger of economic growth. The services sector would progressively occupy a central role as a propellant for economic growth (GHANI; O'CONNELL, 2014; FELIPE *et al.*, 2009). The increase in commodity prices during the 2000s stimulated the debate on economic development and the strategy of productive specialization in commodities (PEREZ, 2013; ROCHA, 2015; FISHLOW, 2013). These authors argue that manufactured goods based on natural products would be expanding with increasing technology and increasing productivity due to augmented P&D activities. The production of salmon and wine in Chile would serve as examples.

A study by UNCTAD (2016) indicated that the sector with the highest productivity in emerging economies is composed of tradable services which, however, demand little manpower. In sequence, there are, respectively, the extractive and the manufacturing industries, followed by non-marketable services and, ultimately, agriculture. The tradable services sector, despite having high productivity, has limited space for structural change because it does not employ a significant share of the population. The extractive industry, in turn, demonstrates high productivity rates, but with a reduced ability to directly foster other sectors, since it is composed of more isolated chains, with fewer connections to other sectors. In addition, they stimulate volatile growth cycles due to fluctuations in commodity prices.

The results of the study also indicate that, as *per capita* GDP rises at a level compatible with middle-income countries, the productivity of the manufacturing industry starts to equate with the tertiary sector. The same occurs with the productivity of the extractive industry, but at the *per capita* income level of a developed country. The productivity of agriculture, despite its constant growth, remains far below that of the other segments.

Non-marketable services and agriculture, despite employing the largest share of working personnel in developing countries, would present low productivity and limited capacity to accumulate skills and learning, which would be reflected in low wages and high rates of informality. Studies in defense of the industry also argue that the industrial sector presents a unique dynamism for the economic activity as a whole. According to Laplane (2015), the industry, despite representing only 16% of the world's GDP, is still be the engine of economic growth. It contributes more significantly to innovation activities, to the expansion of international trade, in which manufactured products represent about 70% of the total traded, and to the dynamization of services related to manufacturing activities.

Nevertheless, the industrial sector is not homogeneous, and its sectoral composition is fundamental to promote growth. On the one hand, there are industrial sectors of low productivity, low technological intensity, which employ workers of low education and low wages, show reduced productive chains and positive economic externalities, and reduced capacity of learning and technological gains. On the other hand, there are sophisticated industrial sectors which are technology-intensive, highly productive, show great possibility of technological development and generation of positive externalities to other sectors, and use skilled labor with high wages.

In this sense, it is important to investigate and analyze the possible impacts of the intrasectoral composition on the productivity growth performance of the Brazilian manufacturing industry and the entire economy. A relevant issue in this discussion is whether the specialization in low-productivity products can impact on the long-term future performance of productivity in Brazil. To a large extent, the relevance of this analysis derives from the fact that structural change in work productivity does not only lead to static gains due to the transfer of workers from less to more productive sectors – which is known in the literature as "structural bonus". Structural change also presents medium- to long-term dynamic advantages due to externalities arising from the expansion of technological intensity and the training of workers and institutions that become more capable to continue accumulating learning and technological development. These changes would stimulate a virtuous cycle of development, with increased productivity, higher wages and reduced informality.

According to Chenery (1986), economic development results from changes in the production factors of low productivity sectors to more highly productive activities. Authors such as Diao *et al.* (2017) and Maia and Menezes (2014) also argue that, in addition to a structural change towards the most productive sectors, it is important to raise the "internal" productivity of these sectors to accelerate economic growth and not limit their potential for expansion. In this sense, the ideal strategy of sustainable economic development would be associated with both the growth of the internal productivity of each sector, as well as the reallocation of production towards the most productive sectors (UNCTAD, 2016).

3. Material and methods

3.1 Data source

To carry out the model of structural change of the Brazilian manufacturing industry from factor analysis, data from the Annual Survey of Industry – Enterprise (PIA-Enterprise) of the Brazilian Institute of Geography and Statistics (IBGE) were used, in the most disaggregated category available (four digits) for the classes of the Brazilian National Classification of Economic Activities (CNAE).

The collected data were deflated by the Wholesale Price Index – Internal Availability (IPA-DI[8]) of the Getúlio Vargas Foundation (FGV) and sectorally disaggregated. The objective of deflating data sectorally was to evaluate the growth of physical production more accurately and reduce distortions from changes in relative prices.

Working with four-digit disaggregation, at the economic Class level, is relevant because at a lower level of disaggregation of activity sectors it is possible to investigate the most specific industrial transformations.[9] From a very disaggregated analysis, it is possible to observe with greater clarity what are the specific sectors that have been contracting and those that have been expanding as well as observe the patterns of productive specialization or diversification of Brazilian manufacturing.

The timeframe is the period from 1998 to 2014. The year 2014 marks the last release of PIA-Enterprise up to the completion of this study. The initial year, 1998, although it is two years after the beginning of PIA-Enterprise, in 1996, was chosen due to the availability of information from the Foreign Trade Studies Center Foundation (FUNCEX), which is accessible for 1998 onwards.

Two hundred sectors of the processing industry were considered. Although CNAE 1.0 (1996-2007) owns 300 classes and CNAE 2.0 (2007-2014), 274, it was necessary to reduce the number of sectors due to the need to be combine and conform CNAE classes in order to align the 1.0 and 2.0 series. Moreover, due to

8 This indicator is part of the "FGV Dados Premium" database, which was granted by the institution for academic purposes.

9 The lack of publications with a well-disaggregated, of three and four digits, approach on deindustrialization is due, to a great extent, to the difficulty of working with and presenting conclusions about a large sampling of sectors and indicators. Furthermore, in the Brazilian case, there are also complications arising from methodological changes in the statistics used, notably the National Classification of Economic Activities.

data deficiencies and the impossibility of conforming some sectors, some CNAE classes were excluded from this research and the conformity between the 1.0 and 2.0 classes follows the model exposed in Maia (2018).

In 2014, the 200 sectors used in this work accounted for 95.6% of all Employed Personnel (EP) in the processing industry and 82% of the Value of Industrial Transformation (VIT).[10] However, excluding the Manufacture of Refined Petroleum Products class, which represents 15% of the VIT of the manufacturing industry, the sectors used correspond to 97% of the total in 2014. That is, the 200 sectors analyzed were the most relevant in the generation of jobs and value added in the Brazilian industrial sector.

