Assessing the Brazilian Regional Economic Structure: a spatial output decomposition analysis

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Resumo

O uso de um modelo inter-regional de insumo-produto nos permite entender melhor a estrutura de produção regional. Ela fornece uma rica e detalhada fotografia de uma determinada economia. É possível implementar uma comparação ao longo do tempo e espacialmente. A segunda comparação será realizada neste trabalho e permitirá uma avaliação das diferenças na estrutura econômica entre as regiões (Jackson e Dzikowski, 2002). O objetivo principal deste trabalho é avaliar as mudanças estruturais e inter-regionais entre os estados Brasileiros. O método aplicado neste artigo usa uma matriz inter-regional de insumo-produto para o Brasil. Esta matriz leva em conta as 27 unidades da Federação e 55 setores em cada região e foi construída no âmbito do NEREUS/USP. Ao utilizar este banco de dados é possível decompor as diferenças na produção total em duas categorias distintas: a) estrutura técnica de produção e b) características da demanda final. A decomposição implementada neste artigo é uma variação do método implementado por Feldman *et al* (1987). A decomposição espacial (SOD) será utilizada para explorar as diferenças entre os estados brasileiros e uma economia "média". Para cada estado brasileiro usaremos o método SODL que compara um estado a uma média para a economia brasileira tanto para a matriz de coeficientes técnicos como para o vetor de demanda final. O método SODL enfatiza a diferença no tamanho dos estados.

Palavras-chave: decomposição espacial do produto; economia brasileira; estrutura econômica regional.

Abstract

The use of an interregional input-output model enables us to better understand the regional economic structure of production. It provides a rich and detailed static picture of a specific economy. We can implement a comparison overtime and across space. The second one will be implemented in this paper and enables an assessment of the differences in economic structure across regions. (Jackson and Dzikowski, 2002). The main aim of this paper is assessing structural change and interregional structural differences among Brazilian regions. The method applied in this paper uses the interregional input-output matrix for Brazil. This matrix considers 27 Brazilian states and 55 sectors in each region and was constructed by NEREUS/USP. Using this data set it will be possible to decompose differences in gross output into two distinct categories. The variation in gross output can be a function of the technical structure of production and of the final demand characteristics. The decomposition implemented in this paper is a variation of the method implemented by Feldman *et al* (1987). The spatial output decomposition (SOD) will be used to explore output differences between each region in Brazilian economy and an "average" Brazilian region. For each Brazilian state we will use SODL method that compares a state to an average Brazilian inter industry coefficient table and an average vector of final demand levels. The SODL method emphasizes differences in the sizes of the state economies.

Key-words: spatial output decomposition, Brazilian economy; regional economic structure

JEL CODE: R15

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Introduction

The production part of an economy can be well represented by an input-output table. Observing the flows we can have a numerical description of the size and structure of a specific economy in relation to the interactions among producing and consuming components. It is possible to affirm that, for those who are interested in going deep in the analysis of the economic structure, the input-output data contain the most detailed and accessible source of data on economic transactions. (Dewhurst and Jensen, 1993).

The idea behind the study of the economic structure using input-output can be divide into two groups. The first one wants to examine the input-output table and from the database discover some structural attributes of the economy. From these is possible to collect measures of connectedness, dispersion, ordering of some sectors, pattern analysis and input-output comparisons. The idea behind is looking for regularities and commonalities in table structure. The other group of studies comprehends the structural decomposition approach. This approach is really tight to the idea of comparative static analysis of the changes in the input-output structure of an economy.

Jackson *et al.,* (1990) define structural economic change as temporal changes in interactions among economic sectors. Takur (2011) understand the structural economic change as the modifications in relative importance of the aggregate indicators of the economy. Jackson *et al.,* (1990) affirms that the input output structure fits well for this kind of analysis because of its outstandingly rich representation of economic structure. The use of an interregional input-output model enables us to better understand the regional economic structure of production. It provides a rich and detailed static picture of a specific economy. The definition of economic structure is based on the composition of macro aggregates, relative change in their size over time, and its relationship with the circular flow of income.

Thus, according to Takur (2011) in order to define regional economic structure we need to analyze the composition and patterns of production, employment, consumption, trade and gross regional product. There is a positive correlation between the process of regional development and the structural change. This correlation implies that as the process of economic development takes place there will be a movement of strengthen and changing in the direction of inter sectoral relationship. This movement leads to shifts in the importance, direction and interaction of economic sectors such as: primary, secondary, tertiary, quaternary and quinary sectors.

