Artigo submetido a 1 de Junho 2021; versão final aceite a 24 de Novembro de 2021
Paper submitted on June 1, 2021; final version accepted on November 24, 2021

Regional Deconcentration in Brazilian Economy: Putting some Lights on the Industrial Sector in the 1995-2018 Period

Desconcentração Regional na Economia Brasileira: Colocando Luzes sobre o Setor Industrial no Período 1995-2018

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Abstract

The article analyzes the trajectory of industry and its reverberations across Brazilian regions during the period 1995-2018. The technical restructuring of industrial activities is investigated through the macroregional scales (North, Northeast, Southeast, South and Midwest) and the relevant industrial agglomerations. Results have indicated that the recent movements of regional deconcentration continue to occur but are on a small scale and mainly linked to intensive activities in natural resources and labor. The perceived changes in the composition of the industrial sector - particularly in the manufacturing industry –, as something new within Brazil's economic development, are an indication of how this sector has lost its relevance in the expansion of the national economy.

Keywords: industrial restructuring; Brazilian industry; regional development; regional inequalities

JEL Classification: O1; O4; R0; R3

Resumo

O artigo analisa a trajetória da indústria e seus rebatimentos no território nacional no período 1995-2018. A reestruturação técnica das atividades industriais é investigada nas escalas das macrorregiões (Norte, Nordeste, Sudeste, Sul e Centro-Oeste) e das aglomerações industriais relevantes. Resultados indicam que os movimentos recentes de desconcentração regional continuam ocorrendo, mas são de reduzida monta e estão ligados, principalmente, a atividades intensivas em recursos naturais e em mão-de-obra. As mudanças percebidas na composição do setor industrial –

principalmente na indústria de transformação – apontaram, como uma novidade no desenvolvimento econômico brasileiro, para a perda de relevância deste setor na expansão da economia nacional.

Keywords: reestruturação industrial; indústria brasileira; desenvolvimento regional; desigualdades regionais

Classificação JEL: O1; O4; R0; R3

1. INTRODUCTION

Profound productive and technological transformations have been realized in Brazilian industry specially in the last two decades. Corresponding territorial impacts on those activities are in action and they are somewhat different from what we were used to know related to regional inequalities issues. The industrial sector, which over a long period between the 1930s and 1980s commanded the expansion pattern and pace of regional economies, during the period that followed, began to lose relative importance in the national economy. Its weakening has undoubtedly had very relevant implications for the course of regional disparities, since, as this paper will go on to discuss, the intersectoral and interregional links of industrial activities have been very tenuous. Most of official statistics on industrial activity during the years 1995-2018, the period adopted for this investigation, indicate that the regional deconcentration of industry continued, even though it was accompanied by a loosening in the links of the productive chains.

Although many other studies have recognized the decreasing pattern of regional inequalities, they are not attempted to the fact that what is occurring is a spurious one. In fact, deconcentration that has been now taking place is more related to the deindustrialization and diminishing share of the industry in the Brazilian economy than to the desirable robustness of it.

In addition to this introduction, the article is organized into three basic sections and a final conclusion. Section 1 specifies the core aspects of the current debate on industry and territory. In section 2, the sectorial dynamics of Brazilian industry are analyzed with a view to determining the structural pattern, characterized by a small increase in its value of industrial transformation (VIT), a reduction in the total average productivity and an expansion of resource-intensive industry groups in the sectoral composition of industry associated with a significant reduction of scale-intensive industry groups and differentiated technologies. In section 3, the regional patterns of deconcentration are discussed with a concern to highlight which types of industry preferentially move between regions and what is the sectoral productivity pattern associated with the identified regional specializations.

The study concludes by describing a regressive pattern of industry that has been installed in the most developed region and that has spread throughout the regions. Its most characteristic effects have been to maintain the heterogeneity of productive activities. The recent territorial deconcentration of industrial activities is much more grounded in labor-intensive and natural resource-based activities and less in the more capital- and technology-intensive activities, which has tended to reproduce regional gaps of per capita income.

2. REGIONAL ECONOMIC DECONCENTRATION: CURRENT ASPECTS OF THE DEBATE

The academic debate on regional development has once again concerned itself with the effects of the transformations that have resulted from the ongoing technological change in developed and developing countries, which increasingly affect prevailing notions of economic activity. Industrial activities were seen as a driver of national growth in the pioneering analyzes, such as those by Kaldor (1966, 1970), Kuznets (1971), Furtado (1961) and more recently Rodrik (2006, 2013), Timmer *et al*. (2014) and Stiglitz (2015), since they generated economies of scale and, consequently, cumulative income inequalities. For these authors, the national development strategy that should be pursued is that of reallocating economic resources from traditional sectors (agriculture) to higher value-added industrial activities and high forward and backward sectoral linkage.

Particularly, in Kaldor's view the industry is seen as the "engine of growth", because the existence of increasing returns of scale, this sector can boost other sectors of the economy (Kaldor, 1966). First, it does so through the structural change channel, i.e., in the beginning of the industrialization process starts to occur a reallocation of productive resources from the agrarian sector, with low productivity and low salaries, to the modern industrial activities with high levels of productivity and high salaries. Second, by being characterized by economies of scale (both static and dynamic) the industrial sector is capable of stimulate and foster high rates of productivity in the other sectors (agricultural and services). Because of its powerful capacity to generate threads and spillover effects not only over sectorial branches but also over regions, industrial activities contribute to the diversification and productive complexity of a given national or regional economy.

