THE BRAZILIAN DEINDUSTRIALIZATION THESIS REVISITED: A SUBSYSTEM APPROACH, 2000-2015

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ABSTRACT: This article investigates the structural transformation of sectors and subsystems in Brazil during the 2000–2015 period, applying Momigliano and Siniscalco's approach. We employed the official Brazilian input-output tables from 2000, 2005, 2010, and 2015 to evaluate employment, value-added, and profits of six economic activities. Looking at sectors and subsystems, we can better understand the structural change and its connection with domestic outsourcing, particularly in manufacturing. Our findings underscored a weaker process of manufacturing decline when we take the subsystem approach. The rising integration of market services into the manufacturing sector explains, at least partially, the smaller manufacturing decline in terms of value-added and profit participation in the overall economy.

KEYWORDS: Employment; value-added; subsystems; structural change.

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A TESE DA DESINDUSTRIALIZAÇÃO BRASILEIRA REVISITADA: UMA ABORDABEM DE SUBSISTEMAS, 2000-2015

RESUMO: Este artigo investiga a transformação estrutural em setores e subsistemas no Brasil durante o período de 2000 a 2015, aplicando a abordagem de Momigliano e Siniscalco. Foram empregadas as tabelas brasileiras oficiais de insumo-produto de 2000, 2005, 2010 e 2015 para averiguar o emprego, valor adicionado e lucros de seis atividades econômicas. Analisando os setores e os subsistemas, pode-se melhor compreender as mudanças estruturais e sua conexão com a terceirização, particularmente na manufatura. As estimações alcançadas enfatizaram um processo mais fraco de declínio da manufatura quando utilizamos a abordagem do subsistema. A crescente integração dos serviços de mercado na manufatura explica, pelo menos parcialmente, o menor declínio manufatureiro em termos de participação de valor adicionado e lucro na economia.

PALAVRAS-CHAVE: Emprego; valor agregado; subsistemas; mudança estrutural.

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INTRODUCTION

The deindustrialization thesis remains a "hot topic" in Brazil. More ink has likely been spilled on this issue than on any other topic in Brazil since many economists claim that manufacturing is crucial to foster economic development. During the 2000s, this debate returned presenting two opposing sides. Neoclassical economists argue that manufacturing is not a strategic sector to boost economic growth, whereas structuralists and post-Keynesians state that it is pivotal for economic development.

This debate suffers from at least one shortcoming: both Neoclassicals and structuralists/post-Keynesians look exclusively at the sectoral level of analysis, disregarding the contributions of Sraffa (1960), Pasinetti (1973), and Momigliano and Siniscalco (1982). For the latter, activities are understood as producing commodities and relatively independent of other columns in the input-output model. Looking only at the sectoral level might render an incomplete picture of the economy since economies function throughout sectors and subsystems. A vast body of research deals with subsystems' analysis – e.g., McFetridge and Smith (1988), Scazzieri (1990), Milberg (1991), Montresor and Marzetti (2010), and Ciriaci and Palma (2016) – highlighting the importance of this method. In this context, an approach that also focuses on the subsystems is required.

In this article, we trace the activities' performances using the sectoral and subsystem approaches, combining two complementary levels of analysis. Our objective is to investigate the deindustrialization hypothesis in Brazil, from 2000 to 2015. Following Momigliano and Siniscalco (1982) and Montresor and Marzetti (2010), we gauge the sectoral and subsystem employment levels, the value-added, and the profits for six activities: primary, manufacturing, public utilities, construction, market services, and non-market services. Detecting the performance of six activities in these two levels of analysis is crucial to our study since the tertiarization of manufacturing industries and the statistical illusion (CHANG, 2012) may distort sectoral indicators. It is necessary to use robust indicators to deal with the tertiarization and reclassification of manufacturing activities.

This central issue is overlooked in Brazil, mainly when domestic outsourcing is analyzed over time. Domestic outsourcing captures the migration of activities from manufacturing to services at the national level. At least part of the manufacturing decline might be related to activities within the sector migrating to services. For example, a firm might decide to close an accounting or lawyer division and hire this from activities located in the services. Some studies, such as those by Hoekman and Braga (1997), Franke and Kalmbach (2005), Lesher and Nordås (2006), deal with the issue of tertiarization. The present article examines sectoral and subsystem changes in Brazil between 2000 and 2015 and its subperiods (2000-2005, 2005-2010, and 2010-2015). A central thesis of our paper is that the integration process between manufacturing and

services observed at the subsystem level of analysis was insufficient to avoid Brazilian deindustrialization. We address two main questions in this paper: what the actual extent of deindustrialization in Brazil was, if it happened at all, between 2000 and 2015; and which were the sectors and subsystems that presented rising employment, value-added, and profits in the 2000-2015 period.

We employed the official input-output tables (Henceforth, I-O tables for brevity) for 2000, 2005, 2010, and 2015, to evaluate the performance of the six activities mentioned above. To the best of our knowledge, no study explores employment, value-added, and profits in Brazil at the sectors and subsystems levels of analysis.

Giovanini's (2021) study is perhaps the only one that deals with Momigliano and Siniscalco's (1982) approach within the Brazilian work-hours subsystems[1]. Our study is innovative in that it compares the results generated by the sectoral and subsystem approaches using a different level of disaggregation for productive activities. It also discriminates activities for a more detailed time frame, obtaining value-added and profits indicators, in addition to employment indicators.

The rest of the article is organized into four additional sections. Section 1 explores the role of manufacturing in economic development and reviews the deindustrialization literature applied to Brazil. Section 2 outlines the method and data. This section introduces the subsystem approach. Section 3 presents the results. Section 4 concludes.