There are in the literature several methods that enable the researches to measure, interpret and understand structural change. These methods shed light to themes as the relationship among sector composition, structural change and economic development. We can highlight the identification of key sectors, sector composition and economic growth, structural decomposition analyses and spatial structural convergence as examples of indicators of structural change. (Jackson and Dzikowski, 2002)

The structural decomposition analysis enables us to implement a comparison overtime and across space. The second one will be implemented in this paper and enables an assessment of the differences in economic structure across regions. (Jackson and Dzikowski, 2002).

The Brazilian economy is marked by a spatial heterogeneity in spatial terms. If we make an aggregate analysis considering 27 Brazilian states we can see that the states located at the North and Northeast part of the country are responsible for 5.04% and 13.51% of total GDP for 2009, respectively and 8.32% and 27.83% of the total population[4], respectively. On the other hand the states located at the Southeast and South part of the country are responsible for 55.32% and 16.54% of total GDP for 2009 and 42.13% and 14.36% of the total population. For the states located at Center-west the shares are 9.59% and 7.37%, respectively. Observing table 1 we note that, in the recent period, there is a small change in the regions

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[4] Census Data (2010) from IBGE

shares. Center-west was the macro region that gained more participation in GDP and Southeast region was the one that lose more, but the whole picture of concentration did not change.

TABLE 1 – REGIONAL GDP (%) - BRAZIL

Regions	Year				
	2005	2006	2007	2008	2009
Center-West	8.86	8.71	8.87	9.21	9.59
North	4.96	5.06	5.02	5.10	5.04
Northeast	13.07	13.13	13.07	13.11	13.51
South	16.59	16.32	16.64	16.56	16.54
Southeast	56.53	56.79	56.41	56.02	55.32

Source: Elaborated by the authors from IPEADATA/IBGE.

In sectorial terms we can note that there is also a spatial heterogeneity in its distribution. The agriculture sector is mainly located at South and Center-west region. On the other hand we still note a high degree of concentration in terms of industrial GDP. Observing data for 2009 it is possible to affirm that Southeast region is responsible for 58.17% of the industrial GDP and North region is responsible for 5.34% of the industrial GDP[5]. The share of the rest of Brazilian regions in industrial GDP is 18.57% (South); Northeast (12.25%) and Center-west (5.67%). It is also important to highlight that this pattern does not change among 2006 to 2009.

The main aim of this paper is assessing structural change and interregional structural differences among Brazilian regions. The variation in gross output can be a function of the technical structure of production and of the final demand characteristics. The method provides a measure of the differences in inter industry structure among regions and also provides a measure of the way in which differences in inter industry structure and final demand distributions differentiate production across regions and sectors.

This paper is organized as follows. The second section presents the literature review. On the first part we examine the use of structural decomposition analysis and on the second part we examine the Brazilian literature that deals with regional inequalities. The third section presents the database used and describes the methodology. The fourth section presents the results and finally we make some conclusions.

2. Literature Review

2.1 Structural Decomposition Analysis: a brief overview.

The idea behind the use of input-output analysis is better understand the role played by economic structure in the process of growth. The literature presents a different collection of measures dealing with this topic. Among those measures we can highlight the idea of Decomposition Analysis. According to Dietzenbacher and Los (2001) the principal idea behind a structural decomposition is that the variation in a specific factor/variable can be decomposed into the changes in its determinants. The majority of decompositions are implemented in an additive way. This measure can be used for comparisons overtime and across space. In the first case it is possible to assess structural changes and in the second case it is possible to assess the differences in economic structure across regions (Jackson and Dzikowski, 2002)

There is a wide range of applications of structural analysis using input-output matrices (Silva and Perobelli, 2012; Thakur, 2011; Fernández-Vasquez, Los and Ramos-Carvajal, 2008; Guo, Hewings and Sonis, 2006; Dietzenbacher, 2001; Dietzenbacher and Los, 2000; Liu and Saal, 2001; Casler, 2000; Durand and Markle, 1994; Gunluck-Senensen and kuçukçifiçi, 1994; Dewhurst, 1993; Gowdy, 1991; Barker, 1990). We do not want to cover in this section all the subjects addressed using structural analysis. The idea consists on the presentation of some papers to get the idea of the diversity of themes that could be studied using the structural decomposition analysis.

