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Outsourcing and Structural change: Sectoral and subsystem approaches applied to Brazil, 2010-2015♦

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Abstract

This article combines the sectoral and subsystem analytical approaches to explore the connection between outsourcing and structural change in Brazil. We applied statistical tests to examine the actual extent of service outsourcing in the domestic market from 2010 to 2015. Our results reveal a process of domestic outsourcing marked by the vertical integration of industrial activities and the increased weight of services in industrial subsystems. This process might reflect the reorganization of industrial activities in the 2010-2015 period. The increasing integration of market services into industrial subsystems explains, at least partially, the commonly claimed stagnation of Brazilian industry during that time.

Keywords

Structural change; Outsourcing; Sectors; Subsystems.

Resumo

Este artigo explora a conexão entre terceirização e mudança estrutural utilizando a perspectiva setorial e dos subsistemas para o Brasil. Aplicamos testes estatísticos para examinar a subcontratação nacional de 2010 a 2015. Nossos resultados destacaram um processo diferente de subcontratação nacional, marcado pela integração vertical das atividades industriais e pelo aumento do peso dos serviços nos subsistemas industriais. Esse processo pode refletir a

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reorganização das atividades industriais no período 2010-2015. A crescente integração dos serviços de mercado em subsistemas industriais explica, pelo menos parcialmente, a estagnação da indústria no Brasil durante esse período.

Palavras-chave
Mudança estrutural; Terceirização; Setores; Subsistemas.

JEL Classification
C67; D57; J21; O47.

1. Introduction

The relationship between outsourcing and structural change over time is a critical issue in economics. Outsourcing reflects the breakdown of formerly vertically integrated sectors. For example, a manufacturing firm might contract out activities such as machine maintenance to the market (Montresor and Marzetti 2010). To accurately assess the extent of outsourcing and structural change in different countries, researchers should employ subsystem techniques to map such transformations. Vertical reintegration and disintegration necessitate a more dynamic approach to defining industries, redrawing their productive boundaries (Momigliano and Siniscalco 1982).

McFetridge and Smith (1988), Milberg (1991), and Montresor and Marzetti (2010) conducted studies exploring outsourcing and structural change from a subsystem perspective.[1] According to Momigliano and Siniscalco (1982), a given "subsystem *i* is a unit of investigation identified by all the activities used directly and indirectly to satisfy the final demand for commodity *i*" (Momigliano and Siniscalco 1982, 280). It is a logical process that stresses the transformation of primary inputs into finished products, excluding the interdependencies among productive processes (Scazzieri 1990, 20; Cardinale 2018, 1).

In short, the subsystem approach is a simplifying tool that focuses on the sequential features of the production process. It represents production in

[1] The subsystem approach or vertical integration analysis is depicted in classical theories such as, Smith's labor fund theory and may also be found in Austrian analyses (SCAZZIERI 1990).

a linear and vertical manner, with each subsystem functioning as an independent productive chain separate from the others. In Scazzieri's (1990) words:

> *…the most characteristic features of a production economy require the consideration of incomplete circular flows, that is, subsystems in which certain inputs are parametrically given, so that the whole economic system may be partitioned into subsets of economic activities that may be associated with distinct patterns of dynamic behavior.* (Scazzieri 1990, 21)

Thus, the subsystem serves as a conceptual device where activities are defined as producers of commodities and operate with relative independence from other activities. Given that the economy operates through sectors and subsystems, analyzing both these levels is pivotal when seeking to trace performance. However, in Brazil, only a few studies, among them Costa Júnior and Teixeira (2010) and Giovanini (2021), have sought to employ a subsystems approach.

This article investigates the actual extent of domestic outsourcing (or intersectoral disintegration) in Brazil from 2010 to 2015. We employed sectoral and subsystem indicators to gauge the level of intersectoral disintegration of industrial activities (including manufacturing and construction) into services. To do so, we analyzed the official input-output matrices for 2010 and 2015 and applied parametric and non-parametric statistical tests to assess the presence of domestic outsourcing. To the best of our knowledge, the current literature includes no other inquiry into the implications of domestic outsourcing and structural change in Brazil that employs the sectoral and subsystem approaches. The results can serve as a guide for policymakers.

This article is structured as follows. In section 2, we briefly overview outsourcing and the role of services in the economy. Section 3 outlines the subsystem approach and provides a theoretical background. The methodology and dataset are presented in Section 4. Section 5 analyzes the findings. Section 6 concludes.

2. The relevance of service outsourcing from a historical perspective

Early studies, carried out by classical authors, saw service activities as a source of unproductive work, incapable of generating wealth (Ricardo 1996; Malthus 1983; Say 1983). From the mid-twentieth century onwards, these activities began to be classified into more rigorous sectoral typologies. Indeed, the first breakdown of productive activities in a sectoral approach was proposed by Fisher (1939), who divided the economy into three sectors, namely: primary (agricultural), secondary (manufacturing) and tertiary (services). Any activity perceived as non-productive was included within the tertiary sector, which thus constituted an artifice for bringing together a heterogeneous set of activities, considered of little relevance for generating wealth.

Later, the tertiary sector was renamed 'services' by Clark (1940), thus acknowledging the diverse range of activities encompassed within this category and contributing to the analysis of the process of structural change underway at the time. He linked this process to changes in final demand, arguing that as per capita income levels rise, the demand elasticity for manufactured products becomes inelastic, resulting in a shift in the value-added composition in favor of the service sector.

Baumol (1967) reinforced this argument by categorizing productive activities into two groups based on their technological features. The first group, manufacturing, consists of activities characterized by innovations, capital accumulation, and economies of scale leading, over time, to an increase in productivity. The second group, services, includes activities that do not consistently contribute to productivity growth. Thus, the increase in manufacturing productivity drives the transition of workers to the service sector. As a result, manufacturing's decreasing share is accompanied by the service sector's increasing share, leading to reduced aggregate productivity growth rates.

Hence, Clark (1940), arguing from the demand side, and Baumol (1967) arguing from the supply side, claimed increased per capita income leads to deindustrialization and economic stagnation. However, Kaldor (1966) claimed that only the growth in demand for manufacturing can foster a self-determined virtuous circle of economic growth. He stated that services are unable to produce a similar effect since they are unable to increase their demand.

In this vein, the predominant view of service activities was negative, making the definition of theories that adequately capture the broad spectrum of activities comprising this sector challenging (Gershuny 1987). This view only began to change in the 1980s, as new evidence emerged on the effects of information and communication technologies (ICTs) on the productive structure (Bhagwati 1984).

Indeed, with the spread of ICTs, the decline in transport costs, and the lowering of trade barriers, manufacturing processes have increasingly become fragmented, both within and beyond national borders. Firms no longer need to carry out all the steps to manufacture a product and have transferred some production phases to other locations. The expansion in services primarily occurred among business services, specifically in those activities used as inputs by manufacturing, rather than services purchased by final consumers (Francois 1990; Francois and Reinert 1996).