1. THE MANUFACTURING ROLE AND THE DEINDUSTRIALIZATION THESIS

1.1. THE ROLE OF MANUFACTURING IN THE ECONOMY

The pre-classical 18th-century Italian and German economic traditions emphasized manufacturing as crucial for economic development (REINERT, 2005). Subsequently, Kaldor and structuralists formulated theories in which manufacturing functioned as a growth engine of nations (OCAMPO; RADA; TAYLOR, 2009; RONCOLATO; KUCERA, 2013). Conversely, neoclassical economics disregards the centrality of manufacturing in the development process (KON, 2013; SHAIKH; TONAK, 1994).

Kaldor (1966) seeks answers to the different countries' economic growth rates and investigates why some countries have higher per capita income growth than others.

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[1] Costa Júnior and Teixeira (2010) studied structural change and productivity between 1990 and 2003, using the notion of vertically integrated sectors, developed by Pasinetti (1973). Fevereiro (2015) studied structural change and productivity in vertically integrated sectors in Brazil from 2000 to 2008.

For him, the higher the manufacturing growth, the faster the income grows. A key feature is the potential to disseminate technical progress with the rest of the economy. Kaldor introduced three "laws" showing the fundamental role of manufacturing and explained the differences observed in the countries' economic growth rates. These laws assume that changes to the manufacturing production process are cumulatively propagated and that it influences the countries' labor productivity. That is, the gross domestic product (GDP) growth accelerates with the increase in manufacturing participation.

In his first law, Kaldor (1966) shows that the manufacturing growth rate is higher than the rise that occurs in participation with the aggregate economy, so its growth must accelerate as its participation increases. An explanation for the higher growth of industrialized countries is found in the productivity dynamics of the manufacturing sector and not in the difference in labor productivity between sectors. Due to the economies of scale and the increasing returns in the industry, the output growth in this sector triggers its productivity (KALDOR, 1966, p. 12).

Kaldor's second law, also known as the "Kaldor-Verdoorn law," states that manufacturing value-added growth increases labor productivity. Kaldor (1966) shows that manufacturing productivity rises in response to surges in production that ultimately induce technical progress.

Kaldor's third law establishes a positive relationship between the productivity growth rate, the manufacturing growth rate, and the manufacturing employment growth. This argument is linked to structural change; it is clear to Kaldor (1966) that manufacturing has higher productivity than other sectors. Thus, its expansion requires workers from other sectors who are in a situation of hidden unemployment, which would raise the economy's overall productivity.

Later, Thirlwall (2011) proposed a fourth Kaldor law. This shows a relationship between manufacturing income-elasticity and the balance of payments restrictions on income growth. Countries with mature industries are less externally restricted, allowing them to achieve higher economic growth.

These four laws help to explain the positive relationship between the growth of manufacturing productivity and the size of this sector. Increasing productivity is seen as an emerging result of the dynamic relationship between the changes in productivity and manufacturing production. As this sector grows, the stagnant service productivity and its inability to generate additional demand hinder the process of self-reinforcing economic growth. Therefore, only manufacturing expansion boosts a cumulative causation process favorable to growth.

After Kaldor's analysis, evidence emerged reporting that the manufacturing share of value-added decreases as a country develops (FUCHS, 1968). The term "deindustrialization" is usually used to indicate the decline in the participation of

manufacturing in total employment as countries develop (ROWTHORN; RAMASWAMY, 1998). Tregenna (2009) extends this concept to include the drop in the manufacturing's participation in the value-added of the economy.

According to Rowthorn and Ramaswamy (1998), internal and external factors can cause deindustrialization. The internal factors can be broken down into i) faster growth in manufacturing productivity than in the service sector productivity; and ii) a change in the relationship between the income elasticity of demand for manufacturing products and services. For Rowthorn and Ramaswamy (1997), deindustrialization is harmful, being a consequence of economic development and an increase in the population's standard of living (ROWTHORN; RAMASWAMY, 1997).

Moreover, Clark (1957) argues that the demand for manufacturing products declines as per capita income increases. The rising demand for service goods – encapsulating Engel's law – increases the participation of service activities in employment and value-added. This explains the decline of the industry's participation in the GDP among countries with high per capita income levels.

Wood (1994) sees an explanation for developed countries' deindustrialization in international trade. Since intermediate manufacturing imports are highly labor-intensive, a proportional increase in North-South trade diminishes manufacturing employment in the North. The decline of low-skilled employment, lost with the rise in imports, results in lower manufacturing participation in total employment.

To this factor, we can add specialization in services. Given the increase in international trade, some countries have specialized in manufacturing products (mainly China and Germany), while others have specialized in services (for example, the United States and the United Kingdom). As a result, we observe an increase in manufacturing employment in the first group and a fall in the second group (OREIRO; FEIJÓ, 2010).

This debate is summarized by Palma (2005), who identifies four sources of deindustrialization: i) the "inverted U" relationship between manufacturing employment and per capita income; ii) the declining relationship between per capita income and manufacturing employment over time; iii) a fall in the level of per capita income associated with the turning point of the "inverted U" curve between manufacturing employment and per capita income; and iv) the Dutch disease[2].

Furthermore, with globalization and the emergence of new communication technologies, from the 1970s onwards, communication, banking, insurance, and business services became tradable and began to be "digitally transported" (BAUMOL, 1985). Greater communication

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[2] The abundance of natural resources and the ease to export it results in exchange rate overvaluation, which leads to deindustrialization provoked by the Dutch disease.

encouraged outsourcing and offshore service activities, which resulted in a reorganization of production chains and more significant trade in services (FRANKE; KALMBACH, 2005; HOEKMAN; BRAGA, 1997; LESHER; NORDÅS, 2006).