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[5] For 2009 - IPEADATA/IBGE

Silva and Perobelli (2012) aims to measure the influence of changes in production structure on variations in emissions of carbon dioxide in Brazil. Sectorial emissions were obtained from the balance of emissions and the input-output matrices from IBGE for the years 2000 and 2005. The main results indicate that: the sectors of transport, steel and food and beverages are those that were more likely to increase emissions when considering the change in final demand, while the cement industry sectors, non-metallic minerals, pulp and paper stand out for emissions reductions due to technological change.

Fernández-Vasquez, Los and Ramos-Carvajal (2008) deals with the main problem of SDA analysis that is the correlation between the results and the specific formulae chosen. Thus the authors propose the use of a maximum entropy econometrics technics to select a specific decomposition formula if additional information on one or more determinants is available.

Guo, Hewings and Sonis (2006) ideas are in the field of structural changes. The authors propose a new way to analyze temporal changes for a specific region. The main idea is the possibility of integrate two flow decomposition methods. They are: push-pull decomposition and structural Q-analysis. The authors applied the methodology to the Chicago metropolitan region.

The idea presented by Dietzenbacher and Los (2001) is based on the hypothesis that there is a range of the determinants of a specific phenomenon that are not independent. For the authors changes in one component present some degree of correlation with changes in another component. Thus, they propose a way to overcome this topic and implement an empirical analysis for Netherlands 1972-1986.

Liu and Saal (2001) applied the structural decomposition analysis to understand the structural changes in output growth of South Africa's economy during the period 1975-93. They implement a SDA from a demand side perspective. The authors want to calculate the contribution of private consumption, government consumption, investment and export components to the variation in output.

Casler (2000) uses the structural decomposition analysis to investigate the short-run impact of privatizing the defense costs of oil. The main idea is estimation of the changes in relative prices predicted to result from privatization and distributional consequences of these price changes.

Gunluck-Senensen and kuçukçifiçi (1994) wants to address the idea of inter temporal change using input-output tables. To get this aim they divide the components into price and technology changes. The authors applied the methodology to input-output tables to Turkey for 1973 and 1985.

2.2 Regional Inequalities in Brazil

To address the regional inequalities issues in Brazil is important to consider also climate and land differences and the historical and sociological process of regional growth. There is a group of authors that highlight the role played by market failures to explain the Brazilian regional heterogeneity. There is also the discussion about the production factors, more specifically the spatial distribution of those factors. As far as we know some of those factors are immobile (*e.g.* land, climate, railways, highways, ports, airports, etc). Thus those fixed factors may leads to the specialization of a specific region.

The discussion on regional inequalities in Brazil begins with Furtado (1959; 1974). The main idea is that a region whose production is based on primary export activities has a limited growth. This is due to the exports of productivity gains through price reduction in its products because of the market competition. On the other hand the industrialized products do not have this kind of problem. Firms with market power retain the productivity gains.

According to the author the imports substitution process enables the appearance of structural conditions to the industrial development in Brazil. The domestic industry on that time was able to produce to satisfy part of the domestic consumption. The majority of the population that had in its consumption basket industrial goods lived in the Southeast, mainly in Sao Paulo and Rio de Janeiro.

As a consequence, the first Brazilian industries flourished in this region. Thus the productivity gains from industrial activities were incorporated by the Southeast. This process leads a decrease in the number of persons employed in the agriculture sector located at the Southeast.

On the other hand, on the Northeast part of the country there is a stagnation process due to the exports problems, mainly the sugar cane exports. This agriculture production was not able to generate an internal market to develop industry in the Northeast. The internal consumption of manufactured goods in the Northeast was less than in the Southeast. The scale not justifies the industrial investments on that region. Thus Northeast region production remained as primary exports.

The author also examines the theme from the concentration of industrial workers and national income data. The author makes an analysis of industrial workers for the period 1920 to 1950. It shows the increase of Sao Paulo's share during this period. For the period 1944 to 1950 the author analyzes the data of industrial production and finds similar results, *i.e.,* a loss of market share on the northeast rather than a gain in relative importance of the economy of the state of Sao Paulo.