In the recent Brazilian case, the evolution of the industrial sector has been guided by a regressive bias characterized by a structural shift towards branches of activity based increasingly on natural resources and labor-intensive and less and less towards those activities associated to presence of economies of scale, differentiated technologies and knowledge-based technologies. For many authors, Brazilian economy instead of diversifying and gaining complexity is, in fact, falling behind relative to the world economy and to the frontier of modern technologies (Nassif *et al*., 2015; 2020).

In studies on regional economy, by analysts such as Richardson (1973) or Bailey et alli (2019), industrial activities were also recognized as being significant in understanding the processes involved in the concentration/deconcentration of economic activity. The economies of scale created by industry lead to a process of cumulative causation in those activities that generate intra-urban agglomeration economies in a given region, and contribute to the concentration of activities in that territory.

A process of deconcentration, in turn, comes into being when the costs of the factors of production (labor, urban land, transport, etc.) become exceeding high in the most industrialized region and economic agents begin to seek new regions with lower production costs to move to. The moment-to-moment movement that becomes established between the polarizing and dispersive forces is of interest to regional development.

In the case of Brazil, economic growth throughout the twentieth century, from a territorial viewpoint, was characterized by a strong concentration of industrial activities in the Southeast region, particularly in the state of São Paulo. The evolution of this state's economy occurred at much higher rates than in the rest of the nation's regions, thus widening the regional economic differentials. In 1970, 58.2% of the national manufacturing industry was rooted in the state of São Paulo; and the metropolitan region of São Paulo, in turn, accounted for 43.5% of the national total.

Moving onwards, during the 1970s and 1990s, an economic deconcentration occurred and the beginning of a process whereby there was a convergence of the state and regional per capita product. The São Paulo economy, although growing considerably, began to evolve at a slower pace than the other regional economies, thereby allowing room for the existing disparity to slow down. On the one hand, agglomeration diseconomies in the metropolitan region of São Paulo, as well as in the rest of the state itself, contributed to the search for new territories and cheaper labor for industry and, on the other, actions by the federal government - directly through regional development policies and the creation of communications and energy infrastructures to promote national market integration, or indirectly through state-owned investment - was decisive in stimulating the relocation of private enterprises to the poorest or most stagnant areas of the country (Cano, 1998; Azzoni, 1986).

In the mid-1990s, the process of deconcentration was already beginning to weaken and concern regarding the reconcentration of productive activity returned to the national agenda. Once again, the debate spoke of the danger of reconcentration with the fragmentation of the interconnected links between regional economies (Cano, 1995; Pacheco, 1998) and also of the 'concentrated deconcentration' of industrial activity. Although the process of industrial deconcentration was still taking place, it was headed towards a relatively contained area of the national territory confined to a polygon of micro-regions with a high potential of industrial employment (called relevant industrial agglomerations – RIAs, containing over 10,000 industrial jobs) in the Southeast and South (Diniz, 1993; Diniz & Crocco, 1996).

Recognizing that industrial activity has historically played a crucial role in the integration of the national market by stimulating growth in less developed regions, an effort has been made to assess the consequences of recent sectoral changes in industry on the dynamics of Brazilian territorial

development. In addition to discovering whether or not a process of regional deconcentration is underway, we seek to evaluate the sectoral specializations associated with it.

Two territorial perspectives are explored: the first is the macroregional, expressed in the five major regions (North, Northeast, Southeast, South and Midwest) and the other is the microregional, represented by the cross-section of relevant industrial agglomerations (RIAs). In the first case the industrial activity database covers the period 1996-2018. In the second, related to micro-regions named "relevant industrial agglomerations" (RIAs), data coverage is for the years 1995-2015. It is expected to obtain a broad panel of research from these two decades.

3. THE SECTORAL DYNAMICS OF BRAZILIAN INDUSTRY DURING THE PERIOD 1996-2018

3.1 Methodological references and the database

From the perspective of the five major regions, research into the transformations of industry is based on recent data for the value of industrial transformation (VIT), the gross value added (GVA) and employed persons (EP) for the branches of the extractive industry, of manufacturing and of total industry for the period 1996-2015, according to the Annual Survey of Industries (ASI) from the Brazilian Institute of Geography and Statistics (IBGE). The VIT and GVA values are deflated to 2015 values of the Real, according to the Getúlio Vargas Foundation Extended Producer Index (FGV) (EPI).

Branches of industrial activities are grouped according to the classification used by the OECD (1987) and adapted from Pavitt (1984) by the predominant competitive factor in the industry. This classification enables a simultaneous assessment so as to identify the winning and losing regions, as well as which types of industries were spatially relocating.

To this end, the industrial branches were regrouped according to five types of competitiveness factors, namely: a) industries based on natural resources, whose main domestic competitive factor is natural resources, b) labor-intensive industries and, therefore, those whose competitive differential is labor, c) production-scale intensive industries supported by cost reductions through expanding revenue scales, (d) industries with differentiated technology that enables them, on a significant scale, to meet a diversity of demands from the same production line; and e) science-based industries, their competitive edge is a specific, advanced type of technology embedded in the product; industries of this type tend, for a reasonable period of time, to obtain monopoly revenues from the invention (Box 1).[1]

The OECD (1987) classification, initially designed to analyze countries, also presents an enormous explanatory potential for investigations into the dynamics of regional disparities regarding the level and pace of development within countries. On the one hand, the production and marketing of labor-intensive and natural resource-intensive products is very close to the factor endowments identified in less developed regions within the country.

On the other hand, the specialization of cost-intensive products tends to be more intense in regions where industrial development began more favorably, causing difficulties for another region to compete in the same production. Similarly, regional specialization in differentiated goods as well as science-based products, because of high fixed costs and R&D risks, often creates insurmountable obstacles for new entrants. For these reasons, the typology allows us to highlight, in the Brazilian case, which sectoral profile is presented by the movement of regional concentration/deconcentration of agglomeration economies in the industrial activities.