As a result, Giovanini (2021) and Bernard, Smeets, and Warzynski (2017) argue that deindustrialization derives from the advance of knowledge-intensive technologies based on services. The advancement of these technologies demands new services, which explains the differences in countries' growth. The technological path plays a role in describing the deindustrialization process in different economies.

1.2. THE DEINDUSTRIALIZATION DEBATE IN BRAZIL

Although Brazil presented lower manufacturing participation both in value-added and employment from the 1980s onwards, a consensus on the causes and implications of this phenomenon is lacking. As highlighted by Hiratuka and Sarti (2017), there are three main groups of studies. The first group minimizes the decline in the manufacturing share in employment and value-added (BACHA, 2013; BONELLI; PESSÔA, 2010; BONELLI; PESSOA; MATOS, 2013; PASTORE; GAZZANO; PINOTTI, 2013).

Bonelli, Pessoa, and Matos (2013) argue that during the 1970s and 1980s, Brazil experienced the "Soviet disease" phenomenon, identified by the industry's participation in the value-added at a level higher than the international standard. The fall in this participation, after the 1980s, resulted from a process of convergence towards normal participation, arguably caused by low national savings. Bacha (2013), analyzing the period 2005-2011, argues that the manufacturing share decline in the GDP is explained by the rise in commodity prices and the inflow of foreign capital. This situation allowed for an increase in domestic demand in favor of non-tradable goods, to the detriment of the industry. Pastore, Gazzano, and Pinotti (2013) also associate deindustrialization with the growth of real wages above productivity, the contagion of the international crisis, and the government's strategy of maintaining demand to avoid the effects of the international crisis.

The second group of scholars follows a Kaldorian approach and argues that deindustrialization derives from macroeconomic policy errors. For these authors, the premature opening of the economy (CARNEIRO, 2002; FEIJÓ; CARVALHO, ALMEIDA, 2005; RODRIK, 2016) and the presence of Ricardian incomes (BRESSER-PEREIRA, 2012; CANO, 2012; OREIRO; FEIJÓ, 2010; MARCONI; ROCHA, 2012; MARCONI; ROCHA; MAGACHO, 2016) due to the abundance of natural resources, results in exchange rate overvaluation, which is referred as the Dutch disease. Given the centrality of manufacturing in terms of productive linkages, they suggest counteracting policies to fight the exchange rate appreciation tendency to protect manufacturing activities. This argument is refuted by Lazzarini, Jank, and Inoue (2013),

Rocha (2015), and Fishlow (2013). Factors such as a complex tax structure, weak institutions, regulatory problems, weak infrastructure, and low innovation investments explain Brazil's deindustrialization.

The third group adds structuralist and neo-Schumpeterian elements to the analysis (FORNARI; GOMES; HIRATUKA, 2017; MEDEIROS; FREITAS; PASSONI, 2019; MORCEIRO, 2012; NASSIF, 2008). They show that scale-intensive and science-based manufacturing sectors maintain their share of the GDP. The increase in shares of natural resource-intensive sectors occurs at the expense of labor-intensive sectors (NASSIF, 2008). The high and medium-high technological sectors observed an increase in the imported coefficient of tradable goods, being the ones most affected by this process (MORCEIRO, 2012). That is, internal features of industry explain the deindustrialization process. Medeiros, Freitas, and Passoni (2019) show that the manufacturing decline between 2000 and 2014 is connected to the increase in international competition after 2008, and they found stable manufacturing structural linkages during that period. Similarly, Fornari, Gomes, and Hiratuka (2017) also found a relatively stable manufacturing density in Brazil.

2. METHODOLOGY AND DATA

In this section, we introduce the methodology and the dataset. Initially, we describe Momigliano and Siniscalco (1982)'s method to study subsystems and evaluate the structural transformation in Brazil. Then we describe the dataset.

2.1. METHOD

Although some studies have shown a manufacturing decline followed by the rising of the service sector's participation in employment, this evidence is from a sectoral viewpoint. Montressor and Marzetti (2011) emphasized that the sectoral approach has two limitations that might reduce the validity of the evidence obtained. First, it considers that sectors are vertically integrated production models in which the intermediate inputs of a sector are not considered means of production but instead are defined as products external to the sector. Its use in evaluating structural change implies that since each sector does not use inputs produced by other sectors, there is no sectoral interdependence, with all sectoral production being used to meet the final demand of the sector itself. Second, depending on the level of disaggregation of I-O tables, the sectoral approach might be sensitive to changes in the way that firms organize their production processes. Therefore, the change in the internal organization of production processes (e.g., outsourcing

activities) may be misinterpreted as a structural change. To circumvent this problem, both sectoral and subsystem approaches should be applied in a complementary manner.

One implication derived from advancing new communication technologies is the outsourcing of manufacturing activities to service firms. Thus, the sectoral approach may imply a bias in assessing the structural change processes. The increase in service participation can be interpreted as structural change, despite only adjusting the internal organization of productive activities (CHANG, 2012; MONTRESOR; MARZETTI, 2010). Studies that evaluate structural change processes must use robust methods to reorganize productive activities (SARRA; BERARDINO; QUAGLIONE, 2019). These methods should differentiate the structural change caused by the reorganization of activities from the actual structural change resulting from changes in the final demand. Applying the subsystem approach proposed by Momigliano and Siniscalco (1982) makes this differentiation possible.