The greatest shortfall of the research refers to the Manufacture of Refined Petroleum Products class, which was purposely excluded for two reasons: due to the allocation of PIA-Enterprise to firms with more than 30 employees in their "Main Sector", i.e., all the activity of companies that produce in more than one sector is classified entirely in their preponderant sector and, as the main sector of Petrobras is petroleum refining, all its value added by oil extraction is also allocated as refining; and the class exhibits a high VIT, which distorts and impairs some relative analyses.

The data from the PIA-Enterprise that were used are indicators related to the dynamism of the manufacturing industry sectors: EP, VIT, and Net Sales Revenue (NSR). Both absolute and relative variations for all 200 sectors were employed, given that a very small sector has greater propensity to show exacerbated growth (or reduction) in relative terms, while a large sector tends to present larger absolute variations. As we are working with a wide range of sectors, it is crucial to weigh relative and absolute effects. Thus, the six variables used in the classification of the sectors are: *vit_r*: relative VIT variation; *vit_a*: absolute VIT variation; *ep_r*: relative EP variation; *ep_a*: absolute EP variation; *nsr_r*: relative NSR variation; and *nsr_a*: absolute NSR variation.

The advantage of using several indicators comes from the multiplicity of phenomena that may represent a loss of relative participation of a given sector in the economy. If the analysis focused only on the variation of employed personnel, we would have a limited focus, since a particular sector can present growth in its EP level and, at the same time, a decrease in value added, be it due to a reduction in relative prices or a decline in productivity. On the other hand, value added levels might be rising and, still, the number of employees might fall (boosting productivity).

10 The VIT corresponds to the difference between the gross value of industrial production and the cost of industrial operations. It's a proxy of the Value Added.

The choice for these indicators occurred because of a convergence of behaviors among the economic sectors. In other words, these indicators presented strong correlations, allowing for a better discrimination of behavior patterns across the sectors analyzed (to be explained below).

3.2 Factor analysis

Factor analysis[11] is a statistical technique which allows the exploration of the unknown dimensionality of observable quantitative variables. The technique presumes that the observable variables are linear combinations of non-observable and non-autocorrelated factors (KIM; MUELLER, 1978). In other words, given the observable variable X_i (i=1..n), its linear relation to m hypothetical factors F (by which $m \geq n$) would be given by (CUADRAS, 1981):

$$X_i = a_{i1}F_1 + ... + a_{im}F_m + d_iU_i \quad (1)$$

Non-observable variables F are called *common factors*, since they help explain the variability of the n observable variables. Variables U are called *unique factors*, since each factor U_i influences the variability of a single observable variable X_i and refers to the behavior that is not explained by the common factors. Coefficients a inform the existing relationship between the observable variables and the new hypothetical factors.

The Central objective of the factor analysis technique is to obtain m common factors F that explain the total variability of n observable variables X to a great extent. For convenience, observable variables X are initially standardized to a mean of 0 and variance of 1. An important measure of the power of factors to explain variables is given by communality (h_i^2), which measures the share of total variability of the i-th observable variable X_i to be explained m common factors F (CUADRAS, 1981).

Several techniques may be employed for obtaining common factors. Here, the principal component technique was chosen because of its operational simplicity and for the obtention of results that are more aligned to the analytical reality. Coefficients a, as well as the total variability explained by each common factor, are obtained by the process of decomposition of the correlation matrix between observable variables into autovalues and autovectors. The total variability explained by factor Fj will be represented by the autovalue λj.

11 More details on the factor analysis technique can be found in Cuadras (1981), Hair et al. (2006) and Figueiredo Filho and Silva Junior (2010). An applied synthesis can be seen in Kim and Mueller (1978).

Once the factors that reasonably explain the variability of the data are defined and knowing that they refer to implicit dimensions of the observable variables, the interpretation process is somewhat subjective. The goal is to assign to each factor a name that reflects its importance in predicting each observable variable through the analysis of the linear correlation coefficients *a*.

The next step is to estimate the values of the selected factors for each observation of the sample. The inverse relation between the *Fj* factor and the observable variables will be given by:

$$F_j = \frac{a_{ij}}{\lambda_j} X_1 + \frac{a_{2j}}{\lambda_j} X_2 + \ldots + \frac{a_{nj}}{\lambda_j} X_n \qquad (2)$$

Once the correlation coefficients (*a*) that define the degree of linear dependence between each observable variable and the first common factor are obtained, the inverse relationship still remains to be determined, that is, the coefficients of the linear relationship that will estimate the predicted value of the common factor according to the observable variables (equation 2). Note that the variables *X* refer to the standardized observed values, that is, given, for example, an observed indicator of relative average growth of productivity, with a sample average frequency given by $\hat{p}_{ep\_r}$, the standardized value of X_{ep_r} will be given by (3):

$$X_{po\_r} = \frac{po - \hat{p}_{po\_r}}{\sqrt{\hat{p}_{po\_r}\,(1 - \hat{p}_{po\_r})}} \qquad (3)$$

The same thinking is valid for the indicators X_{vit_r}, X_{vit_a}, X_{ep_a}, X_{nsr_r}, X_{nsr_a}.

3.3 Cluster analysis

Cluster analysis defines hierarchical groups of observations within a population. There are several methods that can be employed in this process. However, all are based on the same principle of hierarchical groupings. At the beginning of the process, each element of the sample represents a cluster. The two closest clusters are joined together to form a new cluster that replaces them and so on, until only one cluster is present. The difference between the methods is basically in the forms that distance (or dissimilarity) between the clusters is computed (SAS, 1990).

The grouping method adopted in this study was Ward's, an aggregation strategy based on the analysis of variances within and across the groups formed. The aim of Ward's method is to create hierarchical groups in such a way that the variances within groups are minimal and the variances across groups are maximal (CRIVISQUI, 1999). In the first step, $n-1$ clusters are formed: a size two cluster and the others being size one. For each combination of pairs, Ward's method calculates the variability within the formed clusters (ESS, Error Sum of Squares), the total variability of the data (TSS, Total Sum of Squares), and the proportion of the total variability explained by the clusters formed ($r^2 = [TSS - ESS]/TSS$). The selected cluster is that with the lowest ESS value, or the highest value for r^2. In the next stage, $n-2$ clusters are formed stemming from the $n-1$ of the first step, and so on.