[1] On methodology, see OECD (1987) and practical applications for the European Union in Borbély (2004) and for Brazil in Nassif (2008).

Box 1 – Taxonomic Classification of Industry by Key Competitive Factor

Grouping	Key factor that affects competitiveness	Industrial Activities according to NCEA 2.0 (IBGE)
Natural resource intensive	Access to an abundance of natural resources	Extraction of: coal; oil and related services; metallic minerals; non-metallic minerals; Manufacture of: food and beverages; tobacco products; wood products; pulp, paper and paper products; coke, oil refining, making nuclear fuel and alcohol production; and non-metallic mineral products.
Labor-intensive	Labor costs	Manufacture of: textile products; articles of clothing and accessories; leather preparation and manufacture of leather goods, travel goods and footwear; metal products (except machinery and equipment); furniture and various industries; recycling.
Scale-intensive	Extended chain of production	Editing, printing and reproduction of recordings; chemical and pharmaceutical manufacturing; rubber and plastic articles; basic metallurgy; manufacture and assembly of motor vehicles, trailers and bodies.
Differentiated products	Products designed to meet highly diverse demand characteristics	Manufacture of machinery and equipment; electrical machinery, apparatus and materials.
Science-based	Immediate application of scientific research	Manufacture of: information technology equipment, electronic and optical products; other transport equipment except motor vehicles; maintenance, repair and installation of machinery and equipment.

Source: OECD, 1987; Borbély (2004) and National Classification of Economic Activities (NCEA 2.0), IBGE.

3.2 Regressive-type restructuring of industry sector: facing a new economic context

The industrial sector, which was the driving force behind the growth of the Brazilian economy between 1930 and 1980, began to reduce its participation in the total national economy. The gross value added (GVA) of the manufacturing industry, for example, represented 18.6% of the nation's total GVA in 1995. After this, according to estimates in the Annual Survey of Industries (ASI) from the Brazilian Institute of Geography and Statistics (IBGE), it experienced successive declines, finally reaching 17.2% of the national GVA in 2000, and only 11.3% in 2018.

Recent studies have indicated the emergence of a new pattern of evolution of the industrial sector associated with a decline in the relative importance of the manufacturing industry, a reduction in the average product of labor and a loss in the density of industrial branches. On a national level, this phenomenon has been associated with a loss in the relative importance of the industrial sector and a general reduction of the average product of labor within these activities (Galeano & Feijó, 2013; Cavalcante & De Negri, 2014), as well as a reduction in the importance of the industrial branches producing capital goods and which are technology intensive (Arend & Bichara, 2016; Sarti & Hiratuka, 2017).

Next, we define the structural regression and loss of competitiveness in Brazilian industry through the joint action of three factors: a) the low growth of its VIT, b) a reduction in the of average productivity per worker, and c) a loss of industrial density due to the increased importance of intensive activities in natural resources and labor. Each of these facets are discussed below.

3.2.1 The weak evolution of Brazilian industrial production

The data analyzed demonstrate that the adjustment of Brazilian industry over the last two decades has been characterized by a trajectory of low annual growth rates of the total manufacturing activity and its most relevant branches of activity. This has resulted in maintaining a framework of intersectoral heterogeneity, given the imbalance in the composition of the branches of activity and the low associated synergy, which remains a characteristic of the sector at this recent moment and is also manifested in its regional structure.

In Table 1, the trajectory of the total industry is extremely evident, highlighting its slow growth, with the associated productive groups (extraction and transformation) presenting positive, although very divergent, movements. Data for two periods are displayed: a pre-crisis period given by 1996-2015, and an included crisis period, 1996-2018. From a broad perspective the 2015-2018 economic recession has had a strong negative impact on an already weak trajectory in the industrial sector. Extraction presented a very strong expansion of its VIT at an annual rate of 14.5% between 1996-

2015 and a slower growth represented by 9.8% a year through 1996/2018. The manufacturing industry, in turn, displayed a timid expansion at a rate of just 1.6% per year that was even more reduced for the 1996-2018 period (1.1% a year). The accelerated performance of the extractive industry was unable to change the growth trajectory of the VIT of the total industry. The much less preponderant weight of the extraction branches in the total industry - albeit with very high growth rates - impacted little on the global expansion of industry.

In classifying industries by competitive factor, it may also be noted that in the groups in which the Brazilian manufacturing industry is well established, there was a poor evolution of its VIT. The most outstanding industry groups were, respectively, for 1995-2015 and 1996-2018 periods: a) the processing of natural resources (agricultural and mineral commodities and oil extraction) at rates of 4.3% and 3,5% per year; and b) knowledge-intensive industries with an annual rate of 4.8% and 5,0% per year, representing the aviation industry (Embraer) and information technology equipment. In the first case, much of the success was due to an expansion in the world demand for Brazilian commodities. In the second, these are activities that present a very small weight in the total national industry, and which could have evolved with the expansion of the domestic economy during this period.

The most established branches of activity in the Brazilian economy until that moment, however, presented less favorable results. These are industries that have either suffered from intense external competition or that used imported inputs to a high degree throughout the production chain. Both traditional and labor-intensive industries presented negative rates respectively of -1.1% and 0.0% per year between 1996-2015 and 1996-2018; and differentiated product industries also demonstrated a similar drop in the VIT (-1.1% and -2.0% per year). Scale-intensive industries remained almost stagnant with respective rates of 0.8% and 0.3% per year for the same periods.