The subsystem concept was developed by Sraffa (1960) and Pasinetti (1973). They identified an aggregation that analytically represents all activities (direct and indirect) involved in satisfying the final demand, with the stock of fixed capital as a given. Momigliano and Siniscalco (1982) use this concept to develop a methodology that reclassifies variables from a sectoral to a subsystem basis. More recent studies have applied this method, such as the ones by De Juan and Febrero (2000), Montresor and Marzetti (2010, 2011), and Giovanini (2021), among others. This method measures the amount of employment within the service sector that is used as an intermediate demand, identifying the actual destination of the employment. It avoids analyzing the structural change process based on the hypothesis that all products are intended to meet the final demand of the sector in which they are manufactured. The advantage of this method is that the estimations of deindustrialization are unaffected by outsourcing productive activities and by changes in the internal organization of the economic system. Referring to two theories (changes in consumption patterns and the structure of labor markets) that aim to explain deindustrialization exclusively at the sectoral level, Momigliano and Siniscalco (1982, p. 275) wrote:

> In both cases, therefore, the process of change is attributed to something different … to the modifications taking place in the structure of the productive system, that is, extraneous to the modification of the relations of interdependence and integration between phases of activity which, though classified as industry or services, jointly contribute to the production of specific commodities called for by final demand. If a modification of this type exists, investigations which ignore its effects are incomplete because they neglect an important determinant of the phenomena being investigated.

In formal terms, it transforms the representation of input-output tables. Each sector is linked by purchase and sale relationships into vertically integrated subsystems that use labor as an external input to satisfy the final demand. This method can be formally defined as follows:

$$B = (\hat{x})^{-1}(I - A)^{-1}\hat{f} \tag{1}$$

In (1), $(I - A)^{-1}$ is the well-known Leontief inverse matrix, x is the vector of total domestic gross production at current prices, f is the final demand column vector, and "^" shows that vectors x and f were diagonalized. The sum of each row of B equals 1, where each cell in a row denotes the sector's fraction, which belongs to the various subsystems. Each column of matrix B "indicates in its elements the proportion of the activities of the various branches which come under a subsystem" (MOMIGLIANO; SINISCALCO, 1982, p. 281). The B operator reclassifies any variable, such as employment, value-added, and profits, from a sector (rows) to a subsystem base (columns) as follows:

$$\beta = \hat{h}B \tag{2}$$

In (2), $\hat{h}$ is the diagonalized vector of employment. Matrices B and β are not influenced by price levels, and the evolution of these matrices over time identifies the sources of structural change in each subsystem (RAMPA, 1982). For further details and mathematical proof, see Montresor and Marzetti (2010, 2011).

The subsystem approach can gauge the extent of the deindustrialization by dividing the value resulting from the sum of the cells that make up each column of the matrix β (the total employment) by the sum of all cells of β (the total employment). This procedure allows for the measurement of each sector's direct and indirect participation in the total employment in each subsystem. A similar procedure can be applied to analyze the value-added and profits of subsystems. We employed the sectoral gross operating surplus as a proxy for profits[3].

2.2. DATA

The dataset used in this paper comes from the Brazilian Institute of Geography and Statistics (IBGE, 2015). We employed the official Brazilian input-output tables (direct pooling tables) for 2000, 2005, 2010, and 2015. The most up-to-date I-O tables available were employed in our study. These tables provide sectoral employment, gross output, value-added, final demand, and intermediate purchases. Following Momigliano and

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[3] The sectoral gross operating surplus also includes the remuneration of self-employed workers.

Siniscalco (1982) and Sousa Filho, Santos, and Ribeiro (2021), we considered the capital stock as given in our short/medium-term analysis. The survey-based I-O tables for Brazil comprise 12 sectors: i) agriculture; ii) extractive industries; iii) manufacturing industries; iv) public utilities;v) construction; vi) trade; vii) transport; viii) communications; ix) financial services; x) real estate; xi) other services); and xii) public administration, defense, public education, and health. The sectoral aggregation of the I-O tables follows the Brazilian Institute of Geography and Statistics (In Portuguese acronym IBGE) classification.

Here, we followed the sectoral aggregation employed by Montresor and Marzetti (2011), and the I-O table was further aggregated into six sectors: primary (agriculture and extractive industries), manufacturing, public utilities, market services (trade, transport, communications, financial activities, real estate, and other services) and non-market services (public education, public health, and public administration).

The IBGE changed the methodology to estimate the I-O tables in 2010. The table for 2005 (reference 2000) uses the System of National Accounts 1993, whereas the I-O tables for 2010 and 2015 (reference 2010) employ the System of National Accounts 2008 (SOUSA FILHO; SANTOS; RIBEIRO, 2021). As a result, it becomes difficult to compare the disaggregated official I-O tables for 2005, 2010, and 2015.

Following Sousa Filho, Santos, and Ribeiro (2021), we have opted to circumvent this problem by analyzing the IO tables at a high aggregated level. This procedure would arguably reduce the bias presented when comparing tables constructed from different methodologies. A drawback of using this procedure would be in the study of structurally heterogeneous activities. This shortcoming of our study is to be overcome with a cautious interpretation of our results.

After the computation of the I-O model, we estimated the contribution in terms of employment[4], value-added, and profits for each activity, taking both the sectoral and subsystem approaches. These I-O tables display vital information to evaluate the changes in the structure of the Brazilian economy, highlighting the outsourcing of activities and the changes in the productive integration of the whole system. Specifically for value-added and profit, the implicit deflators of each variable were employed from the Supply and Use tables to gauge the I-O tables at prices for 2015. Each variable was deflated and then aggregated into our six activities. The implicit deflators indexes were calculated using the Supply and Use tables at current prices and previous years' prices. The year 2015 was employed in our analysis since it is the last year we have the official I-O table for Brazil available.

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[4] We did not use worked hours in our estimation as employed by Montresor and Marzetti (2010) and Giovanini (2021). Our estimations considered sectoral occupations only. Occupations serve as a proxy for employment. Although employment and occupations are somewhat different, to simplify, they are used interchangeably in this article.