Despite long-standing to raise the establishment of policies and the creation of government institutions geared specifically to combat the regional inequalities, the difference between regions remain high whatever the criteria used to measure them. In this regard, it is especially disturbing to note that the indicators of regional inequality that usually refers, based on regional participation in national GDP, do not indicate a strong tendency to reduce inequalities.

In order to measure regional inequality, the authors use GDP per capita, for example, as a basis for the estimation of indices, whose specification varies according to the analyst's choice. For the period 1970/85, there is unanimity about the trends of convergence of incomes and therefore the reduction of regional inequality [Ferreira and Diniz (1995); Azzoni (1995), Ferreira and Ellery (1996)].

On the other hand, including a dataset for the nineties we can observe that there is an evidence of re-concentration of industrial activity in a region that goes from the center of Minas Gerais to the northeast of Rio Grande do Sul, [Diniz and Crocco (1996)]. This is due to the restructuring process associated with technological and organizational changes. Medium-sized cities that are located in the neighborhood of the main three cities in the Southeast (São Paulo, Rio de Janeiro and Belo Horizonte) and the corridor that connects those cities to the extreme south of the country tend to attract technologically advanced industrial activities due to its location and the comparative advantages they have in terms of communications infrastructure, availability of skilled labor and research university structure. The result may be to reverse the trend towards industrial decentralization that began in the late 60's. It is important to highlight that it was already quite soft in the period between 1985/90. By adopting annual estimates of state GDP per capita for the period 1985/94, Lavinas (1997) brings just evidence of growing inequality in the period 1990/94.

Cavalcante (2002) analyzes the regional disparities in Brazil for 1985-1999. In order to address this topic the author calculates three indicators (*e.g* the Relationship between Per Capita Income, the Williamson Weighted Coefficient of Variation and the Theil Index). Considering all the period is possible to observe that the inequality among the Brazilian regions falls. On the other hand when the author considered only the period between 1994 and 1999 it was possible to observe stability on the indicators results.

3. Data base and Methodology

3.1 Database

The method applied in this paper uses the interregional input-output matrix for Brazil. This matrix considers 27 states and 55 sectors in each region and was constructed by NEREUS/USP for 2007. Appendix I and II present the list of sectors, states and macro regions.

3.2 Methodology

The decomposition implemented in this paper is a variation of the method implemented by Feldman *et al* (1987). The spatial output decomposition (SOD) will be used to explore output differences between each region in Brazilian economy and an "average" Brazilian region. For each Brazilian state we will use two different computational methods. The first method (SODL) compares a state to an average Brazilian inter industry coefficient table and an average vector of final demand levels. The second decomposition uses, instead, a standardized final demand vector for each state and for the average Brazilian economy (SODS). The first method, SODL, emphasizes differences in the sizes of the state economies and the second, SODS, call the attention for final demand distributions.

3.2.1 Input-output model and the temporal decomposition[6]

Equation (1) represents the traditional input-output model solution

$$X = (I - A)^{-1}f \qquad (1)$$

Where X is a vector of industry output, A is a matrix of technical coefficients, and f is a vector of final demands. Letting B representing the standard Leontief inverse matrix, (1) becomes:

$$X = Bf \qquad (2)$$

Equation (2) is time subscripted to represent the initial and terminal period for analysis, yielding:

$$X_{t-1} = B_{t-1}f_{t-1} \qquad (3)$$

$$X_t = B_t f_t \qquad (4)$$

Inter period gross output changes can be expressed in one of two ways. Subtracting (3) from (4), then both adding and subtracting $C_t f_{t-1}$ to the right hand side of the difference equation provides:

$$X_t - X_{t-1} = C_t f_t - C_{t-1}f_{t-1} + C_t f_{t-1} - C_t f_{t-1} \qquad (5)$$

Collecting terms in (5) produces the analytical form shown in (6):

$$X_t - X_{t-1} = C_t(f_t - f_{t-1}) + (C_t - C_{t-1})f_{t-1} \qquad (6)$$

3.2.2 The spatial output decomposition

The derivation of spatial output decomposition is based on Jackson and Dzikowski (2002) and follows the temporal formulation presented at the earlier section. We departures from the equations (1) and (2) in order to implement the SOD. We add regional subscripts to represent each region and to our average economy.

$$X_s = C_s f_s \qquad (7)$$

$$X_m = C_m f_m \qquad (8)$$

S – Represents regions.
M – Represents average economy.