The restructuring of Brazilian industry has combined a low growth of the most relevant branches of activity (labor, scale and differentiated-based) with a significant expansion of activities based on natural resources, mainly extraction and oil refining and metallic minerals: the share of VTI of natural resources industries has increased from 34,5% in 1996 to 49,5% in 2015 and finally to 52.0% in 2018 in total VTI. In other direction, scale industries that once were the most important in Brazilian industrial structure had diminished its share in total VTI from 35,5% to 26,2% and slightly increase to 26.8% in 2018. Industries related to differentiated products have diminished continuously from 13.4% to 7.1% and 6.0% respectively for the 1996, 2015 and 2018 years. This new pattern of sectorial specialization suggests a loss and/or weakness of intersectoral links throughout the production chains (Negreiros & Monteiro Neto, 2019; Monteiro Neto & Silva, 2018; Morceiro, 2016; Bonelli *et al*., 2013).

Table 1 – Brazil - Evolution of the Value of Industrial Transformation (VIT) and of Mean Productivity (VTI/EP), by type of Industry and Competitive Factor

Type of Industry	Annual Growth Rates (%) of the VIT		Evolution of Mean Productivity (VIT/EP) Number-index (1996=100)			Relative Composition (%) of the VIT, by type of industry and competitive factor		
	1996/2015	1996/2018	1996	2015	2018	1996	2015	2018
Total	1.8	1.6	100	98	96	100	100	100
Extractive	14.5	9.8	100	256	326	2.3	9.3	12.5
Manufacturing	1.2	1.1	100	90	86	97.7	90.7	87.5
Industry Group by Competitive Factor								
Natural resources	4.3	3.5	100	135	138	34.5	49.5	52.0
Labor Intensive	-1.2	0.0	100	83	78	14.4	11.5	10.2
Scale	0.8	0.3	100	84	84	35.5	26.2	26.8
Differentiated	-1.1	-2.0	100	67	60	13.4	7.1	6.0
Science-based	4.8	5.0	100	78	44	2.3	5.7	4.9

Source: Raw data: Value of Industrial Transformation (VIT) and employed persons (EP), Annual Survey of Industries – ASI-IBGE. Deflator used: IPA-FGV (2015=100).

3.2.2 Diminishing average labor productivity

One of the most striking features of industrial activity is the economies of scale it produces. The intense technical specialization associated with the increasing incorporation of productive capital leads to the expansion of productivity levels per employed worker, initially in the sector itself, and then afterwards, reverberating throughout the rest of the economy. Technical progress, which is a key element of industrial development, tends to provoke growing waves of productivity expansion in branches of industrial activity and other sectors of the upstream and downstream economy, as markedly pointed out by Kaldor (1966) and Rodrik (2013), for instance.

However, in Brazil, average industrial productivity, estimated by the relationship between the VIT and the number of employed persons in the industry (VTI/EP), currently presents different characteristics to the expected pattern. The average productivity of total industry decreased going from the 100 index in 1996 to 98 in 2015, and to 96 in 2018. In general terms, industry, with considerable effort, only managed to achieve roughly the same level of productivity in had reached almost 20 years ago (Table 1). It was in the manufacturing industry that the average level of productivity became most problematic. Starting from the 100 index in 1996, it settled in 2015 at 90% of the VTI/EP in 1996, and 86% in 2018 of this one.

The striking difference in the trajectories of the extractive and manufacturing industries helped to verify that the "exceptional" behavior of the extractive industry was not able to induce the expansion of productivity in the remaining manufacturing activities. These results are in convergence with analyzes on a national scale and covering previous periods by authors who observed the loss of productive density of industrial activities in Brazil (Cano, 2012; Sampaio, 2017; Sarti & Hiratuka, 2017).

In the presence of diminishing levels of productivity, the industrial sector has lost its capacity to boost the other sectors in Brazilian economy and, as result, not being capable anymore to act as an engine of growth in Kaldorian terms.

3.2.3. Increasing role for natural resource-intensive activities

The Brazilian industrial structure also presented significant changes in the composition of its activities. Activities related to natural resources expanded and, consequently, activities with a higher technical and capital density were reduced within the group of activities. Taking advantage of a favorable context for exporting agricultural and mineral commodities, the industrial agenda benefited greatly from the extractive activity, the participation of which in the industrial VIT was practically tripled during the period.

It is evident that there was a specialization in activities related to natural resources, which went from around 1/3 in 1996 in the composition of the VIT to practically 50% of all industrial activities in 2015 and continued to grow to 52% in 2018 (Table 1). This group of natural resource-intensive industries became the predominant activity on the national industrial agenda. Labor-intensive and scale-intensive activities have jointly hold 49.9% of the total in 1996, 37.7% in 2015 and ended 2018 with only 37.0% of the total. Furthermore, differentiated technology activities - representative of technologic robustness and high competitiveness - were also not spared, and their relative position was reduced by half (from 13.4% to 6.0%).

Results have shown that Brazil has seen its industry become more dependent upon and concentrated in natural resource-based activities (52.0% of the total in the last year). Overall, the total industry has seen the domestic generation of value-added, i.e., its VIT has grown at very low rates. Industry groups with higher technological intensity, such as scale-intensive and differentiated, were stagnant during this period. As a result, the average labor productivity of the manufacturing industry, in particular, was severely compromised, and only branches of industry linked to natural resource processing experienced an increase in average productivity.

4. Territorial trends of industry in Brazil

4.1 The evolution of industry on a macro-regional scale

It is relatively common in the experiences of industrialized countries to perceive that the productive structures between regions of the same country are very heterogeneous. Industry is not spread

evenly across the territory, since certain specific availability of productive factors induce regional specializations. However, the region with the most dynamic industrial branches tends to stimulate the growth of subsidiary activities in other regions. Interregional links of production chains possess a desirable power, induced by the most developed region, usually through the demand for inputs and intermediate or final components, over others.