3. RESULTS

3.1. EMPLOYMENT

Table 1 reports the employment numbers for sectors and subsystems in Brazil from 2000 to 2015 and its subperiods[5]. In terms of absolute numbers, Table 1 shows that the employment in the manufacturing subsystem is larger than the one found in the manufacturing sector, indicating the high integration of other activities into manufacturing. Sectoral and subsystem results for manufacturing show a similar trend, with the sectoral expansion in absolute employment (18.1%) surpassing the subsystem one (8.4%) from 2000 to 2015. However, the high integration was insufficient to avoid the decline in both sector and subsystem shares. The manufacturing subsystem share in the total economy declined 16% between 2000 and 2015, dropping 8.3% if we consider the sectoral perspective. For a view of the ups and downs of aggregate economic activity and its links with manufacturing, see Medeiros, Freitas, and Passoni (2019).

Table 1 reveals that sectoral employment in primary activities (agriculture and extractive industries) fell 24.7% between 2000 and 2015. However, examining the subsystem, we found a rise of 14.5% in employment. This difference in magnitude and sign is explained again by a rise in integrating other activities (e.g., manufacturing and market services) into primary ones. Looking at the employment shares in the economy, we found that the same pattern persists. The primary sector diminished its share substantially at the sectoral level (41.6%), while the subsystem results showed a smaller decline (11.5%). Similar overestimation was found for market services but in the opposite direction. The participation of this segment rose by 16% from 2000 to 2015 from the sectoral viewpoint, while it increased its share in the total only by 6.7% using the subsystem approach. To sum up, the sectoral approach seems to overestimate the decline of primary (and the rise of market services) employment in the share of employment in the total economy.

Table 1 – Sectoral and subsystem employment in Brazil, 2000-2015

a. Sectoral and subsystem number of occupations in the total economy					
Sectors		**2000**	**2005**	**2010**	**2015**
Primary	Sectoral	17,846,824	19,256,324	15,747,875	13,425,082
	Subsystem	7,596,600	8,365,520	8,250,344	8,697,649

(Cont.)

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[5] To a large extent, this section draws on Montresor and Marzetti (2011).

Table 1 – Sectoral and subsystem employment in Brazil, 2000-2015 - (CONTINUAÇÃO)

a. Sectoral and subsystem number of occupations in the total economy					
Sectors		**2000**	**2005**	**2010**	**2015**
Manufacturing	Sectoral	9,493,708	11,673,764	11,604,977	11,213,515
	Subsystem	20,199,523	24,830,126	24,139,714	21,901,730
Public Utilities	Sectoral	342,196	372,432	698,961	677,421
	Subsystem	452,800	462,952	739,553	864,637
Construction	Sectoral	5,329,906	5,872,879	7,844,451	8,639,884
	Subsystem	7,296,247	7,223,133	10,845,562	11,239,595
Market services	Sectoral	37,943,862	44,429,691	51,695,459	56,831,643
	Subsystem	31,745,950	36,053,272	39,311,160	43,736,432
Non-market services	Sectoral	8,015,851	9,300,583	10,524,495	11,167,531
	Subsystem	11,681,227	13,970,670	14,829,885	15,515,032
b. Sectoral and subsystem occupation shares in the total economy (%)					
Sectors		**2000**	**2005**	**2010**	**2015**
Primary	Sectoral	22.6%	21.2%	16.1%	13.2%
	Subsystem	9.6%	9.2%	8.4%	8.5%
Manufacturing	Sectoral	12.0%	12.8%	11.8%	11.0%
	Subsystem	25.6%	27.3%	24.6%	21.5%
Public Utilities	Sectoral	0.4%	0.4%	0.7%	0.7%
	Subsystem	0.6%	0.5%	0.8%	0.8%
Construction	Sectoral	6.7%	6.5%	8.0%	8.5%
	Subsystem	9.2%	7.9%	11.1%	11.0%
Market services	Sectoral	48.0%	48.9%	52.7%	55.7%
	Subsystem	40.2%	39.7%	40.1%	42.9%
Non-market services	Sectoral	10.2%	10.2%	10.7%	11.0%
	Subsystem	14.8%	15.4%	15.1%	15.2%

Source: Authors' own elaboration.

The opposite happened for the manufacturing sector, where the subsystem approach shows a stronger decline. According to the outsourcing hypothesis, if employment is being transferred from manufacturing to services, the subsystem approach should show a lower decline in manufacturing employment by putting these activities "back" in manufacturing. The fact that employment fell more at the subsystem level suggests that the manufacturing subsystem goes through an important process of productive restructuring. The fall in the manufacturing subsystem share was accompanied by a process of integration with non-labor-intensive services. The specialized services' capacity to develop manufacturing solutions to generate employment seems reduced. The sectoral approach underestimates the total effect of deindustrialization in terms of a drop in

employment by disregarding its effect on other activities that rely on this sector. Overall, these results align with the views of Montresor and Marzetti (2011) found in a study with countries from the Organization for Economic Co-operation and Development (OECD).

Table 2 shows the numbers for the integration of market services into several subsystems. It reveals that market services increased both in absolute and relative (share) terms. Market services are highly integrated with most of the subsystems in Brazil. For instance, market services are more integrated with primary activities and manufacturing over time. Market services exhibit high vertical integration (inputs used to come from the market services), which rose from 90.29%, in 2000, to 94.02%, in 2015. Moreover, this branch showed high integration with manufacturing in 2000, 24.26%, which increased to 38.02%. This result corroborates the literature that points to the increasing use of services in industry and agriculture (BERNARD; SMEETS; WARZYNSKI, 2017; FRANKE; KALMBACH, 2005; HOEKMAN; BRAGA, 1997; LESHER; NORDÅS, 2006). It also suggests that the advance in market services stems from a growing vertical integration, using more inputs from the market services sector (MONTRESOR; MARZETTI, 2010; GIOVANINI, 2021).