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[6] This section is based on Jackson and Dzikowski (2002).

It is important to shed light to the meaning of "average economy". Those regions are represented by the inverse table derived from averages elements in the *"n"* coefficients tables and an average of the elements in the *"n"* final demand vectors.

Similar to the temporal model, the difference in spatial economic structure can be represented in two ways. We calculate the first by subtracting (7) from (8), then both adding and subtracting $C_m f_s$ on the right hand side.

$$X_m - X_s = C_m f_m - C_s f_s + C_m f_s - C_m f_s \qquad (9)$$

Or

$$X_m - X_s = C_m(f_m - f_s) + (C_m - C_s)f_s \qquad (9)$$

The first term on the right hand side of (9) shows the difference in industry outputs due to differences in regional final demand distributions, weighted by the average inter industry structure, C_m. The second term enables us to calculate the portion of output differences due to differences in inter industry coefficients, weighted by the final demand structure of the study region (state, in the present region), f_s. There is another way to present the spatial output decomposition. It follows like that:

$$X_m - X_s = C_m f_m - C_s f_m + C_s f_m - C_s f_s \qquad (10)$$

Or

$$X_m - X_s = C_s(f_m - f_s) + (C_m - C_s)f_m \qquad (11)$$

The first term on the right hand side of (11) shows the difference in industry outputs in the two regions due to differences in final demands, weighted by the state specific inter industry distribution, C_s. The second term measures the portion of industry output difference due to differences in inter industry coefficients weighted by the final demands. This can be calculated in levels or standardized terms, for the f_m.

As we can find on the literature the decomposition analysis can be developed in different ways. Dietzenbacher *et al.,* (2000) shed light to specific ways to implement the decomposition. Following those authors we will implement a combination of (9) and (11). This combination measures, for each industry i, the difference in gross industry output as a result of differences in final demand:

$$\frac{1}{2}\left[\sum_{j=1}^{n} C_{ij}^{M}\left(f_j^s - f_j^M\right) + \sum_{j=1}^{n} C_{ij}^{S}\left(f_j^s - f_j^M\right)\right] \qquad (12)$$

Where C_{ij}^{M} and C_{ij}^{S} are elements of the Leontief inverse matrix for the average region and the state under investigation, respectively. The vector obtained provides a measure of the contribution of differences in final demand to differences in gross industry output between the average region and the particular region under investigation.

We can also use equation (9) and (11) to obtain, for each industry i, a measure that represents the difference in gross industry output as a result of differences in inter industry coefficients:

$$\frac{1}{2}\left[\sum_{j=1}^{n}\left(C_{ij}^{S} - C_{ij}^{M}\right)f_j^S + \sum_{j=1}^{n} C_{ij}^{S}\left(C_{ij}^{S} - C_{ij}^{M}\right)f_j^M\right] \qquad (13)$$

The result of this equation enables us to calculate the contribution of differences in inter industry structure to differences in gross industry output between the average region and the state under investigation.

4. Results[7]

The methodology enables us to have a complete picture of the intraregional and interregional disparities and similarities among the Brazilian states/regions and productive sectors. We will make a comparison using as an "average" first each of the five Brazilian macro-regions and second the Southeast region. So each Brazilian state will be compared with the "average structure of production of its own macro region and with the most important Brazilian macro region in terms of the contribution to GDP." In Figures 1A to 5A we will implement an intraregional comparison. Thus we will use the average of each Brazilian macro region. Those figures are based on equation 12 and enable us to identify how final demand by economic sector differentiates each state's production structure.

The idea behind the spatial output decomposition analysis is the possibility to calculate the difference in state production structures based on coefficient and final demand characteristics. The results presented on equation (12) – using final demand levels (SODL) and standardized final demand (SODS) enables us to verify the contribution of final demand differences to regional output differences.

The results can be interpreted in the following way:
   a) In SODL final demand analysis, a large positive value for an industry sector in a given Brazilian state identifies, primarily greater than average final demands for that industry. For such a sector, output differences can be attributed to high levels of final demand. On the other way around, small values for a specific sector indicate that any differences in output between the regions cannot be attributed to differences in final demand levels.
   b) In SODS analysis a large value for a sector in a given Brazilian state identifies a substantial role for that sector with respect to the overall regional final demand distribution. Likewise, small values for such sector in a given state indicate a role for the sector that is more in line with the other Brazilian states. The SODL method shed light on scale of a state economy than on its distribution of activities. The SODS method emphasizes the distributions of industry activity.