Thus, the expansion of industrial branches with higher productivity and technological intensity in the most developed region tends to resonate productivity increases within the sectoral structures in the less developed regions. This results in productive modernization with reduced heterogeneity in all regions.

In Brazil, the interregional division of industry established until the 1980s, allocated the branches with the most capital and technology to the most industrially dynamic region. Even in the 1990s, as studies have revealed, the regional division of labor continued with a predominance of more capital and technology-intensive activities and higher productivity in the Southeast and South. Lower capital intensity and lower average productivity activities remained in the less developed regions of the North, Northeast and Midwest.

In a national context characterized by adversities for structural transformation and a moderate evolution of production per worker in industry, it is necessary to investigate how, and if, a different pattern was established for the territorial location of industrial activities during the examined period in Brazil.

From amongst the many spatial location measurements to be found in the specialist literature, the territorial coefficient of specialization (CS) is one of the best known. Its estimation aims to observe the sectoral pattern observed in the Brazilian regions throughout this regressive adjustment of industry. The CS is given by the following ratio: CE = [VITri / VITrt] / [VITbri / VITbrt], where VITri is the VIT of the group of industries i in region r; VITrt is the VIT of total industry t in region r; VITbri is the VIT of the group of industries i in Brazil br; VITbrt is the VIT of total industry t in Brazil br. When CS< 1, the region r is less specialized in the sector i than in the country as a whole; if CS = 1, the region has the same level of expertise as the country as a whole; and if CS> 1, then the region is more specialized in sector i than the country as a whole.

Table 2 presents data on the productive specialization observed, according to the availability of the competitive factor verified in the industry, in each major region of Brazil. Natural resource-intensive industries are relatively more important in the industrial structure in the relatively less developed regions of the country, the Midwest, North and Northeast, where the coefficient of specialization is higher than the whole.

In the case of labor-intensive industries, the coefficient of specialization for the VIT is more intense and higher than the whole (CS> 1), in this order, in the Southern and Northeastern regions. For these regions, the industry branches of the group are proportionally more relevant in the regional industrial structure than they are in the nation as a whole, indicating the relevance of the labor factor as the most favorable competitive resource of these regions. In the other regions, the productive coefficient of specialization was lower than the unit. The branches of industries in this group of activities mainly produce textiles, clothing, leather goods, shoes and furniture.

The group that comprises the branches of industry with the predominant competitive factor in scale is more intensely concentrated in the South-eastern region (more developed and formed by the states of São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo) with a coefficient higher than the whole. The South-eastern region is more outstanding because of its profile with the advanced technological factor, predominantly in consolidated multinational companies. The regional participation of this group of activities in the group's national total was very high, and in 2015, reached 67.5%.

The branches of differentiated technology (non-standard) - related to machinery and equipment; electrical machinery, apparatus and materials; electronic material, communication devices and equipment; medical and hospital instrumentation equipment; and optical instruments, chronometers and clocks - are more relevant in the South and Southeast than in the other vis-à-vis the national standard of the group.

Finally, knowledge-based industries are more relevant to the North (IT equipment) and the South-east (aeronautics, optical and IT), where the coefficients of specialization are higher. However, it should be noted that the high value of the coefficient for the Northern region is explained by the importance of 21.8% of the group's national production in 1996 and 20.6% in 2015, attracted

by the financial and fiscal incentives offered by the Manaus Free Zone (according to data obtained from SIA-IBGE). In the Southeast, in turn, there was a 60.8% share of the VIT of the group from this industry in 2015, and in the South, during the same year, these activities accounted for 12.0% of the national total of the sector.

Table 2 – Brazil, Regions and States: Coefficient of Specialization of the VIT, Region vs Country Ratio of the Average Productivity (VTI/EP) and Regional Participation (%) of the VIT, by Industry Group according to the Competitive Factor

Industry Group by Competitive Factor	Coefficient of Specialization of the VIT		Region vs Country Ratio of Average Productivity		Participation (%) of the Region in the National Total of the VIT of the Industry Group	
	1996	2015	1996	2015	1996	2015
Based on Natural Resources						
North	1.08	0.83	1.20	0.82	4.9	3.5
Northeast	1.36	1.14	0.62	0.73	10.4	12.1
Southeast	0.87	0.96	1.23	1.28	59.6	57.0
South	1.17	0.93	0.82	0.76	20.2	18.9
Mid-West	2.17	1.51	0.83	0.87	4.9	8.5
Labor Intensive						
North	0.45	0.84	3.11	2.62	2.0	3.5
Northeast	1.08	1.26	0.86	0.84	8.3	13.4
Southeast	0.88	0.80	1.03	1.00	60.0	47.0
South	1.65	1.58	0.97	1.01	28.5	32.4
Mid-West	0.52	0.67	0.54	0.98	1.2	3.8
Scale Intensive						
North	0.36	0.61	1.07	1.32	1.7	2.6
Northeast	0.92	0.91	1.13	1.11	7.0	9.7
Southeast	1.18	1.14	1.05	1.03	80.7	67.5
South	0.56	0.84	0.72	0.85	9.7	17.1
Mid-West	0.45	0.55	0.56	0.81	1.0	3.1
Differentiated						
North	2.47	0.57	2.39	0.93	11.0	2.4
Northeast	0.33	0.48	0.71	0.88	2.6	4.3
Southeast	0.98	1.07	0.94	1.05	66.9	60.9
South	1.12	1.34	0.93	0.93	19.4	30.5
Mid-West	0.08	0.37	0.49	0.95	0.2	1.9
Science-Based						
North	5.75	6.99	2.13	1.57	22.0	21.3
Northeast	0.23	0.31	0.43	0.77	1.8	4.8
Southeast	0.99	0.95	0.89	0.96	66.7	60.8
South	0.24	0.54	0.62	0.61	9.0	12.1
Mid-West	0.32	0.04	0.50	0.54	0.5	1.0

Source: Raw data: IBGE. Annual Survey of Industries (ASI), 1996-2015. Produced by the authors.