Table 2 – Market services occupations in subsystems

a. Absolute numbers						
	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
2000	397,142	4,900,111	206,310	1,210,974	28,664,072	2,565,254
2005	724,723	6,382,704	225,171	1,012,231	32,772,772	3,312,090
2010	980,821	8,310,468	287,909	2,019,876	36,637,990	3,458,396
2015	1,347,907	8,327,156	393,406	1,966,201	41,119,598	3,677,375
Change 2000-2005	82.5	30.3	9.1	-16.4	14.3	29.1
Change 2005-2010	35.3	30.2	27.9	99.5	11.8	4.4
Change 2010-2015	37.4	0.2	36.6	-2.7	12.2	6.3
Change 2000-2015	239.4	69.9	90.7	62.4	43.5	43.4
b. Market services shares in subsystems (%)						
	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
2000	5.2	24.2	45.5	16.6	90.2	21.9
2005	8.6	25.7	48.6	14.0	90.9	23.7
2010	11.8	34.4	38.9	18.6	93.2	23.3
2015	15.5	38.0	45.5	17.4	94.0	23.7
Change 2000-2005	65.7	5.9	6.7	-15.5	0.6	7.9
Change 2005-2010	37.2	33.9	-19.9	32.9	2.5	-1.6
Change 2010-2015	30.3	10.4	16.8	-6.0	0.8	1.6
Change 2000-2015	196.4	56.7	-0.1	5.4	4.1	7.9

Source: Authors' own elaboration.

When we look at the results of manufacturing integration into the rest of the subsystems, we find a reverse picture. Table 3 shows a rise in the participation of manufacturing integration into primary activities and manufacturing, but it dropped in the rest of the subsystems. As Giovanini (2021) and Giovanini, Morrone, and Pereira (2022) have argued, in Brazil, a disconnection between manufacturing and services was found using the subsystem approach. The disconnection is related to a lower integration of manufacturing into the market services subsystem.

Table 3 – Manufacturing occupations in subsystems

a. Absolute numbers

	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
2000	192,676	7,130,095	42,407	590,116	1,139,907	398,506
2005	327,859	8,989,620	47,487	521,924	1,305,157	481,718
2010	315,955	8,933,776	65,652	843,066	1,083,835	362,692
2015	415,999	8,488,144	79,524	758,318	1,153,190	318,340
Change 2000-2005	70.2	26.1	12.0	-11.6	14.5	20.9
Change 2005-2010	-3.6	-0.6	38.3	61.5	-17.0	-24.7
Change 2010-2015	31.7	-5.0	21.1	-10.1	6.4	-12.2
Change 2000-2015	115.9	19.0	87.5	28.5	1.2	-20.1

b. Manufacturing shares in subsystems (%)

	Primary	Manufacturing	Industrial Utilities	Construction	Market services	Non-market services
2000	2.5	35.3	9.3	8.0	3.5	3.4
2005	3.9	36.2	10.2	7.2	3.6	3.4
2010	3.8	37.0	8.8	7.7	2.7	2.4
2015	4.7	38.7	9.2	6.7	2.6	2.0
Change 2000-2005	54.5	2.5	9.5	-10.6	0.8	1.0
Change 2005-2010	-2.2	2.2	-13.4	7.5	-23.8	-29.0
Change 2010-2015	24.8	4.7	3.6	-13.2	-4.3	-16.1
Change 2000-2015	88.5	9.7	-1.7	-16.5	-26.5	-39.8

Source: Authors' own elaboration.

3.2. VALUE-ADDED

Having explored the employment/occupations results previously, we now delve into value-added numbers for sectors and subsystems in Brazil. In absolute terms, Table 4a shows that the manufacturing value-added expanded over time. The subsystem growth surpassed the sectoral expansion for manufacturing. The manufacturing sector grew 17.2% between 2000 and 2015, while the manufacturing subsystems increased 33.1%. The same happened to primary activities.

Table 4 – Sectoral/subsystem value-added in Brazil, 2000-2015

a. Sectoral/subsystem value-added in the total economy (1,000,000 Reals) (Prices of 2015)		2000	2005	2010	2015
Primary	Sectoral	203,981	263,501	317,636	369,740
	Subsystem	101,631	148,715	215,993	275,962
Manufacturing	Sectoral	538,067	633,442	703,337	630,813
	Subsystem	751,792	932,141	1,077,312	1,000,485
Public Utilities	Sectoral	88,111	96,184	116,746	123,183
	Subsystem	49,266	46,407	70,038	81,063
Construction	Sectoral	201,333	204,868	284,819	296,018
	Subsystem	279,602	258,851	425,401	421,903
Market services	Sectoral	1,805,672	2,070,104	2,646,424	2,850,260
	Subsystem	1,490,136	1,666,813	2,076,061	2,285,193
Non-market services	Sectoral	641,167	740,321	836,134	885,587
	Subsystem	805,903	955,492	1,040,292	1,090,995

b. Sectoral/subsystem value-added shares in Brazil, 2000-2015		2000	2005	2010	2015
Primary	Sectoral	5.9	6.6	6.5	7.2
	Subsystem	2.9	3.7	4.4	5.4
Manufacturing	Sectoral	15.5	15.8	14.3	12.2
	Subsystem	21.6	23.3	22.0	19.4
Public Utilities	Sectoral	2.5	2.4	2.4	2.4
	Subsystem	1.4	1.2	1.4	1.6
Construction	Sectoral	5.8	5.1	5.8	5.7
	Subsystem	8.0	6.5	8.7	8.2
Market services	Sectoral	51.9	51.6	54.0	55.3
	Subsystem	42.8	41.6	42.3	44.3
Non-market services	Sectoral	18.4	18.5	17.0	17.2
	Subsystem	23.2	23.8	21.2	21.2

Source: Authors' own elaboration.