A graph with the degree of dissimilarity obtained at each stage of the analysis, called dendogram, facilitates the interpretation of the results and the choice for the best structure of aggregations. There are several measures of dissimilarity. The most traditional one, also adopted here, is the Quadratic Euclidean Distance, which is based on the same principle of ESS. That is, it consists on a measure of quadratic variability within the groups formed. The higher the variability within the clusters, the lower the quality of the grouping.

4. Analysis of results

4.1 Synthetic indicator of sectoral dynamics

Once the factor analysis technique is applied to the matrix of correlations of the indicators related to the 1998-2014 sectoral dynamics, the results for the dimension with the largest partial contribution (% of total variability) can be observed in Table 1. The choice for a single factor is because it was responsible for 62.74% of the total variability of the six indicators of sectoral dynamics, owing to the low relative contribution of the other factors,[12] and to facilitate the analysis of the results.[13]

All the indicators showed positive relationships with the first common factor. The analysis of the correlation coefficients *a* indicates that this dimension is more strongly associated with the relative variation of the VIT (*vit_r*) and the NSR (*nsr_r*)

12 The second factor has a contribution of 17% and the third of 13%.

13 Moreover, the adoption of two or more factors would not contribute to the analysis, because some variables had a load greater than 0.40 in more than one factor, which transposes the assumptions of simple structure of the components of factor analysis (FIGUEIREDO FILHO; SILVA JUNIOR, 2010).

and that all variables have a correlation greater than 49%.[14] In turn, the variables related to employed personnel (*ep_r* and *ep_a*) were those that reached the highest communalities (variability explained by the factor) – 47.3% and 75.4%, respectively. Barlett's test of sphericity[15] is statistically significant ($p < 0.001$), suggesting that the variables are correlated and the data are favorable to factor analysis (FIGUEIREDO FILHO; SILVA JUNIOR, 2010).

TABLE 1
First common factor of the sectoral dynamics variables

Indicator	Correlation (a)	Communality (h_i^2)
vit_r	0.8974	19.47
vit_a	0.8592	26.18
ep_r	0.7259	47.30
ep_a	0.4955	75.45
nsr_r	0.8995	19.08
nsr_a	0.7996	36.07
Autovalues (l)	**3.76**	
% Variability	**62.74**	

Source: Authors, from PIA-Enterprise.

Applying the expression (2) to the values observed in Table 1, we finally obtain the following weighting structure for the Synthetic Indicator of Sectoral Dynamics (SISD):

$$ISDS = 0{,}238X_{vti\_r} + 0{,}228X_{vti\_a} + 0{,}193X_{po\_r} + 0{,}132X_{po\_a} + 0{,}239X_{rlv\_r} + 0{,}212X_{rlv\_a} \quad (4)$$

The coefficients of this linear equation, or *factor scores*, reflect the discriminatory power of the standardized variables in relation to the different indicators of sectoral dynamics. The variables with higher correlation and commonality present higher weight in the calculation of the SISD. Variations (both absolute and relative) of the VIT and NSR have greater weight, while the (absolute and relative) variations of EP have lower weight in the SISD because this variable is more weakly correlated to the factor.

14 Following the recommendations of Hair et al. (2006).

15 Barlett's test of sphericity tests the hypothesis of correlation between the variables (FIGUEIREDO FILHO; SILVA JUNIOR, 2010).

Applying this structure of considerations in all industrial sectors, we can classify them according to their economic dynamics in the period. In other words, we can list the sectors from best to worst performance according to the SISD. In the appendix, the position of each sector in the sectoral dynamics ranking can be seen.

Among the top ten performer, there are sectors associated with electronics (computers, telephones, peripheral equipment, radio and television), automotive, food (slaughter of poultry and meat and meat products, fruit and vegetable preserves), and textile industries (manufacture of clothing), among others (optical instruments, manufacture and repair of ships and boats). In turn, among the least dynamic sectors, there are both those associated to the industry of machinery and equipment (machinery for the metallurgical industry, crawler tractors, machinery and equipment for apparel), segments of the chemical industry (such as thermoplastic resins and elastomers) and of the textile industry (wiring of artificial or synthetic fibers and manufacture of socks), as there are sectors associated to the food industry (corn flour and derivates, refining and grinding of sugar). A more evident pattern of behavior across the sectors can be identified by grouping them according to the SISD, the topic of the next subsection.

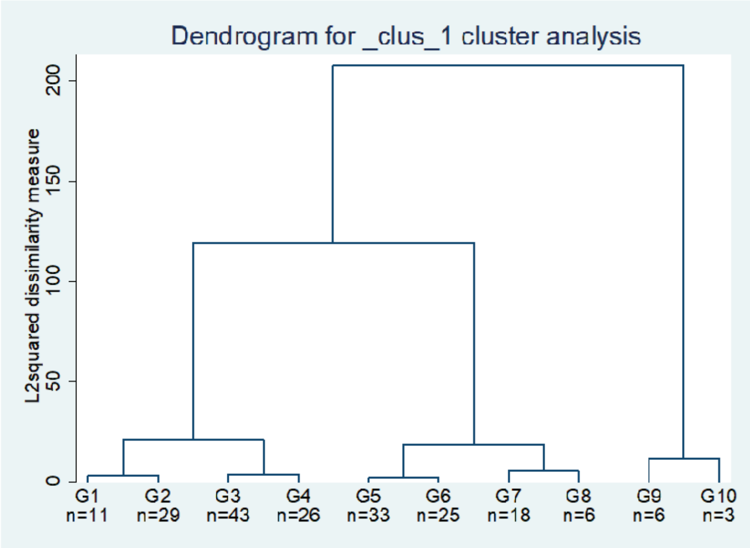
4.2 Sectoral dynamics

In order to group sectors with a similar profile of economic dynamism in the 1998-2014 period, we applied cluster analysis to SISD. Although it is possible, in a simple indicator, to apply a frame stemming from the visual reading of the data and create the number of desirable groups, we opted to use cluster analysis to avoid case-by-case choices.

The dendogram in Figure 1 presents the dissimilarities associated to up to 10 groupings. Five groups were initially selected, and they were chosen because they had close and relatively low dissimilarity when compared to those of other grouping possibilities, besides the analytical convenience of the groups formed. However, one of the clusters (formed by groups G9 and G10 in Figure 1) presented only nine economic sectors. To lend more consistency to the analyses, these were aggregated to the cluster formed by the sectors with the most similar SISD values (groups G5 and G6 in Figure 1).