Analyzing the productivity levels of the industry groups reveals relevant aspects prevalent in the regional specializations (Table 2). The most specialized regions (C> 1) in natural resource-intensive industries – in the North, Northeast and Midwest – presented a productivity level of the industry group below the national average of the same group. In the Northeast, the productivity of this group was lower than amongst all the Brazilian regions: 62% of the national level in 1996 and 73% in 2015. Productivity in the Northern region demonstrated a decreasing pattern during the period, although its average level was relatively high, and above the national level until, at least, 2015.

Similarly, in the labor-intensive group, average productivity in the Southeastern region was higher than the national average, and higher than all other regions (except the North). In the Northeast, there was a high standard of specialization in labor-intensive activities and the productivity of these activities, although on the increase during the period, was lower than the pattern of the national average (in 2015 it corresponded to 84% of the national average). In the North, the average productivity was much higher - more than twice - than the national average and contrasted with that observed in the other regions. The result is the specializations of the Manaus Free Zone, in the state of

Amazonas, in the manufacture of metal products and various products competed towards these results.[2]

The situation of the scale-intensive activities was the opposite of what would normally be expected. In the North and Northeast, where specializations in activities were below the national average, but grew during the period, the average productivity of the sector was placed above the national pattern and even above that observed in the Southeast. This behavior indicated that the productive efforts towards modernization induced by federal and state policies, in fact, was a stimulation for more efficient and productive industrial plants to be located there.

The Midwest region has had little tradition in branches of scale-intensive industry and, in national terms, it is also its lowest average productivity. However, there was an effort to expand these types of activity (and the CS grew during the period) and, at the same time, the installed branches significantly increased their productivity: they corresponded to 56% of the national level in 1996, and were already at 81% in 2015.

The South also increased its expertise in the activities of this industry group, although it remained below the national standard. The corresponding average productivity of the branches of this industry remained below the national average and below the levels observed in the North, Northeast and Southeast. For this region, the observed sectoral pattern did not exactly correspond to what was expected. In fact, it could be considered that the industrial densification verified therein would favor the branches of activity with higher technical levels and higher productivity, but this did not occur.

In industry groups with differentiated and science-based technologies, the most outstanding regions, with higher specializations, were the Southeast and, exceptionally, the North, with its production concentrated in the Manaus Free Zone, privileged by tax incentives. The associated productivity levels were also higher in these regions than in others.

In conclusion, it may be stated that the most industrially developed region (the Southeast) retained within its territories the branches of activity with the highest levels of technology and average productivity (scale intensive, differentiated and science based). Less developed regions, such as the North, Northeast and Midwest, in turn, advanced towards more substantive positions in the natural resources and labor-based industries, and were successful in expanding certain positions in scale-intensive activities.

4.2 The decreasing value of industrial density

Considering the index of industrial density as the ratio between the Value of Industrial Transformation (VIT) and the Gross Value Added (GVA), that is the same as the actual proportion of the production in the interior of the company compared to the total production including input and/or equipment imports. The less the VIT is, less is produced by the industry and so is the industrial density index.

In Table 3 we present the results for Brazilian regions and for the whole economy. The industrial density has been strongly diminishing through the years with more intensity in those industries associated to more complex technologies (scale intensive, differentiated products and knowledge based). The density index is roughly a half or generally less than that for each region and each kind of industry. Scale intensive industries used to have the greater proportion in total industry and now suffered from a substantial reduction in their density index from 0,48 in 1996 to 0,36 in 2015. In the opposite direction industries associated to natural resources and labor have increasing or sustaining their density. They are becoming more representative in industrial branches and have been stimulated by the growing global demand for agricultural and mineral commodities in the 2000's. Even in Southeast and South regions, the more industrialized ones, this process of loosening industrial density is well stablished. In fact, we could say that a deindustrialization process in strongly in action in the actual Brazilian economy as whole as well as for their regional economies.

[2] In 2015, the 2.9% share of the national VIT of the labor-intensive industry group was located in the state of Amazonas. This percentage, in turn, corresponds to 82.8% of the regional total of the group (data from ASI-IBGE).

Table 3 – Productive Density* in the Industry Sector for Regions and Total, by Competitive Factor in Selected Years