Table 4b shows some important results when we look at changes in the shares. For manufacturing, we detected a drop in its share only after 2005. The subsystem result indicates a decline of 10% in its share when we compare 2000 with 2015. From a sectoral viewpoint, the decline doubles.

Tables 5 and 6 reveal the numbers for market services and manufacturing share into subsystems. Two essential results are worthy of notice. Firstly, market services increased their shares in almost all subsystems. This rise in integration between services and manufacturing was also found in Fornari, Gomes, and Hiratuka (2017). Secondly and conversely, manufacturing diminished its share in almost all subsystems. This evidence is in line with Giovanini (2021) and Giovanini, Morrone, and Pereira (2022). Other studies also found similar results in developed countries – e.g. Momigliano and Siniscalco (1982),

and Montresor and Marzetti (2010, 2011). Thus, Brazil's deindustrialization does not only derive from outsourcing and reclassifying manufacturing activities as services. When the effects of these phenomena are addressed through the subsystems approach, there is still a decline in manufacturing shares in employment and value-added.

Table 5 – Market services Value-Added in subsystems

a. Absolute numbers (1,000,000 Reals) (Prices of 2015)					
	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
2000	17,783	220,683	9,000	52,148	1,378,302	127,755
2005	31,405	276,071	9,369	41,009	1,543,431	168,818
2010	44,945	372,870	13,606	90,609	1,952,238	172,156
2015	58,455	356,808	17,776	85,032	2,154,176	178,013
Change 2000-2005	76.6	25.1	4.1	-21.4	12.0	32.1
Change 2005-2010	43.1	35.1	45.2	120.9	26.5	2.0
Change 2010-2015	30.1	-4.3	30.7	-6.2	10.3	3.4
Change 2000-2015	228.7	61.7	97.5	63.1	56.3	39.3

b. Market services shares in subsystems (%)					
	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
2000	17.5	29.3	18.2	18.6	92.5	15.8
2005	21.1	29.6	20.1	15.8	92.6	17.6
2010	20.8	34.6	19.4	21.3	94.0	16.5
2015	21.1	35.6	21.9	20.1	94.2	16.3
Change 2000-2005	20.7	0.9	10.5	-15.1	0.1	11.5
Change 2005-2010	-1.5	16.9	-3.8	34.4	1.6	-6.3
Change 2010-2015	1.8	3.0	12.9	-5.4	0.2	-1.4
Change 2000-2015	21.1	21.5	20.0	8.1	1.9	2.9

Source: Authors' own elaboration.

Table 6 – Manufacturing Value-Added in subsystems

a. Absolute numbers (1,000,000 Reals) (Prices of 2015)					
	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
2000	10,920	404,106	2,403	33,446	64,606	22,586
2005	17,790	487,795	2,577	28,321	70,820	26,139
2010	19,149	541,445	3,979	51,095	65,687	21,982
2015	23,402	477,498	4,474	42,659	64,872	17,908
Change 2000-2005	62.9	20.7	7.2	-15.3	9.6	15.7
Change 2005-2010	7.6	11.0	54.4	80.4	-7.2	-15.9
Change 2010-2015	22.2	-11.8	12.4	-16.5	-1.2	-18.5
Change 2000-2015	114.3	18.2	86.1	27.5	0.4	-20.7

(Cont.)

Table 6 – Manufacturing Value-Added in subsystems - (CONTINUAÇÃO)

	Primary	Manufacturing	Public Utilities	Construction	Market services	Non-market services
b. Manufacturing shares in subsystems (%)						
2000	10.7	53.7	4.8	11.9	4.3	2.8
2005	11.9	52.3	5.5	10.9	4.2	2.7
2010	8.8	50.2	5.6	12.0	3.1	2.1
2015	8.4	47.7	5.5	10.1	2.8	1.6
Change 2000-2005	11.3	-2.6	13.8	-8.5	-2.0	-2.4
Change 2005-2010	-25.9	-4.0	2.3	9.8	-25.5	-22.8
Change 2010-2015	-4.3	-5.0	-2.9	-15.8	-10.3	-22.3
Change 2000-2015	-21.1	-11.2	13.1	-15.5	-34.5	-41.4

Source: Authors' own elaboration.

In summary, the manufacturing subsystem's decline in value-added was weaker due to the high integration of market services activities into this subsystem. Studies that focus only on the sectoral approach tend to overestimate the decline of manufacturing in terms of value-added. A possible way to somewhat reduce this problem, using the sectoral approach, would be to look at different manufacturing segments. Medeiros, Freitas, and Passoni (2019) is one example of a study focusing on a specific manufacturing segment, finding a modest decline in manufacturing between 2000 and 2014.

Low national investments in innovation (FISHLOW, 2013; ROCHA, 2015) and exchange rate appreciation (BRESSER-PEREIRA, 2012; CANO, 2012; OREIRO; FEIJÓ, 2010; MARCONI; ROCHA; MAGACHO, 2016) likely played a part in the decline of the manufacturing participation in the entire economy. It is possible that the increase in international competition also played a role in the result for manufacturing (MEDEIROS; FREITAS; PASSONI, 2019). Thus, the country needs to advance the integration between market services and manufacturing through sectoral policies.