As a result, activities previously carried out by manufacturers themselves are now offered by firms specialized in providing services. This phenomenon, known as outsourcing, has led to increasing interdependence between manufacturing and services (Park and Chan 1989; Franke and Kalmbach 2005).

Therefore, the transfer of activities from manufacturing to services partially explains deindustrialization, resulting in the reduction of manufacturing's share of total jobs and value added (Bernard et al. 2017). Montresor and Marzetti (2010) emphasize that the restructuring of productive activities presents two different interpretations regarding the outsourcing of production. Firstly, outsourcing is understood as a vertical integration process, since it reduces the 'vertical scope' of the company. Outsourcing manufacturing activities results in a smaller contribution of manufacturing to income generation.

Secondly, outsourcing makes the boundaries of firms more permeable to other organizations and market mechanisms. According to this interpretation, outsourcing enhances the relevance of manufacturing by initiating a process of restructuring. It denotes a specific structural change where manufacturing extends into non-manufacturing sectors. As a result, distinguishing between manufacturing and services at the sectoral level can lead to misleading conclusions since the total contribution of manufacturing includes activities that are classified as services (Montresor and Marzetti 2010).

According to Bernard et al. (2017), this suggests numerous instances of deindustrialization in high-income countries are misclassified. This primarily occurs due to the transformation of the manufacturing sector and the diversification of the productive structure towards more advanced activities. These activities rely heavily on inputs from the services sector, which contributes to an apparent decline in manufacturing's share.

The nature of the structural change resulting from the advancement of the outsourcing of manufacturing activities to services differs across countries. Tregenna (2009) and Rodrik (2014) point out that developing countries experience service sector growth primarily through the advancement of less economically dynamic activities, particularly in the primary sector. In these countries, the increase in the share of services is insufficient to drive productivity growth and diversify the productive structure towards more sophisticated products. Consequently, it fails to engender a trajectory of long-term economic development.

Rocha et al. (2019) claim Brazil experiences a particular form of structural change, characterized by deindustrialization together with growth in final consumer services. The process of opening up the economy in the 1990s, coupled with the limited adoption of information and communication technologies (ICTs) and the introduction of demand-stimulating policies, played an active role in driving this structural change (McMillan and Rodrik 2011; Diao et al. 2019; Silva 2021).

In this context, we further explain and apply the subsystem approach in the following sections. This approach enables us to identify the extent to which industrial activities have been outsourced to service firms and helps to explain the structural change in Brazil.

3. The subsystem approach

The sectoral viewpoint in economics focuses on the external interdependencies among sectors. Momigliano and Siniscalco (1982), Scazzieri (1990) and Montresor and Marzetti (2010) argued that the sectoral method has two shortcomings. Firstly, it assumes that sectors are vertically integrated production models in which intermediate transactions are viewed as

products external to the sector. This implies that not every sector uses inputs from the remaining sectors, indicating an absence of sectoral interdependence, whereby a sector employs all of its production to meet its own final demand. Secondly, a firm's organizational processes can influence the sectoral approach. The reconfiguration of internal production processes, such as outsourcing activities, may occasionally be mistaken for a structural transformation.

As mentioned above, one expected outcome of the new communication technologies is the outsourcing of industrial activities to service firms. In this regard, the sectoral approach can introduce a bias when estimating structural change, as the growth in services' share may be misinterpreted as actual structural transformation (Montresor and Marzetti 2010). Researchers evaluating structural change should differentiate between the structural change induced by the reconfiguration of productive activities and the genuine structural change stemming from shifts in final demand. The subsystem approach (Sraffa 1960; Pasinetti 1973) and the method proposed by Momigliano and Siniscalco (1982) enable researchers to make this distinction.

According to Scazzieri (1990), a subsystem (or a vertically integrated sector) is a logical device that focuses on transforming primary resources into finished commodities, while disregarding the interdependencies of productive processes expressed by the general supply of inputs. As Cardinale (2018, 1) highlighted, vertical integration "is the logical process whereby intermediate commodities are eliminated and attention is concentrated on primary inputs and final commodities". Activities are understood as producing finished commodities relatively independently of other activities. The subsystem explores the productive interconnection, wherein each subsystem is considered a separate productive chain independent of the others. This theoretical approach is central to capturing structural transformations in economies as it can accurately capture outsourcing and its effects on structural change. A vast body of research focuses on subsystem analysis (McFetridge and Smith 1988; Scazzieri 1990; Milberg 1991; Montresor and Marzetti 2010) and highlights the importance of this method.

This approach does not rely on the hypothesis that products are intended to meet the final demand of the sector in which they are produced. For instance, outsourcing does not alter the estimates of deindustrialization. Momigliano and Siniscalco (1982) accurately captured the advantage of

the subsystem approach when compared to two alternative well-known theories, namely changes in consumption patterns and the structure of labor markets, which attempt to explain deindustrialization at the sectoral level:

> *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.* (Momigliano and Siniscalco 1982, 275)

Momigliano and Siniscalco (1982) demonstrate that the subsystem approach outperforms the sectoral approach when analyzing the process of outsourcing and internal reorganization of manufacturing activities. The increase in the weight of intermediate services has both vertical and horizontal effects as it changes the proportions of total production between sectors and the distribution of services used among sectors. Thus, the representation of the circular flow in the input-output matrix is impaired. Using technical coefficients to understand the determining factors of expanding intermediate demand in the manufacturing sector for services is challenging. It is difficult to separate the expansion of services that result from changes in demand-side factors from the internal reorganization of firms on the supply side (Momigliano and Siniscalco 1982).

Therefore, the subsystem approach should be employed to assess outsourcing and structural change. When a manufacturer contracts out a service to the market, it can enhance the efficiency of the former and increase the impact of manufacturing on service activities. As mentioned earlier, this scenario can be regarded as a reconfiguration of the productive activity.

4. Methodology and Data

This section introduces sectoral and subsystem indicators that contribute to the investigation of the domestic outsourcing hypothesis in Brazil. Additionally, it includes an outline of the statistical techniques employed and a description of the dataset used in this study. Beginning with the methodology, the statistical procedures applied to input-output tables have their antecedents in Östblom (1992) and Aroche-Reyes (1995, 2006). Next, there is an overview of the data we used, which primarily consists of the official input-output tables for 2010 and 2015 from the National Statistical Office (IBGE 2021).