Region	Natural Resource Based			Labour Intensive			Scale Intensive			Differentiated Products			Knowledge Based		
	1996	2005	2015	1996	2005	2015	1996	2005	2015	1996	2005	2015	1996	2005	2015
	Percentage (%)														
North	0,65	0,60	0,47	0,63	0,53	0,50	0,44	0,41	0,36	0,45	0,46	0,29	0,35	0,27	0,30
Northeast	0,47	0,54	0,51	0,47	0,41	0,49	0,44	0,32	0,32	0,55	0,46	0,34	0,42	0,41	0,39
SouthEast	0,47	0,54	0,52	0,48	0,43	0,48	0,48	0,40	0,37	0,54	0,42	0,44	0,53	0,35	0,32
South	0,38	0,38	0,41	0,48	0,42	0,48	0,46	0,33	0,36	0,50	0,40	0,41	0,58	0,46	0,42
Mid-West	0,37	0,36	0,36	0,37	0,38	0,42	0,54	0,38	0,29	0,65	0,35	0,40	0,48	0,52	0,62
Brazil	0,45	0,49	0,47	0,48	0,43	0,48	0,48	0,38	0,36	0,53	0,42	0,42	0,46	0,33	0,32
	As a proportion (%) of the Total														
North	144,7	121,6	99,8	131,6	123,9	104,5	92,0	107,4	100,4	84,8	108,7	69,3	77,1	82,7	92,0
Northeast	104,0	108,5	108,6	98,1	96,0	103,1	91,9	84,7	88,0	104,6	109,5	82,0	92,0	124,8	120,4
SouthEast	103,8	109,5	109,3	99,7	100,8	99,2	101,3	105,4	103,3	102,2	101,0	104,5	117,0	106,9	98,8
South	84,2	77,9	86,2	99,9	99,5	101,1	96,8	85,4	99,5	94,7	95,5	98,4	126,6	139,6	129,9
Mid-West	81,5	72,6	76,6	77,5	88,4	87,6	113,7	100,8	80,4	123,2	84,0	94,4	105,6	156,8	192,3
Brazil	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source: Raw data: National Institute of Statistics (IBGE). Annual Survey of Industries (ASI), 1996-2015. Produced by the authors.

Note: * Productive Density is the Ratio between Value of Industrial Transformation (VIT) and Gross Value Added (GVA) for Regions and Total, by Competitive Factor

** Competitive fator classification according to OECD (1987).

4.3 - Industry in the microregional context: relevant industrial agglomerations (RIAs)

Undoubtedly, the debate on productive deconcentration gains new contours when addressed through the cross-sectional or territorial scale of geographical microregions. In the 1990s, Diniz (1993) and Diniz & Crocco (1996) were the first to introduce the concept of relevant industrial agglomeration (RIA) into the regional discussion in Brazil, and which corresponded to a geographical micro-region with 10,000 or more industrial jobs each year. They presented evidence regarding the strength of the agglomeration economies produced by industry throughout Brazil. They observed, on the basis of evidence from the years 1970, 1980 and 1991, that a process, which they called "concentrated deconcentration", was under way in Brazil, and was restricted to a so-called industrial territorial polygon, roughly comprising the industrial microregions of the South and South-eastern regions of Brazil.

This line of research was subsequently developed further in studies that continued to conclude, using the microregion cross-section, with the territorial deconcentration of industry (Saboia, 2001 and 2013). The following analysis presents an update to this debate through micro-regional data on the gross value added (GVA) and formal employment in the Ministry of the Economy's Annual Report on Socio-Economic Information (RAIS) for the period 1995-2015 and indicates some of the most relevant regional dynamics of the RIAs. In particular, this paper has advanced into a cross-section of the relevant agglomerations by population size so as to better understand the relevance of regional agglomeration scales and their role in attracting industry.

Initially, the RIAs will be highlighted in general terms, regarding the quantity and number of industrial jobs. Starting from a total of 85 in 1995, the RIAs successively expanded to reach a total of 126 in 2005 and finally 160 units by 2015. There were 75 new industrial agglomerations in Brazil, a figure that almost doubled the original situation in 1995. Thus, it appears that even amidst a low growth trajectory of industrial activity (section 2), the national territory for industrial agglomerations continued to expand over the period. While in 1995 the RIAs comprised 3,8 million industrial jobs, twenty years after 160 units totaled 6,3 million. By far employment in manufacturing branches have been more relevant than in the extractive industries: in 1995 manufacturing employment covered 3,8 million (98,7% of all jobs in RIAs) and in 2015 achieved 6,1 million (97,4% of that jobs).

The regional distribution of RIAs reveals significant aspects of the territorial dynamics of industrial agglomerations in the chosen years 2000 and 2015 (Table 4). First, it may be observed, confirming the pattern recognized by Diniz (1993), that the highest number of RIAs is in the Southeast. Its participation in the national total of RIAs was 48.5% in 2000, which reduced to 45% in 2015, although the absolute number still increased during the period: going from 48 to 72 out of 160 in Brazil as a whole. Furthermore, together with the South-eastern region, the South was also the best

location for industrial activity. In the latter, the number of RIAs grew from 28 to 45 between 2000 and 2015, i.e., from 28.3% to 28.1% of the national total each year.

One can note that 61 new RIAs appeared from 2000 to 2015 in the economy. Although the South and Southeast regions were responsible for 67,2% of that increase it is worth to mention that almost one third (32,7%) of those newest were in peripheral regions (North, Northeast and Mid-west), indicating that some beneficial deconcentration has actually occurred for industrial activities.

Using slightly different data for employment Diniz & Mendes (2021) have shown results that come into the same direction we have obtained: they suggested that industrial agglomerations prefer to remain in South and Southeast regions, but some new ones had appeared in areas directly connected to the production of commodities in the Mid-West.

It has been clear that new industrial agglomerations are growing in more intensity towards mineral and natural resources frontiers and into activities that are natural resources or labor intensive. Otherwise, consolidated agglomerations in urban centers and traditional industrial areas in Southeast region are diminishing total employment, production, and productivity.