FIGURE 1

Dendogram with degree of dissimilarity for each grouping stage



Source: Authors, from PIA-Enterprise.

The four final groupings of defined associations were thus denominated:

1. dynamic;
2. above average;
3. below average;
4. atrophied.

Table 2 shows the number of sectors that comprise each of the clusters, as well as the mean values of the relative variables that compose the SISD. The group with the worst performance, called atrophied (Cluster 4), suffered a significant decrease in its sectoral dynamics: it presented, on average, a 3.6% retreat in VIT per year, 1.3% in EP and 3.1% in revenues. On the other hand, the dynamic sectors group (Cluster 1) obtained substantial growth in all the variables analyzed: 11% of variation in the VIT, 6.8% in EP, and 11.4% in the NSR. The group of above-average sectors (Cluster 2) showed positive dynamics, slightly above the aggregate average of the 200 sectors: 4.8% in the VIT (versus 2.7% across all sectors), 4.9% in EP (versus 2.9% in total), and 5.7% in the NSR (versus 3.4% in total). In turn, the group of below-average sectors (Cluster 3) showed dynamics that, despite being positive, was below the national average: 0.8% in the VIT, 1.8% in EP, and 1.5% in the NSR.

TABLE 2
Mean of the relative variables per group

Group	Sectors	*vit_r (%)*	*ep_r (%)*	*nsr_r (%)*
1	33	11.0	6.8	11.4
2	58	4.8	4.9	5.7
3	69	0.8	1.8	1.5
4	40	-3.6	-1.3	-3.1
Total	**200**	**2.8**	**2.9**	**3.4**

Source: Authors, from PIA-Enterprise.

However, it should be emphasized that aggregation according to SISD hides, to a certain extent, the heterogeneity in the behavior of some sectors. For instance, sectors of the same grouping can present distinct dynamics (positive and negative) for the variables that make up the SISD. On the whole, of the 200 sectors analyzed, 63 (31.5%) had their VIT reduced, 113 (56.5%) grew at rates lower than the average annual GDP growth – which was 3.2% per year (Central Bank) –, 40 (20%) had their number of employees reduced, 135 (67.5%) increased EP levels at rates lower than the average growth of employment in the economy (4.5%), and 113 (56.5%) showed decreased productivity (VIT/EP).[16][17]

Table 3 complements the description of the clusters with information about the absolute variables of SISD. The results indicate important changes in the industrial structure in the period. For example, the VIT participation of the atrophied sectors group fell from 17.3% in 1998 to just 6.3% in 2014. The group formed by below-average sectors had a less pronounced decrease: from 28.5% to 21.4%. The above average and dynamic groups increased their VIT participation, from 28.4% to 34% and from 25.8% to 38.2%, respectively. Thus, while the 40 sectors of the atrophied group lost 11 percentage points in their participation of value added to manufacture, the 33 sectors of the dynamic group expanded by 12.6 percentage points their participation in the VIT of the manufacturing industry.

16 It is interesting to relate this result to that found by Maia (2018) through a shift-share model that showed that there has been an improvement in the internal productivity of the manufacturing industry sectors. The main difference is that the first result ponders the weight of each sector, while the latter considers all sectors as if they had the same participation in the economy.

TABLE 3
Percentage and total of absolute variables per cluster

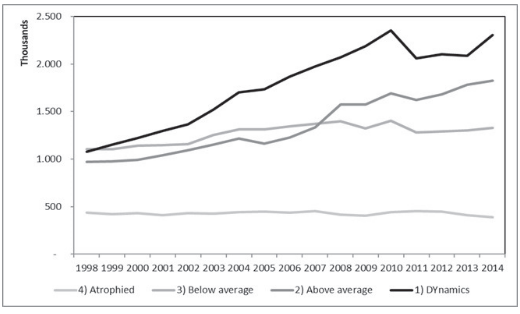
Cluster	Sectors	VIT participation in 2014 (%)	VIT participation in 1998 (%)	Sum of EP 2014	Sum of EP 1998	Balance in US$ billion
1	33	38.2	25.8	2,511,703	1,077,795	156.9
2	58	34.0	28.4	1,965,832	971,527	-91.1
3	69	21.4	28.5	1,412,558	1,100,094	-14.2
4	40	6.3	17.3	388,037	434,491	-203
Overall Total	**200**	**100.0**	**100.0**	**6,278,131**	**3,583,907**	**-151.4**

Source: Authors, from PIA-Enterprise.

An important fact from Table 3 refers to the accumulated balance between 1998 and 2014, which evidences a commercial deficit of US$ 203 billion across the sectors of the atrophied group, considerably contributing to the aggregate deficit of the 200 analyzed sectors (US$ 151.4 billion). The intermediary groups (2 and 3) also showed deficit, with negative balances of US$ 91.1 billion and US$ 14.2 billion, respectively. Only the dynamic group had a positive result, obtaining a surplus of US$ 156.9 billion.

Figure 2 shows the evolution of employment in each cluster over the 17 years (1998-2014) of analysis. The group of dynamic sectors showed substantial and consistent growth between 1998 and 2010. But it was particularly affected by the economic crisis of the period: between 2009 and 2010, the EP of this group was reduced by 290,000. However, the levels recovered between 2013 and 2014, with generation of 220,000 jobs.

FIGURE 2
Evolution of EP per cluster – 1998-2014

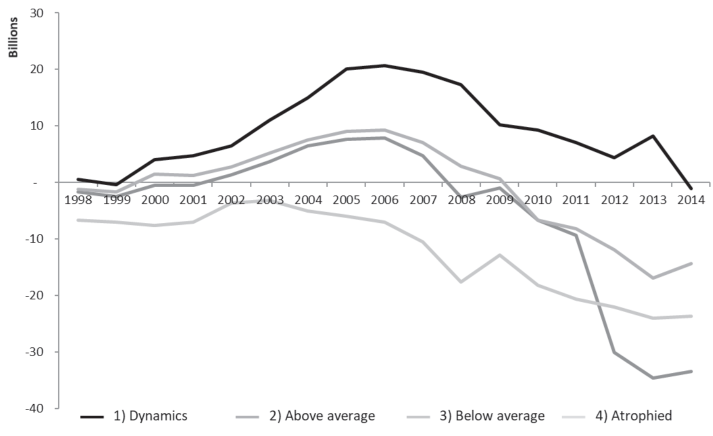


Source: Authors, from PIA-Enterprise (IBGE).