4.1. Method

4.1.1 Sectoral Measure

Changes in input-output coefficients serve as a sectoral measure to assess service outsourcing, enabling outsourcing trends to be traced over time. Outsourcing impacts intermediate consumption, value-added, and gross output. A drop in I-O coefficients in the main diagonal (i.e., when i=j) over time suggests the presence of outsourcing since intermediate consumption tends to drop, but gross output remains stable. Declining technical coefficients express a reduced need for inputs, that is, a rise in the productivity of inputs, resulting in efficiency gains in lines of production (Aroche 1995, 2006). Stable autocoefficients (a_{ii}) are also recognized in the literature as a sign of outsourcing (Montresor and Marzetti 2010). Vertical integration or intra-industry disintegration is indicated by an increase in technical coefficients.

This sectoral indicator of outsourcing is insensitive to price changes, but it has some limitations. Differentiating between a change in input coefficients due to technical change and one resulting from productive reorganization is challenging. To mitigate the risk of biased estimations, it is advisable to complement this indicator with other subsystem indicators. The following subsection delves into subsystem indicators to further investigate outsourcing.

4.1.2. Subsystem measures

Sraffa (1960) and Pasinetti (1973) were the initial developers of the subsystem approach,[2] which implies an aggregation that analytically represents all the activities (direct and indirect) involved in satisfying the final demand. Momigliano and Siniscalco (1982) used this concept to develop a methodology that reclassifies variables from a sectoral to a subsystem basis, considering the stock of fixed capital as given. More recent studies, such as those by De Juan and Febrero (2000), Montresor and Marzetti (2010), and Giovanini (2021), have also applied this procedure, possibly because it enables the measurement of employment in services used as intermediate demand, facilitating the identification of the actual destinations of employment.

In formal terms, the subsystem approach transforms the representation of input-output tables. Every sector is connected by purchase and sale relationships into vertically integrated subsystems that use labor as an external input to satisfy the final demand. This procedure can be denoted as follows:

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

where $(I - A)^{-1}$ stands for the Leontief matrix, x is the vector of total gross domestic production at current prices, f is the final demand column vector and "^" indicates that x and f were diagonalized. It is supposed to have constant returns to scale, and technical coefficients are given. The sum of each row of matrix B equals 1, where each cell in a row represents the sector's fraction that belongs to the various subsystems. In matrix B, every column "indicates in its elements the proportion of the activities of the various branches which come under a subsystem" (Momigliano and Siniscalco 1982, 281). The B operator reclassifies each variable from a sector (rows) to a subsystem level (columns) as:

[2] A central difference between Sraffa's (1960) subsystem and that of Momigliano and Siniscalco (1982) is that in the latter more relevance is given to the actual final demand vector. Additionally, they consider a fixed capital stock, which limits the scope of their analysis compared to Sraffa's seminal work (Momigliano and Siniscalco 1982; Montresor and Marzetti 2010). Despite deviating from the sectoral approach, Sraffa (1960) and Pasinetti (1973) do not employ the subsystem approach in empirical data. Momigliano and Siniscalco (1982) conducted one of the first empirical applications of subsystems and obtained evidence that the advancement of service activities in Italy was attributed to the increase in intermediary demand originating from the manufacturing sector, as well as the outsourcing process and reorganization of manufacturing activities, rather than the increase in final demand.

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

where $\hat{h}$ stands for the diagonalized matrix of employment. The Matrix β shows the employment in subsystems and sectors. We find the vertically integrated labor coefficient by adding the cells of a given column *j* from this matrix. It shows the quantity of labor directly and indirectly used by the whole system to produce the final good of subsystem *j*. Matrices B and β are unaffected by price changes, and changes in these matrices over time reveal the sources of structural transformation in the subsystems (Rampa 1982).

Matrix C can be computed as follows:

$$C = \hat{h}B\,(h'\hat{B})^{-1} \tag{3}$$

where h is the employment row vector and as mentioned above, the hat symbol expresses diagonalization. Matrix C is computed from β (the employment matrix) and demonstrates the centrality of each sector within the subsystems in terms of employment. When read by column, it reveals the structure of a particular subsystem. The cells within a column can be aggregated as desired, and their total sum is equal to one.

From matrix C, two indicators can be used to assess outsourcing: the autocoefficients (c_{ii}) and $\sum_{i=m}^{n} C_{ij}$. The term $\sum_{i=m}^{n} C_{ij}$ represents the sum of each column j, pertaining to industrial activities, in the rows of the C matrix consisting exclusively of market services, from m to n. That is, the symbols m and n comprise all market service activities that supply inputs to industrial ones. Here, we draw notation from Montresor and Marzetti (2010). They serve as proxies to capture the degree of integration between sectors in the case of the former and service outsourcing in the latter. As previously mentioned, outsourcing or vertical disintegration occurs when formerly vertically integrated sectors are broken down. For example, it emerges when an activity that belonged to a given firm, e.g., an accounting department, is contracted out to the market (Montresor and Marzetti 2010). A decline in the autocoefficients of matrix C, c_{ii} (where a row equals a column or *i=j*; that is, the cells located in the main diagonal of matrix C), suggests outsourcing since it implies that other activities increased their shares in the subsystem structure. The closer c_{ii} is to zero, the more vertically disintegrated the activity is; that is, the more relevant the outsourcing processes are. The closer c_{ii} is to 1; the less disintegrated

the activity. In this sense, declining autocoefficients suggest the presence of outsourcing or technical change in subsystems.

The second indicator, $\sum_{i=m}^{n} C_{ij}$ can also provide insights into the presence of service outsourcing. As mentioned above, this indicator is obtained by adding the rows *m* to *n* (rows of market service activities only) of the columns of industrial activities of matrix C. This sum captures the weight of market services in industrial subsystems. The larger this sum is, the higher the integration of services in industrial subsystems. For the complete list of industrial and market service activities, see the appendix.

4.1.3. Summary

The separate use of sectoral and subsystem indicators to assess service outsourcing has certain drawbacks and they should be employed in a complementary manner to enhance their effectiveness. Table 1 provides a summary of the indicators for detecting inter-industrial disintegration or service outsourcing. In this regard, declining or stable technical coefficients (a_{ii}) over time are indicative of outsourcing. Similarly, decreasing autocoefficients (c_{ii}) also imply outsourcing, while positive variations in $\sum_{i=m}^{n} C_{ij}$ over time suggest the presence of outsourcing.

Table 1 - Sectoral and Subsystem indicators to detect service outsourcing

Occurrence	Sectoral indicator	Variation (over time)
Service outsourcing	a_{ii}	Decline (-)/Stable (=)
	Subsystem indicator	
Service outsourcing	c_{ii}	Declining (-)
	$\sum_{i=m}^{n} C_{ij}$	Rise (+)

Note: The well-known direct technical coefficient, denoted as a_{ii}, is located in the main diagonal of Matrix A. Similarly, the degree of vertical integration of activities is measured by c_{ii}, which corresponds to the main diagonal of Matrix C. Additionally, $\sum_{i=m}^{n} C_{ij}$ represents the sum of each column j (from industrial activities) of the rows in Matrix C, specifically comprising market services from m to n. Source: based on Montresor and Marzetti (2010).