Table 4 – Brazil and Regions Quantity, Population and Average Productivity of the Relevant Industrial Agglomerations (RIAs)*, by region in 2000 and 2015

Macro-regions	Number of RIAs Units		Total Population of the RIAs (In MM/inhab.)		Average Labor Productivity (ALP)** In R$ Thousand in 2015		ALP as a proportion (%) of the National Average	
	2000	2015	2000	2015	2000	2015	2000	2015
Absolute Values								
North	3	3	3.6	4.9	281.3	282.4	155.0	188.9
Northeast	15	27	16.3	26.9	158.0	149.3	87.1	99.9
Southeast	48	72	53.9	70.5	206.4	160.9	113.7	107.6
South	28	45	15.4	22.7	125.2	111.4	69.0	74.5
Mid-West	5	13	5.0	10.3	180.2	174.9	99.3	117.0
Total	99	160	94.7	135.3	181.4	149.5	100.0	100.0
Percentage (%)								
North	3.0	1.8	3.8	3.6	155.0	188.8	--	--
Northeast	15.1	16.8	17.2	19.9	87.1	99.8	--	--
Southeast	48.5	45.0	56.9	52.1	113.8	107.6	--	--
South	28.3	28.1	16.3	16.8	69.0	74.5	--	--
Mid-West	5.0	8.1	5.3	7.6	99.3	116.9	--	--
Total	100	100	100	100	100	100	--	--

Source: Raw data: 1) for the population – Population Estimations from IBGE; 2) for the gross value added (GVA) of industry, estimations from the ASI, IBGE; and 3) for industrial jobs: Annual Report on Socioeconomic Information-RAIS, Ministry of the Economy. Produced by the authors.

Note: * RIAs are geographic microregions of the IBGE with more than 10 thousand industrial jobs.

** ALP is the average labor productivity provided by the relation between GVA/Formal Employment in Industry each year.

k = thousand, mm = million, inhab. = inhabitants.

With respect to average productivity, measured by the ratio between the gross value added and formal industrial employment, it has been noted that except by North region all the remaining ones have decreased their productivity value from 2000 up to 2015. For the whole Brazilian RIAs, the value achieved in 2015 had totaled just 82,4% of that from 15 years before. The most important territories to the industry have shown a steady pattern of undermining production per person. This kind of trajectory prevailed throughout the whole country, but it was of particular relevance in the South and South-east.

In the other three major regions, this picture was less clear. In the North, mainly because of Special Industrial Zone of Manaus in the state of Amazonas, the average productivity has increased. For Northeast region, even considering a reduction in productivity its level has converged to the national average over the years. In the Mid-west region, in which the industry is based in processing

commodities (grain and cattle) there was an upsurge in productivity levels stimulated by favorable international prices and surpassing national levels.

Among the commonly shared arguments to explain these patterns in locational choices, Brandão (2019) has pointed out the existence of huge deficits in infrastructure, human capital and financial funding which do not encourage companies and businesses with higher levels of productivity to relocate into less developed regions.

The message that may be obtained is that sectoral heterogeneity in Brazil was very high - with industries with high productivity differentials settling in different places - which resulted in equally heterogeneous territories of industrial agglomeration. This heterogeneous pattern has been unfortunately accompanied by a widespread and regressive deindustrialization process.

5. CONCLUSIONS

Recent transformations of industrial sector in Brazilian economy have showed problematic patterns associated not only to its diminishing share in product value and employment but also to the regressive adjustment into an economy with the prevalence of natural resources sectors. As a result, regional deconcentration patterns of industrial activities have been defined and limited by intrasectoral changes.

The evolution of the industrial structure in Brazil over a recent period, 1996-2018, presented characteristics of some concern. We claim the existence of a regressive pattern of change based on main four self-reinforcing and combined characteristics: a) a prevalence of low growth rates of the VIT of total industry and of manufacturing; b) a reduction in real average productivity in industrial activities, with the exception of the natural resource-based group; c) an impressive increase in the relative share of natural resource-intensive activities in the industry's total VIT from 34.5% to 52.0% of the total between 1996 and 2018; and d) a pattern of decreasing productive density has also been observed in industrial activities, namely, the share of internal (to the firm or industry) transformation of value has been diminishing in relation to the share of total (including imports) value for each of the 5 macro-regions studied.

Associated with this adjustment, regional productive specializations of some concern have strongly crystallized in industry over the past two decades. The most technical and capital-intensive activities - scale-intensive, differentiated and science-based – have remained concentrated in the more industrialized regions of the Southeast and South of the country, although mainly in the former. The least developed regions (North, Northeast and Mid-West) have remained specialized in labor-intensive and natural resource-intensive activities.

A specific investigation of geographic microregions called “relevant industrial agglomerations” (RIAs), in turn, have concluded that their preferences in terms of location are still very strong and well established in the Southeast and South regions of Brazil: 73,1% of them in 2015. Despite this level of territorial concentration, figures have shown that a deconcentration path for those RIAs has been underway.

The overall conclusion is that the regional concentration levels of industrial activity have diminished at low rates. Consolidated industries in the most industrialized regions continue to retain industrial activities with higher productivity. The activities that moved to the less industrialized regions were those linked to the factor endowment differentials they presented (natural resources and labor). These results suggest that agglomeration economies have continued to be a force for the localization of industry in Brazil and further research is required on the difficulties faced by industrial and regional policies that do not change or mitigate their effects. In addition, slow growth rates presented in industrial activities for the last two decades clearly indicate that regional policies need to be urgently revised in order to contribute to a new, and not stagnant, regional growth pattern.

Further efforts of research can be pointed out from our discussion. It has been known that federal and state governments, over the 2000-2015 years, had spent significant amount of money in infrastructure (transportation, water supply, housing for the poor, etc) as well federal public banks were used to lend to the industrial sector, so we could say that it is open to discussion the reasons why these investments did not result in strengthening the industry in a way to deter its decreasing share in Brazilian economy.

Additionally, because the global economy demand for Brazilian products has been mainly directed for natural resources, some regions have been positively impacted by exports, especially Mid-West and South regions, but remains unclear why exports activities have been unable – in some cases, poorly capable - to boost industrial activities in those regions.

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