Not all groups were affected in a similar way by the macroeconomic dynamics. For example, the group of above-average sectors showed a particularly substantial growth in EP in 2007 and 2008. Despite a subsequent reduction of growth, the group presented a reasonably positive dynamics in EP throughout the period: on average, 4% per year between 1998 and 2014. In turn, Groups 3 (below average) and 4 (atrophied) presented a behavior with few structural changes, suggesting a historical tendency of employment stability and decrease in its relative participation.

Figure 3 shows the evolution of the trade balance of each grouping. By analyzing the graph, it is possible to see an evident economic cycle, which is in its initial phase in 2000 and reaches its apex in 2006. The trade balance of the dynamic group presented the best dynamics in this period. Although the intermediary groups 2 and 3 also present growth trends, with the outbreak of the 2008 international crisis, the results of the Brazilian Trade Balance of manufactured goods greatly deteriorated. The negative highlight, however, is the group formed by atrophied sectors, which presented a negative balance throughout the period, with a tendency to decline from 2006 onward.

FIGURE 3
Evolution of the trade balance (in US$) per cluster – 1998-2014



Source: Authors, from FUNCEX.

For some authors,[17] the trade balance dynamic during this macroeconomic cycle was largely due to the conduction of the country's macroeconomic policy. In 2009, as the 2008 international crisis pushed on,[18] the Government adopted a series

17 'See Maia (2018).

18 See Krugman (2009).

of anti-cyclical measures, such as the reduction of interest rates and increase in the credit supply of public banks. In the short term, the result was an economy growth of 7.5% in 2010 (BARBOSA FILHO, 2013, 2015). However, in the medium term, monetary expansion led to increasing deficits in current transactions rather than stimulating internal growth, due to a draining of demand through imports (DE CARVALHO, 2017). On the other hand, authors such as Hiratuka and Sarti (2017) highlight the intensification of international competition after the outbreak of the subprime crisis as the major impact factor for the reversal of the Brazilian Trade Balance outcome.

4.3 Sectoral dynamics groups

4.3.1 Cluster 1: dynamic

Cluster 1 consists of the dynamic sectors of the manufacturing industry, which achieved a positive performance in the period. This group consists of 33 economic activity Classes, with an average growth of 11% in VIT, 6.8% in EP and 11.4% in revenues. Due to its VIT growth, this cluster increased its stake in the total manufacturing VIT from 25.8% in 1998 to 38.2% in 2014. In addition, it expanded the number of employees by 1.5 million: from just over 1 million employees in 1998 to more than 2.5 million in 2014.

Among the largest sectors of Cluster 1, the activities with the highest VIT in 2014 were: the slaughter of poultry and meat (R$ 48.4 billion), the manufacture of automobiles (R$ 35.4 billion), sugar mills (R$ 25.7 billion) and the manufacture of clothing (R$ 17.9 billion). In terms of relative dynamics, the manufacture of telephones and of computers were the most dynamic sectors, with average annual growth of 24.7% and 23.4%, respectively.

The trade balance of Group 1 was positive by US$ 156.9 billion between 1998 and 2014. Emphasis can be given to the sectors of meat slaughtering, sugar mills and pulp and paper, which had a surplus of US$ 130, US$ 74 and US$ 45 billion, respectively. The manufacture of fruit juices (US$ 28.4 billion) and the manufacture of trucks and buses (US$ 26.7 billion) also contributed significantly. It should be noted that, to a large extent, the sectors of the dynamic group that presented the best performances in the trade balance are those associated with the national agroindustry, which exhibits high international competitiveness. On the other hand, the country did not achieve competitiveness in most sectors which are not based on natural resources,[19] the major exception being the manufacture of trucks and buses, which has a strong presence in exports to Latin American and African countries.

Among the sectors that presented commercial deficit in the period, the highlights are the electro-electronic sectors – "brown" line – such as the manufacture of computers, telephones, televisions and air conditioners. Besides these, the manufacture of automobiles, pesticides, clothing, and measuring, checking and testing instruments were emphasized. Many of these sectors were stimulated by the high growth of household consumption, by currency appreciation – an increase in real wages – and by the expansion of the consumer market (MEDEIROS, 2015). In turn, Squeff (2015) spotlights the reduction of poverty and income inequality in the 2000s, which would have contributed to an increase of income and consumption for poorer households.[20][21]

4.3.2 Cluster 2: above average

The 58 sectors of Group 2 had an increase in their VIT of 4.8% per year on average, which is higher than the GDP growth. The number of employees rose at the rate of 4.9% and the NSR had an increase of 5.7% per year. With this growth, the participation of this cluster in the total manufacturing VIT increased from 28.4% in 1998 to 34% in 2014. In turn, the number of employees went from 971,000 in 1998 to 1.9 million in 2014.

The prominent sectors in relation to VIT levels in 2014 were: manufacture of medicaments for human consumption (R$ 21.2 billion), production of crude vegetable oils (R$ 15.8 billion) and the manufacture of malt, beers and draught beer (R$ 15.5 billion). Two out of these three activities are exponents of the national agroindustry. Moreover, the production of vegetable oils is a sector in which the country has comparative advantages and the beer segment was particularly stimulated by the growth of household consumption. In addition to the emergence of countless breweries in the period, the creation of a large domestic industry in the beer segment (AMBEV), which happened in 1999, should also be stressed.

The drug sector, despite belonging to the chemical industry (many sectors of which shrunk down in the period), also presented above-average growth during the

19 See Kubielas (1999) and Maia (2018).

20 "The average income growth of the poorest tenth (72%) was much higher than the average income growth (23.3%)" (SQUEFF, 2015, p. 7).

timeframe analyzed. The sector would have been largely driven by the expansion of the internal market (since richer people tend to invest more in health), the ageing population (the elderly consume more medications), and other institutional factors, such as the expansion of the production of generic drugs in the country.