4.1.4. Statistical tests

The statistical tests performed in this study are applied to the changes in the two indicators (c_{ii}, $\sum_{i=m}^{n} C_{ij}$). The changes in the autocoefficient, c_{ii}, of industrial activities are tested over time to identify the significance of their sign changes:

$$D = [C_{ii}]t - [C_{ii}]g = \{d_{ii}\}, \tag{4}$$

the symbols t and g refer to the final and initial years respectively. Performing the statistical tests requires finding out if the mean of the difference between row vectors (d_{ii} elements) is significantly different from zero. The null hypothesis is that the mean of the difference vector is zero, while the alternative one states that it is different from zero. More details about the statistical model are below:

$$d_{ii} = s + \varepsilon_{ii}, \tag{5}$$

where ε_{ii} refers to the statistical error that follows the classical assumptions. We test whether the mean of differences equals zero (s=0) or not (s≠0) in statistical terms. Our hypothesis test can be expressed as follows:

$$\text{H0: } s = 0$$

$$\text{H1: } s \neq 0.$$

In the context of Brazil, we examine whether the mean is different from zero in the 2010-2015 period. Below, we present the schematic difference in matrices for the period under analysis in the next section:

$$D = [C]_{ii(2015)} - [C]_{ii(2010)}.$$

These tests were applied to the other indicators (a_{ii}, $\sum_{i=m}^{n} C_{ij}$) in the same fashion.

After computing these difference vectors, statistical tests can be performed to verify whether the difference between means is statistically significant at a 5% level. This study employed three tests: the well-known parametric "t" test (using the normal approximation for large samples), the Fisher sign test, and the Wilcoxon signed-rank test. The last two tests are non-parametric, allowing for less restrictive assumptions about the

errors. They are distribution-free tests that focus on the median and were employed by Östblom (1992) and Aroche-Reyes (1995).

4.2. Data

The dataset in the present study includes the official input-output matrices for 2010 and 2015. A methodological change in the System of National Accounts in 2010 made comparisons with previous years difficult, if not impossible. Therefore, we chose to focus solely on the 2010-2015 period. The survey-based input-output tables consist of 67 activities. The input-output matrices represent national tables, excluding imports. The final matrices consist of 66 sectors as we have excluded the domestic service activity, which is an imputed activity in the national accounts. The aggregation of activities follows the classification used by the Brazilian Statistical Office (IBGE, in Portuguese). For our estimations, we applied the Eviews VII software.

We used the destination classification of services to capture the effect of market services on the economic system. We specifically focused on services produced by firms and excluded any final services from our analysis. For a comprehensive list of market service activities, see the appendix.

After organizing the input-output tables, we applied parametric and non-parametric statistical tests to assess the domestic outsourcing hypothesis in both the sectoral and subsystem indicators. Our objective was to verify the intersectoral disintegration of industrial activities into market service activities. These input-output tables provide crucial information for evaluating changes in the structure of the Brazilian economy, highlighting the outsourcing of activities and the shifts in the productive integration of the entire system.

5. Results

5.1. Sectoral Results

Figure 1 presents the results of autocoefficients (a_{ii}) used to detect service outsourcing in Brazil. The figure compares the numbers for 2010 and 2015. Our analysis revealed that out of the 30 industrial activities

examined, 19 experienced a decline in their autocoefficients between 2010 and 2015. Overall, most activities exhibited a consistent drop in autocoefficients over time, which indicates increasing input productivity and outsourcing.

Table 2 presents the results for statistical tests (parametric and non-parametric) for the difference of the main diagonal of the A matrices (a_{ii}) for industrial activities in Brazil.[3] We conducted both one-sided and bilateral (or two-sided) tests. However, to save space, we chose to report the bilateral tests.[4] Our analysis for the entire period revealed no statistically significant decline in the average of industrial autocoefficients. The negative variations observed in industrial autocoefficients over time, on average, show no statistical significance. In other words, they are not significantly different from zero.

The sectoral results for the entire period consistently support the hypothesis of outsourcing as presented in Table 1. Outsourcing is commonly indicated by stable or declining autocoefficients.

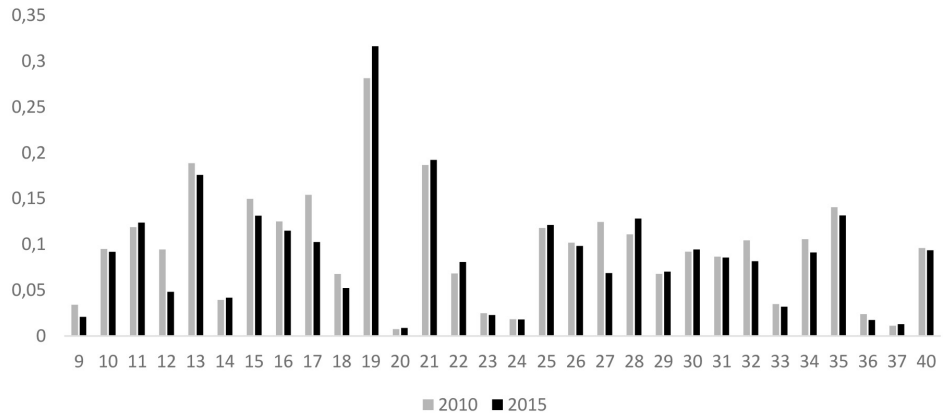

Figure 1 - Input-output autocoefficients (a_{ii}) for Brazil.

Source: Elaborated by the authors based on data from the *Instituto Brasileiro de Geografia e Estatística* (2021).

Note: The industrial sector comprises activities from 9 to 40 on the horizontal axis. For the complete list, see the appendix.

[3] The Jarque-Bera test was applied to test the normality of the distribution in subsections 5.1 and 5.2. The results are available upon request.

[4] Both one-sided and two-sided tests showed similar results. The results are available upon request.

Table 2 - Statistical tests (parametric and non-parametric) for the difference of the main diagonal of the A matrices (a_{ii}) for manufacturing activities in Brazil

	$D = [A]_{ii(2015)} - [A]_{ii(2010)}$
Mean d	-0.004
t value (parametric)	-1.091
H0: d = 0; α = 0.05	Not reject H0
Sign test (normal approximation)	
t value (non-parametric)	0.884
H0: d = 0; α= 0.05	Not reject H0
Wilcoxon signed rank (value)	1.299
H0: d = 0; α = 0.05	Not reject H0

Source: Elaborated by the author based on data from the Instituto Brasileiro de Geografia e Estatística (2021).