4.1. SECTORAL AND SUBSYSTEM PROFITS

Table 7 shows the sectors' and subsystems' profits. A similar pattern emerges in which the manufacturing subsystem profits are higher than the sectoral ones. Between 2000 and 2015, manufacturing sector profits declined 14.9%. Conversely, we found an expansion of 18.7% in the manufacturing subsystem. In terms of shares in the overall economy, profits in the manufacturing subsystem declined 20.3%. If we take a sectoral perspective, it dropped more than double. As mentioned before, market service integration into manufacturing is rising, which is not accounted for when we take the sectoral approach[6].

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[6] For further details, new tables can be provided on demand.

The results suggest only a decline in the manufacturing sector shares in the economy. Furthermore, this process is weaker when we take the subsystem approach. While the manufacturing sector had its participation in the overall economy decrease in terms of employment, value-added, and profits, the primary and market services activities expanded over time. Our results raise doubts that the Brazilian deindustrialization process is more robust than other mid-income countries', and future research should tackle this issue.

The results underscore the expansion of manufacturing employment, value-added, and profits in terms of participation in the whole economy from 2000 to 2005. The following two subperiods (2005-2010 and 2010-2015) were marked by the decreasing participation of manufacturing. In the 2010-2015 period, the manufacturing decline intensified substantially. Both sectoral and subsystem approaches confirmed a deindustrialization process in Brazil between 2000 and 2015. The phases of expansion of the Brazilian economy correlate with the expansion of manufacturing shares, which highlights the importance of manufacturing and supports the structuralist and Kaldorian approaches (BRESSER-PEREIRA, 2012; MARCONI; ROCHA; MAGACHO, 2016; MEDEIROS; FREITAS; PASSONI, 2019; OREIRO; FEIJÓ, 2010).

Table 7 – Sectoral and subsystem profits in Brazil, 2000-2015

a. Sectoral/subsystem profits in the entire economy (1,000,000 Reals) (Prices of 2015)					
		2000	2005	2010	2015
Primary	Sectoral	123,348	153,406	197,276	231,023
	Subsystem	54,654	79,136	123,421	153,080
Manufacturing	Sectoral	242,437	304,965	294,846	206,404
	Subsystem	344,725	457,746	492,048	409,200
Public Utilities	Sectoral	62,167	74,759	88,668	87,447
	Subsystem	31,077	31,480	46,908	50,129
Construction	Sectoral	130,440	100,434	138,119	126,301
	Subsystem	160,707	125,634	202,604	180,221
Market services	Sectoral	825,727	1,018,585	1,355,432	1,436,360
	Subsystem	712,720	846,647	1,105,143	1,194,954
Non-market services	Sectoral	77,822	84,708	78,755	87,589
	Subsystem	158,058	196,214	182,971	187,540
b. Sectoral/subsystem profit shares in the total economy (%)					
		2000	2005	2010	2015
Primary	Sectoral	8.4	8.8	9.1	10.6
	Subsystem	3.7	4.5	5.7	7.0
Manufacturing	Sectoral	16.5	17.5	13.6	9.4
	Subsystem	23.5	26.3	22.8	18.8

(Cont.)

Table 7 – Sectoral and subsystem profits in Brazil, 2000-2015 - (CONTINUAÇÃO)

b. Sectoral/subsystem profit shares in the total economy (%)					
		2000	**2005**	**2010**	**2015**
Public Utilities	Sectoral	4.2	4.3	4.1	4.0
	Subsystem	2.1	1.8	2.1	2.3
Construction	Sectoral	8.9	5.7	6.4	5.8
	Subsystem	10.9	7.2	9.4	8.2
Market services	Sectoral	56.4	58.6	62.9	66.0
	Subsystem	48.7	48.7	51.3	54.9
Non-market services	Sectoral	5.3	4.8	3.6	4.0
	Subsystem	10.8	11.3	8.5	8.6

Source: Authors' own elaboration.

FINAL REMARKS

Our study applied Momigliano and Siniscalco's (1982) procedure to investigate the changes in employment, value-added, and profit levels within the manufacturing sector and subsystem, in Brazil. We computed the changes in these variables from the I-O tables for 2000, 2005, 2010, and 2015. Applying this method, we gauged the actual extent of deindustrialization in the economy, considering the possibility of domestic outsourcing. The five central results for Brazil can be summarized as follows:

i) Sectoral estimates of manufacturing employment shares tend to underestimate the decline in employment compared with the subsystem approach.

ii) Sectoral computations overestimated the decline in value-added and profits as economy shares compared with the manufacturing subsystem calculations.

iii) The results support the deindustrialization thesis for Brazil when the share in the total economy is considered but raise doubts about the intensity of this process. Using the sectoral approach, a modest deindustrialization process was also found by Fornari, Gomes, and Hiratuka (2017), and Medeiros, Freitas, and Passoni (2019).

iv) There was a rise in the manufacturing share of employment, value-added, and profits in the entire economy from 2000 to 2005, when both sectoral and subsystem approaches were used. This expansion was followed by a decline in manufacturing participation after 2005.

v) The deindustrialization process was stronger between 2010 and 2015, a possible result of increased international competition after 2008, as suggested by Medeiros, Freitas, and Passoni (2019).

Our results, thus, confirm the decline of manufacturing only in relative terms or in shares. In absolute terms, employment, value-added, and profits expanded. Manufacturing presented a smaller decrease in the economy at the subsystem level, indicating the rising integration of market services into the manufacturing sector. Unfortunately, this integration process was insufficient to avoid the fall in manufacturing employment and value-added shares of the entire economy. The manufacturing decline seems to relate to the decrease in the participation of profits in the aggregate economy. To guarantee the competitiveness of manufacturing, highly productive market services are required. Policymakers should also focus on the manufacturing subsystem, and in line with Mazzucato (2021), governments should broadly "shape" markets, encompassing both sectors and subsystems.

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