Despite the positive dynamics in the VIT and EP, the commercial balance of Group 2 was negative by US$ 91.1 billion between 1998 and 2014. The economic activity Classes that headed this deficit were the manufacture of intermediates for fertilizers (US$ 94.6 billion), manufacture of medicaments for human consumption (US$ 43.3 billion) and the manufacture of nitrogenous, phosphatic or potassic fertilizers (US$ 34.7 billion). Despite the aggregate deficit of this cluster, the production of crude vegetable oils and tanning and other leather processing had surplus of US$ 80.3 billion and US$ 24.1 billion, respectively.

Thus, although this cluster is composed of sectors with above-average dynamics, the negative aggregate balance outcome suggests that, overall, the expansion of these activities was not motivated by an exporting impetus and an international competitiveness gain. Among the sectors with negative balance, the large import of fertilizers to meet the expansion of agricultural production stands out. The intensification of international competition and the deterioration of the Brazilian economy from 2011 onward may also have contributed to the negative outcome of this cluster (DE CARVALHO, 2017; HIRATUKA; SARTI, 2017; COUTINHO; KUPFER, 2015).

4.3.3 Cluster 3: below average

The third group consists of 69 sectors that showed an average VIT growth of 0.8% between 1998 and 2014. Albeit positive, this dynamic was far inferior to the average growth of the Brazilian GDP (3.2%) or the manufacturing industry (2.5% per year) (Central Bank and IBGE). EP and NSR levels also grew below the national average: 1.8% and 1.5%, respectively. While Cluster 3 had the highest participation in the total VIT of the industry in 1998 (28.5%), it fell to the third position in 2014 (21.4%).

In 2014, the main sectors of this cluster, regarding VIT, were: manufacture of dairy products (R$ 10.2 billion), the “production of long steel products (R$ 9.8 billion), manufacture of tobacco products (R$ 8 billion), manufacture of packaging of plastic material (R$ 7.3 billion) and manufacturing of pneumatic components (R$ 7 billion).

The analysis of the trade balance of this cluster reveals a deficit of US$ 14.2 billion between 1998 and 2014. However, the Classes of aluminum metallurgy, production of pig iron and manufacture of tobacco products were positively distinguished, with surplus of US$ 33.9 billion, US$ 19.4 billion and US$ 33.4 billion, respectively. The positive dynamics of the first two metallurgical sectors is probably a reflection of the global economic dynamics, especially the growing Chinese demand for ores and derivatives. In relation to the positive balance of the manufacturing sector of tobacco products, we highlight the fact that Brazil is the world leader in the exportation of tobacco leaves.

4.3.4 Cluster 4: atrophied

Cluster 4 is the one that presented the worst performance among the groups analyzed; its 40 sectors fare the worst in the factor analysis ranking. These results indicate that the segments of this group have been deflating, presenting negative growth rates. The relative growth in VIT of these industrial activities was -3.6% between 1998 and 2014. As a result, the participation of this cluster in the total manufacturing VIT fell from 17.3% in 1998 to 6.3% in 2014. In turn, employment levels dropped by 1.3%: there were 434,000 employees in 1998 and only 388,000 in 2014.

The Classes that most contribute to the VIT of this sector are the manufacture of paper (VIT of R$ 4.1 billion), manufacture of paints, varnishes, enamels and lacquers (R$ 4 billion), and wheat grinding and manufacture of derivatives (R$ 3.7 billion).

The negative trade balance outcome of this cluster was heavily influenced by imports of electronic and chemical products. Overall, the group presented a commercial deficit of US$ 203 billion accumulated between 1998 and 2014. The most deficient sectors were: manufacture of basic electronic material (US$ 82.4 billion), manufacture of other chemicals (US$ 41.9 billion) and the manufacture of other pharmaceutical products (US$ 18.2 billion). In addition, a large part of the low technology-intensive[21] and labor-intensive[22] sectors, predominantly the textile chain sectors, were largely replaced by Chinese imports due to the intensification of international competition (HIRATUKA; SARTI, 2017; COUTINHO; KUPFER, 2015).

On the other hand, some sectors presented commercial surplus, with the refining and grinding of sugar (US$ 30.1 billion) standing out. However, despite the good external result, this economic activity had an average negative VIT growth

21 See OECD (2011).

22 See Kubielas (1999).

of 9.6% per year. It should also be stressed that some agroindustry sectors, such as the refining and grinding of sugar, may have presented poor performance in the SISD due to the issue of the PIA-Enterprise classification criteria by main activity. In other words, it is possible that production was statistically shifted to another sector. A hypothetical example would be part of the production of refining and grinding of sugar to be allocated as sugar mill (which is in Cluster 1, dynamic). Unfortunately, there is no accurate information to confirm this hypothesis.

5. Discussion and final remarks

Although the discussion about the process of structural change of the Brazilian economy, especially the issue of deindustrialization, has attracted much attention from authors, there is still an absence of information about the losing and winning sectors in the economic dynamics. Based on six economic indicators – relative and absolute VIT variations, EP and NSR – for the period between 1998 and 2014, this work proposed an index (SISD) to rank the industrial sectors from most to least dynamic. The work adopted a rather fragmented structure of the economic sectors, which enabled a disaggregated analysis of the structural change dynamics of the Brazilian manufacturing industry.

Broadly, the average annual growth of the 200 industrial sectors analyzed was: 2.7% in the VIT, -0.1% in productivity, 2.9% in EP and 3.4% in NSR, but the results of cluster analysis identified four main industrial groups, divided according to their economic dynamics, which was evidenced by their SISD score. Two of these groups presented low dynamism, with emphasis on the cluster comprised of atrophied sectors, formed by 40 manufacturing classes.

There was an important change in the production structure of the Brazilian manufacture, in which the participation of the atrophied sectors was reduced by 11%, from 17.3% of the total manufacturing industry in 1998 to 6.3% in 2014. The group of below-average segments obtained a less pronounced decrease in participation – from 28.5% to 21.4%. The above-average and the dynamic sectors, in turn, increased their participation in the period, increasing from 28.4% to 34% and from 25.8% to 38.2%, respectively.

The economic activities of the atrophied cluster suffered a significant reduction in their sectoral dynamics, since they presented, on average, a yearly decrease rate of 3.6% in the VIT, 1.3% in EP and 3.1% in revenues. The sectors of this grouping were the worst in the sectoral dynamics ranking, with emphasis on machines and equipment for apparel (in the 200th place); the manufacture of crawler tractors (198th place); cutlery articles (197th); and the manufacture of thermoplastic resins (196th). A relevant part of this group is composed of sectors of low technology and labor intensity, mainly of the textile chain, and by high and medium technology-intensive sectors, related to the chemical industry.