Note: industrial activities comprise all manufacturing activities and construction. * Reject H0 at 10%. ** Reject H0 at 5 and 10%. *** Reject the null at 1, 5 and 10%.

5.2. Subsystem Results

Figures 2 and 3 reveal the degrees of vertical integration, c_{ii}, and service integration, $\sum_{i=m}^{n} C_{ij}$, for 2010 and 2015, respectively. Figure 2 displays certain activities that demonstrated a decline in the degree of vertical integration, c_{ii}, which serves as a sign of outsourcing. These activities include the Manufacture of cleaning products, cosmetics/perfumes and toilet preparations (23), Manufacture of pharmaceutical products (24), Metallurgy of non-ferrous metals and metal smelting (28), Manufacture of computer, electronic and optical products (30), and Maintenance, repair and installation of machinery and equipment (37), among others. However, there was an increase in the degree of vertical integration for most subsystems from 2010 to 2015.

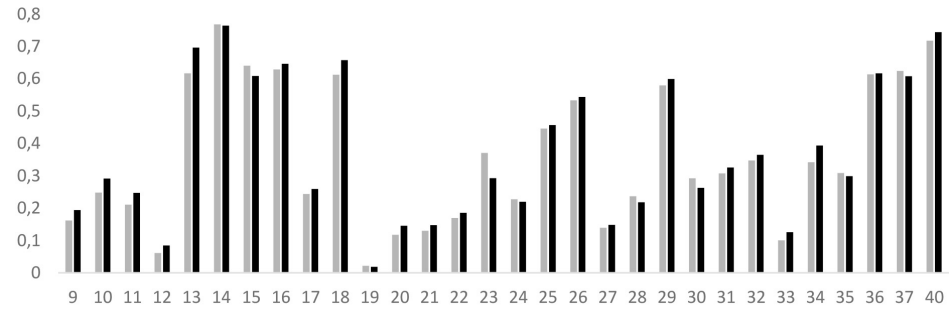

Figure 2 - Degree of Vertical Integration (c_{ii}).

Source: Elaborated by the authors based on data from the *Instituto Brasileiro de Geografia e Estatística* (2021).

Note: The industrial sector encompasses activities from 9 to 40 along the horizontal axis. For the complete list, please refer to the appendix.

Figure 3 presents the numbers for market service integration. We observed that the majority of subsystems (23 out of 30) demonstrated an increase in service integration. This finding suggests a growth in the significance of services within industrial activities, thereby supporting the intersectoral disintegration hypothesis.

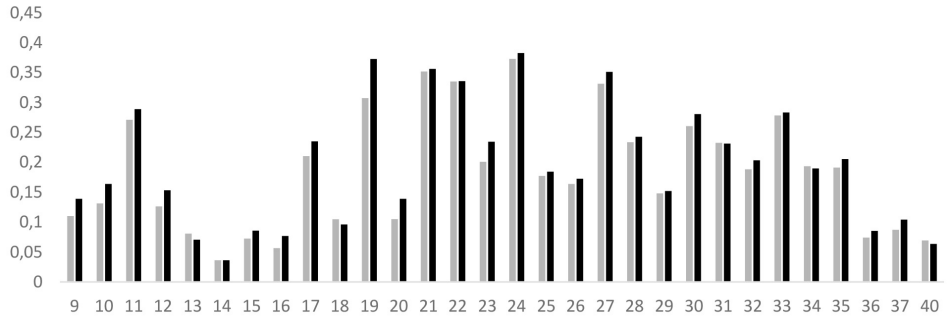

Figure 3 - Service Integration ($\sum_{i=m}^{n} C_{ij}$) in industrial activities.

Source: Elaborated by the author based on data from the *Instituto Brasileiro de Geografia e Estatística* (2021).

Note: The industrial sector comprises activities from 9 to 40 on the horizontal axis. For the complete list, see the appendix.

Tables 3 and 4 display the two subsystem indicators: c_{ii} and $\sum_{i=m}^{n} C_{ij}$, respectively. Our discussion in section 4 has demonstrated that a declining c_{ii} and a rising $\sum_{i=m}^{n} C_{ij}$ indicate domestic outsourcing. In this analysis, we aim to test the statistical significance of these variations on average. Based on Table 3, we have identified a significant overall increase in the mean autocoefficients of Matrix C for industrial activities. We observed a rise in autocoefficients, between 2010 and 2015 at a 5% significance level. This outcome suggests a growth in the degree of vertical integration during this period, which coincided with a peak of economic activity in 2010 and subsequent stagnation in 2015. Furthermore, the emergence of a political and economic crisis in 2015 further influenced the observed changes.

Table 3 - Statistical tests (parametric and non-parametric) for the difference of the main diagonal of the C matrices (c_{ii}) for industrial subsystems in Brazil.

	$D = [C]_{ii(2015)} - [C]_{ii(2010)}$
Mean d	0.011568
t value (parametric)	2.149507**
H0: d = 0; α = 0.05	Reject H0
Sign test (normal approximation)	
t value (nonparametric)	2.008316**
H0: d = 0; α = 0.05	Reject H0
Wilcoxon signed rank (value)	2.385927**
H0: d = 0; α= 0.05	Reject H0

Source: Elaborated by the authors based on data from the *Instituto Brasileiro de Geografia e Estatística* (2021).

Note: industrial activities comprise all manufacturing activities and construction. * Reject H0 at 10%. ** Reject H0 at 5 and 10%. *** Reject the null at 1, 5 and 10%.

Table 4 presents a noticeable rise in the $\sum_{i=m}^{n} C_{ij}$, indicating the growing importance of services in the industry. On average, the presence of market service activities increased in industrial subsystems. However, this subsystem indicator alone supports the thesis of sectoral disintegration of industrial activities, which is only partially consistent with Montresor and Marzetti (2010). Overall, domestic outsourcing in Brazil stands out as being significantly different from that experienced in other countries, as we have identified two indicators showing similar patterns of variation.

Table 4 - Statistical tests (parametric and non-parametric) for the differences in the row vector $\sum_{i=m}^{n} C_{ij}$ (service integration) for industrial subsystems in Brazil.

	$\Delta = [\sum_{i=m}^{n} C_{ij}$ (2015)] – $\Delta = [\sum_{i=m}^{n} C_{ij}$ (2010)] –
Mean d	0.013775
t value (parametric)	4.776298***
H0: d = 0; α = 0.05	Reject H0
Sign test (normal approximation)	
t value (nonparametric)	3.103761***
H0: d = 0; α = 0.05	Reject H0
Wilcoxon signed rank (value)	3.907984***
H0: d = 0; α = 0.05	Reject H0

Source: Elaborated by the authors based on data from the *Instituto Brasileiro de Geografia e Estatística* (2021).

Note: ind ustrial activities comprise all manufacturing activities and construction. * Reject H0 at 10%. ** Reject H0 at 5 and 10%. *** Reject the null at 1, 5 and 10%.

The increase in the share of market services in industrial subsystems over time, considering the destination classification for services (which excludes final services),[5] confirms the growing significance of services in industrial subsystems. As both autocoefficients c_{ii} and $\sum_{i=m}^{n} C_{ij}$ increased during the 2010-2015 period, we can argue that the proportion of industrial activities, c_{ij} (coefficients outside the main diagonal of matrix C and belonging to the industry), decreased over the same period. In other words, Brazil exhibits a distinct form of domestic outsourcing, in which a specific subsystem replaces industrial inputs with service inputs. Between 2010 and 2015, the growth of market services cannot be solely attributed to final services, casting doubt on the strength of the claim made by Rocha et al. (2019) as the sole explanation for deindustrialization in Brazil. This result may reflect the highly heterogeneous nature of industry in Brazil and its restructuring, or simply a reconfiguration of this segment. It is important to note that our analysis focuses solely on domestic production, disregarding the effects of international outsourcing and import substitutions. Future research should investigate the impact of international outsourcing on Brazil.

[5] The Professional Business Services (PBS) classification (United Nations 2008), being more restrictive since it excludes traditional services, was also employed in our estimations as a second scenario. The sign of the changes is similar to that found when we take the destination classification or consider market services as a whole (final and firm services). Moreover, similar results are found when we look at manufacturing alone. The results are available upon request.

Furthermore, we can identify the 'best candidates' for domestic outsourcing by examining the activities that experienced a decline in autocoefficients, c_{ii}, and a simultaneous increase in $\sum_{i=m}^{n} C_{ij}$. These activities, namely the Manufacture of wearing apparel and accessories (14), Manufacture of footwear and leather goods (15), Oil refining and coking plants (19), Manufacture of cleaning products, cosmetics/perfumes and toilet preparations (23), Manufacture of pharmaceutical products (24), Metallurgy of non-ferrous metals and metal smelting (28), Manufacture of computer, electronic and optical products (30), Manufacture of other transport equipment, except motor vehicles (35), and Maintenance, repair and installation of machinery and equipment (37), experienced intersectoral disintegration between 2010 and 2015.

Table 5 presents the results for the first subsystem indicator, c_{ii}, and provides valuable insights into the degree of vertical integration within specific subsystems. Consistent with Montresor and Marzetti (2010), we observed a low degree of vertical integration (indicating high intersectoral disintegration) in certain subsystems. These subsystems include Oil refining and coking plants (19), Manufacture of other organic and inorganic chemicals, resins and elastomers (21), Manufacture of pesticides, disinfectants, paints and various chemicals (22), Manufacture of pharmaceutical products (24), Production of pig iron, steel and seamless steel tubes (27), and Manufacture of cars, trucks and buses, except parts (33). Notably, these subsystems exhibited a high level of market service integration. It is worth mentioning that resource-intensive sectors, such as subsystems (19) and (27), are typically characterized by disintegration due to their strong connections with agriculture and mining activities. Furthermore, the remaining subsystems on the aforementioned list are commonly associated with purchasing rather than production as a key strategic policy for firms, in accordance with the observations from Montresor and Marzetti (2010). The strong correlation of 74% found in Spearman's rank correlation analysis further supports the relationship between low vertical integration and high market service integration in Brazil. For complete numerical details, please contact us for further information.

Table 5 - Bottom (6 lowest) subsystems in terms of degree of vertical integration (c_{ii}, average for the years 2010 and 2015), %.

Subsystems	Vertical integration (c_{ii})	Service integration ($\sum_{i=m}^{n} c_{ij}$)
Low vertical integration/High intersectoral disintegration		
Oil refining and coking plants (19)	2.00	33.99
Manufacture of other organic and inorganic chemicals (21)	13.85	35.39
Manufacture of pesticides, paints and various chemicals (22)	17.74	33.52
Manufacture of pharmaceutical products (24)	22.34	37.76
Production of pig iron, steel and seamless steel tubes (27)	14.36	34.11
Manufacture of cars, trucks and buses, except parts (33)	11.29	28.08

Source: Elaborated by the authors based on data from the *Instituto Brasileiro de Geografia e Estatística* (2021).

The subsystem indicators suggest Brazil underwent a different process of domestic outsourcing from 2010 to 2015. A vital force in this process was the increased weight of service activities in the industrial subsystems. Our results showed insensitivity to changes in service and industrial classifications. Any discussion on the demise of industrial activities should consider the shift towards domestic outsourcing. Unfortunately, this has not been the case in studies of industrial performance in Brazil.

In other words, the criticism raised by Bernard et al. (2017) and Montresor and Marzetti (2010) for high-income countries also applies to Brazil. The decline in the industrial sector's contribution towards value-added can be attributed to the restructuring of industrial activities, which involves the expansion of manufacturing into non-manufacturing sectors. The apparent decrease in the manufacturing sector's share of the national value-added does not necessarily imply a loss of its relative importance, but rather a transformation in its nature, characterized by an increased reliance on services provided by the market.

It is argued that the concept of industry needs to be revisited and expanded to incorporate service activities used as inputs for this classification. There is a need to build national indicators of deindustrialization that are not influenced by the outsourcing of industrial activities to services. Ignoring service outsourcing in current sectoral indicators of deindustrialization can lead to potentially biased results. Outsourcing results in a growing distortion of deindustrialization indicators, which tends to worsen over time (Tregenna 2009).

In this regard, the subsystem approach appears as a natural candidate for constructing an expanded concept of the industry since it identifies the participation of subsystems in the final demand. This approach offers the advantage of eliminating the need for a lengthy discussion about the criteria that would be used to include specific service activities in a potentially extended concept of the industry. It is important to note that the construction of an expanded indicator results from the recognition of the need to control the effect of outsourcing, enabling a more precise identification of the impact of other factors that may explain national deindustrialization, such as the Dutch disease, the abrupt opening of the economy, and globalization, among others.

These results demonstrate the strong integration of services into industrial activities. From 2010 to 2015, there was significant progress in the incorporation of market services within the industry. The design of public policies that contribute to the development of these activities requires closer examination, as it can provide guidance to policymakers. Furthermore, the introduction of new legislation in 2017 has potentially facilitated the further expansion of service-oriented activities, potentially reinforcing the outsourcing process.[6]

6. Final Remarks

This paper has investigated the domestic outsourcing hypothesis for the Brazilian economy from 2010 to 2015. We employed official input-output matrices for 2010 and 2015 and applied parametric and non-parametric statistical tests in our analysis. Applying these tests to sectors and subsystem indicators has enabled us to examine broad patterns in the economy.