Diversely, the cluster comprising the dynamic sectors presented substantial growth in all observed variables, especially in the most dynamic sectors according to the SISD, such as: manufacture of computers (1st place); manufacture of telephones (2nd); radio and television equipment (4th); and meat and poultry slaughtering and products (5th). The highly dynamic sectors focused on the internal market, such as the manufacture of computers, telephones, radio and television, may have been particularly stimulated by the large expansion of credit, household consumption, and, above all, by the Tax on Industrialized Products (IPI). In this sense, the dynamics of these sectors of the white goods industry would have been largely motivated by the macroeconomic policies of the period, such as the expansion of the minimum wage and credit to families, as well as the tax policy of exonerating industrial segments. Regarding the dynamic and exporting sectors, activities based on the processing of natural resources that had a boost from the increase in international trade, especially due to the Chinese demand, prevail.

Another important result refers to the accumulated balance between 1998 and 2014, which evidences a trade deficit of more than US$ 203 billion among the atrophied sectors, contributing considerably to the aggregate deficit of the 200 analyzed sectors (US$ 151.4 billion). Groups 2 and 3 were also deficient, with negative balances of US$ 91.1 billion and US$ 14.2 billion, respectively. The first group, comprised of the dynamic sectors, however, had a surplus of US$ 156.9 billion, mainly due to the high participation of sectors based on the processing of natural resources. In order to reverse this high-deficit panorama, a strategic action would be to stimulate the industrial sectors to export more, as defended by Coutinho and Kupfer (2015), Bacha (2013), Bresser-Pereira *et al.* (2015), and Nassif *et al.* (2018), among others.

The main conclusion of this work is that the analysis of structural change cannot be generalized to a common dynamic of the country's industrial sectors (which would be marked by deindustrialization). There are winning and losing sectors. First of all, it is essential to identify them. Then, to understand the impacts of economic dynamics and public policies on the sectoral structure. Rather than a convergence in the dynamics of the industrial sectors, the results point to two main groups of winning sectors in the period, with distinct characteristics and policy results. The first, the agroindustry sector, was fundamentally stimulated by commercial opening and growth of exports. The automobile and white good industries benefited fundamentally from policies related to tax relief and incentives to household spending. On the other hand, high productivity sectors related to the chemical industry and labor-intensive sectors of the textile segment have been losing participation in the productive structure of the country.

These results also point to the antagonistic effects of the macroeconomic policies of the period. If tax relief and incentives to household spending favored mainly the white goods industrial segments, monetary and exchange policies, marked by high interest rates and currency value, have stimulated a process of replacing local production with imported products. This result was more pronounced in the chemical and textile sectors, which comprise both high technology and capital-intensive segments and low technology and labor-intensive sectors.

The results of this work also question, to a certain extent, the view by which the Brazilian specialization would be essentially marked by a structural change in sectors of lower productivity and less technology-intensive. The fact is that there is a great heterogeneity within the more and less dynamic sectors of the Brazilian economy. The recent dynamics of industries such as telephone and computer manufacturing indicate that the country can develop more qualified and high productivity products, while specializing internationally as a major power in agricultural commodity processing.

The specialization in agricultural commodities is not, per se, a problem, since it is anchored in an accelerated increase of its dynamics, productivity and technological content incorporated into the production process. The concern with the process of productive specialization of the Brazilian manufacturing industry lies in the loss of dynamism of high productivity and technological-content sectors, which can limit the productive and technological capacities of the national industry and constrain productivity and GDP growth. Nonetheless, the examination of the dynamism and capillarity of the Brazilian industry require an analysis of a rather disaggregated input-output matrix, which falls beyond the objectives of this study.

Finally, there are remarks to be made for the policies on industrial development that could derive from this work, related to the importance of combining macroeconomic policies to increase the consumption of households with microeconomic policies focused on stimulating competitiveness, productivity and technological innovation. Regarding macroeconomic policies, Brazil took advantage of the favorable international dynamics of the 2000s to expand household spending, with positive effects in some industrial segments. Yet, this favorable cycle was quickly exhausted, leaving the country in need of immediate reforms to maintain a sustainable pace of growth in the long term. In relation to microeconomic policies, the dynamism of the white goods industrial sectors in view of the tax relief that benefited them points to the need for the country to review its complex tax policy. Lastly, the dynamism of sectors related to the processing of agricultural commodities also points to the importance of trade agreements and international competitiveness to streamline the Brazilian industrial sector.

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Appendix

Ranking	Reference	IPA-cod
1	Manufacture of computers	302
2	Telephone equipment	322
3	Peripheral equipment to electronic machinery	302
4	Radio and television equipment	323
5	Meat and poultry slaughtering and products	151
6	Manufacture of clothing	181
7	Automobiles	341
8	Optical instruments and equipment	32
9	Building and repair of ships and boats	2004
10	Preserved fruit and vegetables	152
11	Medical instruments	32
12	Printing services	2004
13	Sugar mills	156
14	Pesticides and other agrochemical products	246
15	Corrugated paper and paperboard	21204
16	Parts and accessories for motor vehicles	344
17	Manufacture of motorcycles	35901
18	Trucks and buses	342
19	Measuring, checking and testing instruments	32
20	Safety accessories	181
21	Pulp	21101
22	Cocoa products, sugar confectionary and chewing gum	15803
23	Manufacture of workwear and service apparel	181
24	Footwear, except sports footwear	193
25	Electrical equipment for vehicles	31601
26	Manufacture of fruit juices	152
27	Working of precious stones and jewellery	2004
28	Dietetic products and other preserved food products	158
29	Soft drinks	15907
30	Electrical motors and generators	311
31	Manufacture of bodies (cabs) for motor vehicles	34
32	Cassava flour and derivatives	155
33	Air conditioners	29204

(continua)