The sectoral results indicate the presence of outsourcing in Brazil. On average autocoefficients (a_{ii}) dropped over time, although the fall was not statistically significant. At any rate, stable autocoefficients suggest outsourcing.

[6] We thank an anonymous referee for raising this point.

The numbers at the subsystem level present an interesting picture. On average, industrial activities exhibited a rise in the degree of vertical integration (c_{ii}) and service integration ($\sum_{i=m}^{n} C_{ij}$), suggesting a reconfiguration of productive processes. Over time, these activities exerted an increasing influence on services. This indicates a potential reorganization of industrial activities, where firms needed to incorporate a greater proportion of services. The deindustrialization thesis should be considered together with this above mentioned notion.

The activities that exhibited domestic outsourcing showed a decline in autocoefficients and an increase in their shares within service subsystems. Some notable examples include Oil refining and coking plants (19), Manufacture of cleaning products, cosmetics/perfumes, and toilet preparations (23), Manufacture of pharmaceutical and pharmacokinetic products (24), Metallurgy of non-ferrous metals and metal smelting (28), Manufacture of computer, electronic and optical products (30), Manufacture of other transport equipment, except motor vehicles (35), and Maintenance, repair, and installation of machinery and equipment (37).

The results suggest Brazil experienced a distinct form of domestic outsourcing, characterized by an increase in the average vertical integration of industrial activities and a growing incorporation of market services into industrial subsystems. This trend would seem to indicate a potential substitution of industrial inputs with service inputs, leading to a reduction in the significance of industrial activities within other industrial subsystems. This article emphasizes the importance of considering domestic outsourcing when studying structural change and the performance of industrial sectors.

During the 2010-2015 period, the Brazilian economy experienced an overall stagnation. In line with Montresor and Marzetti (2010), a significant reorganization of industrial activities took place across national boundaries. The current analysis has primarily focused on establishments. However, future research should consider incorporating microeconomic data to enhance the comprehensiveness of our results.

In addition, our analysis focused solely on domestic production, disregarding the impact of international outsourcing and import substitution on the domestic economy. Future research should delve into the effects

of international outsourcing in Brazil. Moreover, it is essential to expand the time series of input-output matrices to more effectively differentiate between cyclical and structural characteristics. It is worth noting that the recent legislation enacted in 2017, which facilitated further tertiarization, may have contributed to an increase in outsourcing activities in Brazil.

Future studies should also investigate the vertical integration of industrial activities. Is it a one-off phenomenon resulting from the low economic growth rates observed during 2010-2015, or does it signify a new trend stemming from the extensive outsourcing of industrial activities in previous decades?

References

Aroche-Reyes, Fidel. "Cambio técnico y cambio estructural. La hipótesis de coeficientes decrecientes. Pruebas estadísticas con datos para México." Estudios Económicos 10, no. 2 (1995): 147 –162.

Aroche-Reyes, Fidel. "Regímines de crecimiento, cambio structural y coeficientes de insumo." El Trimestre Económico 73, no 292 (2006): 881 –902.

Baumol, William. "Macroeconomics of unbalanced growth: the anatomy of urban crisis." The American economic review 57, no 3 (1967): 415 –426.

Bernard, Andrew, Valerie Smeets, and Frederic Warzynski. "Rethinking deindustrialization." Economic Policy 32, no 89 (2017): 5 –38.

Bhagwati, Jagdish. "Splintering and disembodiment of services and developing nations." World Economy 7, no 2 (1984): 133 –144.

Cardinale, Ivano. "A bridge over troubled water: A structural political economy of vertical integration." Structural Change and Economic Dynamics 46 (2018):172 –179.

Clark, Colin. 1940. "The morphology of economic growth." The Conditions of Economic Progress London: Macmillan.

Costa Júnior, Leopoldo, and Joanílio Teixeira. "Mudança estrutural e crescimento econômico no Brasil: uma análise do período 1990-2003 usando a noção de setor verticalmente integrado." Nova Economia 20, no. 1 (2010): 85 –116.

De Juan, Oscar, and Eladio Febrero. "Measuring productivity from vertically integrated sectors." Economic Systems Research 12, no. 1 (2000): 65–88.

Diao, Xinshen, Margaret McMillan, and Dani Rodrik. "The recent growth boom in developing economies: A structural-change perspective." In: *The Palgrave handbook of development economics,* 281-334. Palgrave Macmillan, Cham, 2019.

Fisher, Allan. "Production, primary, secondary and tertiary." Economic Record 15, no. 1 (1939): 24–38.

Francois, Joseph. "Trade in producer services and returns due to specialization under monopolistic competition." Canadian Journal of Economics 23, no. 1 (1990): 109–124.

Francois, Joseph, and Kenneth Reinert. "The role of services in the structure of production and trade: stylized facts from a cross-country analysis." Asia-Pacific Economic Review 2, no. 1 (1996): 35–43.

Franke, Reiner, and Peter Kalmbach. "Structural change in the manufacturing sector and its impact on business-related services: an input–output study for Germany." Structural Change and Economic Dynamics 16, no. 4 (2005): 467–488.

Gershuny, Jonathan. "The future of service employment." In: *The emerging service economy*. Pergamon Press, 1987.

Giovanini, Adilson. "Mudança estrutural e serviços intermediários: algumas evidências para o limiar do século XXI." Economia e Sociedade 30, no. 1 (2021): 63–90.

IBGE. Instituto Brasileiro de Geografia e Estatística. 2021. "Matrizes de insumo-produto e CNAE 2.0." Available at: <http://www.ibge.gov.br/home/>. Access: 8 set. 2021.

Kaldor, Nicholas. 1966. "Causes of the slow rate of economic growth of the United Kingdom: an inaugural lecture." London: Cambridge University Press.

Malthus, Robert. 1983. "Ensaio sobre a população." São Paulo: Abril Cultural.

McFetridge, Donald, and Douglas Smith. 1988. "The economics of vertical disintegration." Vancouver: Fraser Institute.

McMillan, Margaret, and Dani Rodrik. "Globalization, structural change and productivity growth." National Bureau of Economic Research, 2011.

Milberg, William. "Structural change and international competitiviness in Canada: An alternative approach." International Review of Applied Economics 5, no. 1 (1991): 77–93.

Momigliano, Franco, and Domenico Siniscalco. "The growth of service employment: a reappraisal." BNL Quarterly Review 35, no. 142 (1982): 269–306.

Montresor, Sandro, and Giuseppe Marzetti. "Outsourcing and structural change: application to a set of OECD countries." International Review of Applied Economics 24, no. 6 (2010): 731–752.

Östblom, Göran. "Parametric and non-parametric tests on technical change for Sweeden." Economic Systems Research 4, no. 3 (1992): 235–243.

Park, Se-Hark, and Kenneth Chan. "A cross-country input-output analysis of intersectoral relationships between manufacturing and services and their employment implications." World Development 17, no. 2 (1989): 199–212.