Ranking	Reference	IPA-cod
34	Printing of newspapers, magazines and books	2004
35	Malt, beer and draught beer	15904
36	Bakery and pastry products	15801
37	Medicaments for human consumption	24501
38	Manufacture of mattresses	36109
39	Domestic appliances	298
40	Flat glass and safety glass	261
41	Meat dishes	15103
42	Stone crushing	269
43	Plastic flat or tubular laminates	25201
44	Articles of concrete	263
45	Processing of other plant products	155
46	Agricultural machinery and equipment	293
47	Additives for industrial use	249
48	Prepared animal feeds	15506
49	Metalworking of precious metals	274
50	Manufacture of sports footwear	19302
51	Non-refractory ceramic products	264
52	Tractors used in agriculture and forestry	29304
53	Knitted and crocheted apparel	177
54	Machinery for mining and construction	29
55	Printing ink	24804
56	Flat-rolled products of steel	272
57	Rice processing	15501
58	Diverse plastic products	252
59	Crude vegetable oils	153
60	Machinery and equipment for all purposes	292
61	Intermediate products for fertilizers	241
62	Nitrogenous, phosphatic or potassic fertilizers	24111
63	Basic petrochemical products	242
64	Bottling and carbonation of mineral waters	15905
65	Other metal products	289
66	Furniture predominantly made of wood	361
67	Stationary internal combustion engines	291

(continua)

Ranking	Reference	IPA-cod
68	Locomotives, wagons and other rolling stock	2004
69	Watches and clocks	32
70	Manufacture of machine tools	29401
71	Manufacture of ethanol	234
72	Other non-metallic mineral products	269
73	Structural metal products for buildings and others	281
74	Coopers' products and wooden packings	202
75	Manufacture of wiring devices	312
76	Manufacture of quicklime, hydrated lime and plaster	269
77	Margarine and other fats	15305
78	Medicaments for veterinary use	245
79	Other domestic appliances	29804
80	Soap and synthetic detergents	24701
81	Special fabrics	176
82	Knitted fabrics	17701
83	Perfume products and cosmetics	247
84	Manufacturing of cement	262
85	Tanning and other leather processing	191
86	Printed metal articles	28
87	Machinery and equipment for pulp and paper	296
88	Machinery for food, beverages and tobacco	296
89	Snack products (cookies and crackers)	15802
90	Other transport equipment	35
91	Manufacturing of machine tools	31
92	Other iron and steel tubes	27302
93	Laminated wood	202
94	Refrigerating and ventilation machinery and equipment	292
95	Casting of other non-ferrous metals	274
96	Parts and accessories of brakes	344
97	Luggage, bags, handbags and travel accessories	19
98	Furniture of other material	36
99	Transmission equipment	291
100	Metal frameworks	28102
101	Plastic articles for the packing of goods	252

(continua)

Ranking	Reference	IPA-cod
102	Hydraulic pumps and rams	29103
103	Made-up textile articles	176
104	Casting of iron and steel	27
105	Parts for gearing and driving elements	34402
106	Weapons and ammunition	29
107	Long steel products	272
108	Heavy boiling work	281
109	Parts and accessories for driving and suspension	34404
110	Batteries and accumulators for vehicles	31401
111	Diverse products	2004
112	Tobacco products	16
113	Pneumatic components	251
114	Farinaceous products	15806
115	Manufacture of wine	15903
116	Other paper articles	214
117	Thermosetting resins	24307
118	Rerolled, drawn and profiled steel products	27217
119	Roasting and grinding of coffee	15701
120	Cleaning and polishing products	24702
121	Apparel accessories	181
122	Light bulbs and other lighting equipment	31501
123	Furniture predominantly made of metal	36107
124	Valves and taps	29104
125	Homogeneity and blending of distilled spirits	15901
126	Hand tools	284
127	Medical and dental material	245
128	Industrial gases	24112
129	Wood sawing	201
130	Fruit preserves	152
131	Manufacture of instant coffee	15702
132	Lifting and handling machinery	292
133	Tyre rebuilding and retreading	251
134	Equipment for thermal facilities	292
135	Paperboard packaging	21302

(continua)

Ranking	Reference	IPA-cod
136	Glass articles	261
137	Brooms and brushes	2004
138	Wood framework	202
139	Glass packaging	261
140	Cordage, rope, twine and netting products	176
141	Dairy products	154
142	Production of pig iron	27101
143	Other inorganic products	241
144	Metallurgy of aluminum and its alloys	274
145	Sawmilling products	284
146	Refractory ceramic products	264
147	Ceramic products	264
148	Spinning and weaving of cotton fibers	17201
149	Parts and accessories for motors	34401
150	Metal packaging	289
151	Welded steel tubes	27301
152	Bodywork	28905
153	Diverse rubber articles	251
154	Central heating boilers and tanks	28
155	Yarns and threads for sewing and embroidery	172
156	Fiber processing, except cotton	17
157	Steam generating boilers	28
158	Fish dishes	151
159	Waterproof materials, solvents and others	24805
160	Steel forged products	28
161	Tapestry articles	176
162	Wheat grinding and manufacture of derivates	15502
163	Corn oils and starches	155
164	Manufacture of paper	21203
165	Milk processing	15401
166	Other printing services	2004
167	Paints, varnishes, enamels and lacquers	248
168	Machinery and equipment for the textile industry	296
169	Toys and recreational games	2004

(continua)

Ranking	Reference	IPA-cod
170	Other leather articles	19
171	Other organic chemical products	242
172	Diverse wood articles, except furniture	202
173	Pharmaceutical products	245
174	Wires, cables and electrical conductors	31301
175	Chemical products	249
176	Manufacture of chlorine and alkalis	241
177	Metal drawn articles	28904
178	Musical instruments	2004
179	Refining of vegetable oils	153
180	Transmitting devices	322
181	Basic electronic equipment	321
182	Paper and paperboard products	214
183	Batteries and electric accumulators	31
184	Electric material for facilities	31202
185	Paper packaging	21301
186	Compressors	291
187	Bicycles and tricycles	35903
188	Intermediates for resins and fibers	242
189	Manufacture of socks	17702
190	Spices, sauces and condiments	158
191	Elastomers	243
192	Wiring of artificial or synthetic fibers	17202
193	Corn flour and derivates	15504
194	Machinery for the metallurgical industry	296
195	Hunting, fishing and sports articles	2004
196	Thermoplastic resins	243
197	Cutlery articles	284
198	Crawler tractors	29
199	Refining and grinding of sugar	156
200	Machines and equipment for apparel	296