Pasinetti, Luigi. "The notion of vertical integration in economic analysis." Metroeconomica 25, no. 1 (1973): 1–29.

Rampa, Giorgio. "Commento a Momigliano e Siniscalco." Moneta e Credito 35, no. 140 (1982): 475–9.

Ricardo, David. 1996. "Princípios de economia política e tributação." São Paulo: Nova Cultural.

Rocha, Carolina, Ana Tatsch, and Silvio Cário. "Mudança estrutural e seu impacto na produtividade: uma análise da ascensão do setor de serviços na economia brasileira." Revista Economia Ensaios 33, (2019): 26–45.

Rodrik, Dani. "The past, present, and future of economic growth." Challenge 57, no. 3 (2014): 5–39.

Say, Jean Baptist. 1983. "Tratado de economia política." São Paulo: Abril Cultural.

Scazzieri, Roberto. "Vertical integration in economic theory." Journal of Post Keynesian Economics 13, no. 1 (1990): 20-46.

Silva, Felipe. "Structural change and labor productivity in Brazil in the 2000s: structural bonus or structural burden?" Revista de Economia Contemporânea 25, no. 2 (2021): 1–30.

Sraffa, Piero. 1960. "Production of commodities by means of commodities." Cambridge: Cambridge University Press.

Tregenna, Fiona. "Characterizing deindustrialization: an analysis of changes manufacturing employment and output internationally." Cambridge Journal of Economics 33, no. 3 (2009): 433–466.

United Nations. 2008. "International Standard Industrial Classification of All Economic Activities (ISIC), review 4." Statistical papers, Series M, No. 4/Rev.4, New York.

Appendix:

The Input-Output table for Brazil contains 66 activities. The activities of the disaggregated I-O table are: Agriculture (1), Livestock (2), Forestry and fisheries (3), Extraction of coal and non-metallic minerals (4), Extraction of oil and gas, including support activities (5), Extraction of iron ore, including processing and agglomeration (6), Extraction of non-ferrous metal ores (7), Slaughter and meat products, including dairy products and fishery products (8), Manufacture and refining of sugar (9), Other Food Products (10), Manufacture of beverages (11), Manufacture of tobacco products (12), Manufacture of textiles (13), Manufacture of wearing apparel and accessories (14), Manufacture of footwear and leather goods (15), Manufacture of wood products (16), Manufacture of pulp, paper and paper products (17), Printing and reproduction of recordings (18), Oil refining and coking plants (19), Manufacture of biofuels (20), Manufacture of other organic and inorganic chemicals, resins and elastomers (21), Manufacture of pesticides, disinfectants, paints and various chemicals (22), Manufacture of cleaning products, cosmetics / perfumes and toilet preparations (23), Manufacture of pharmaceutical and pharmacokinetic products (24), Manufacture of rubber and plastic products (25), Manufacture of non-metallic mineral products (26), Production of pig iron / ferrous alloys, steel and seamless steel tubes (27), Metallurgy of non-ferrous metals and metal smelting (28), Manufacture of metal products, except machinery and equipment (29), Manufacture of computer, electronic and optical products (30), Manufacture of electrical machinery and equipment (31), Manufacture of machinery and mechanical equipment (32), Manufacture of cars, trucks and buses, except parts (33), Manufacture of parts and accessories for motor vehicles (34), Manufacture of other transport equipment, except motor vehicles (35), Manufacture of furniture and products of various industries (36), Maintenance, repair and installation of machinery and equipment (37), Electricity, natural gas and other utilities (38), Water, sewage and waste management (39), Construction (40), Wholesale and retail trade, except motor vehicles (41), Ground transportation (42), Maritime transportation (43), Air transport (44), Storage, auxiliary transport and mail activities (45), Accommodation (46), Alimentation (feeding) (47), Print-integrated editing and editing (48), Television, radio, cinema and sound / image recording / editing activities (49), Telecommunications (50), Development of systems and other information services (51), Financial intermediation, insurance and supplementary pension plans (52), Real estate (53), Legal, accounting,

consulting and corporate headquarters activities (54), Architectural, engineering, testing / technical analysis and R & D services (55), Other professional, scientific and technical activities (56), Non-Real Estate Rentals and Intellectual Property Asset Management (57), Other administrative activities and complementary services (58), Surveillance, security and research activities (59), Public administration (60), Public education (61), Private education (62), Public health (63), Private health (64), Artistic, creative and entertainment activities (65) and Associations and other personal services (66).

Industry and market services activities

In our study the industrial sector comprises 32 activities. They are: Manufacture and refining of sugar (9), Other Food Products (10), Manufacture of beverages (11), Manufacture of tobacco products (12), Manufacture of textiles (13), Manufacture of wearing apparel and accessories (14), Manufacture of footwear and leather goods (15), Manufacture of wood products (16), Manufacture of pulp, paper and paper products (17), Printing and reproduction of recordings (18), Oil refining and coking plants (19), Manufacture of biofuels (20), Manufacture of other organic and inorganic chemicals, resins and elastomers (21), Manufacture of pesticides, disinfectants, paints and various chemicals (22), Manufacture of cleaning products, cosmetics / perfumes and toilet preparations (23), Manufacture of pharmaceutical and pharmacokinetic products (24), Manufacture of rubber and plastic products (25), Manufacture of non-metallic mineral products (26), Production of pig iron / ferrous alloys, steel and seamless steel tubes (27), Metallurgy of non-ferrous metals and metal smelting (28), Manufacture of metal products, except machinery and equipment (29), Manufacture of computer, electronic and optical products (30), Manufacture of electrical machinery and equipment (31), Manufacture of machinery and mechanical equipment (32), Manufacture of cars, trucks and buses, except parts (33), Manufacture of parts and accessories for motor vehicles (34), Manufacture of other transport equipment, except motor vehicles (35), Manufacture of furniture and products of various industries (36), Maintenance, repair and installation of machinery and equipment (37) and Construction (40).

Following the classification according to the destination of goods, we excluded final services from our analysis (United Nations 2008). Hence, market services comprises the following activities: Electricity, natural gas and other utilities (38), Water, sewage and waste management (39), Ground transportation (42), Maritime transportation (43), Air transport (44), Storage, auxiliary transport and mail activities (45), Print-integrated editing and editing (48), Telecommunications (50), Development of systems and other information services (51), Financial intermediation, insurance and supplementary pension plans (52), Real estate (53), Legal, accounting, consulting and corporate headquarters activities (54), Architectural, engineering, testing / technical analysis and R & D services (55), Other professional, scientific and technical activities (56), Non-Real Estate Rentals and Intellectual Property Asset Management (57), Other administrative activities and complementary services (58) and Surveillance, security and research activities (59). It excludes all final services.