The comparison with the Southeast region enables us to shed light to the spatial heterogeneity among the Brazilian regions. The SODL calculated with Southeast as an average enables us to have a picture of the differences in terms of the state's economies.

Equation (13) measures the extents to which inter industry structure distinguish a given state from the average economy. This measure indicates the strength of spatial variation in inter industry interaction. A large positive value for a specific sector indicates a larger than average intermediate industry output orientation.

In this version of the paper we will have the chance to explore: a) the intra-regional results and b) the inter-regional results using as an "average" Southeast region. We will show the gross output decompositions results in 10 groups. This strategy will enable us to identify which sectors have the largest range of structural variation and which states differ most strongly from the average region (in the present case, from each macro Brazilian region and from Southeast region). Figures 1A to 5A displays the results by state for each Brazilian macro regions and Figures 1B to 5B displays the results when the comparison is made using Southeast region as the average. Figures 1A to 5A and 1B to 5B illustrates the results using final demand levels (SODL). The idea behind those figures is to shed light to the following point: how final demand by economic sector differentiates each state's production structure.

An overall analysis of the Figure 1A enables us to affirm that the state of Amazonas and Para present dominance in terms of final demand levels. We can shed light for the result of Para state. We can affirm

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[7] In this section we will present only the standardized result.

that the size of this state (when compared with the other states located at the North region) explains the results obtained (larger than the average).

Implementing a sectorial analysis enables us to identify how final demand in specific sector is responsible to differences among each state's production structure. Following this idea we can shed light for the relative importance of Para´s final demand for service sector (from 40 to 55) and for primary sector (from 1 to 5). At Amazon state the difference at the production structure due to final demand is more explicit in some industrial sectors. (from 28 to 35).

On the other side we can note the results for Acre, Rondônia, Roraima and Tocantins. For these states we can attribute the results to its lower final demand levels. This occurs mainly for the tertiary sectors (trade and services). The small values presented by industrial sector located at Acre, Rondônia, Roraima and Tocantins indicates that any differences in output between those regions and the "average" region cannot be attributed to differences in final demand levels.

The analysis of Figure 1B enables us to emphasize the difference between North region and the average of Southeast region. As we can observe the majority of the results are located below the zero line. This means that for those sectors any differences in output between the regions cannot be attributed to differences in final demand levels. On the other hand the results shed light to the difference between final demands among those states. We have a clear idea of the sectorial difference between those two Brazilian regions. The service and trade sectors present the majority of negative results. This is due, in part, to the relation between the size of the economy and the development of these sectors (see. Souza, *et al.*; 2012). The result for these groups of sectors enables us to emphasize the huge differences among those regions. If the economies are equal we will have a flat graphic with all points located at the origin. As far as the results became positive we can affirm that for states and sectors located at this part of the figure the scale is larger than the average. On the other hand, as far as the results goes down (*e.g* negative results) we can affirm that the state or sector under analysis has a small scale. It is important to emphasize the result for sector 33 (electronic material and communication equipment) located at Amazonas state. This sector presents the greatest positive result in the comparison with the Southeast as an average.

The idea behind the comparison implemented in this version of this paper is also address the following point: a) for intra-regional comparison we can better understand the role played by the states inside the regional economy (*e.g.* which is the role played by Para in terms of North region dynamic?); b) for inter-regional comparison we can better understand the role played by the states outside the regional economy (*e.g.* which is the role played by Para in terms of Southeast region dynamic?). In other words we can capture the relative importance of a specific state.

For the North case we can observe that, as affirmed earlier, Para state played an important role in intra-regional terms. We observe that the size of Para is greater than the average region (the positive values of Para state). On the other hand, when we compared Para state with a more development region (Southeast) there is a huge loss of relative importance.

Figure 2A shows a comparison between the states located within the northeast region. We can see that Bahia state dominate the results in terms of final demand levels, especially for tertiary sectors (from 42 to 55). For those sectors we can also point that Pernambuco and Ceara states present results greater than average. For this group of sectors is possible to affirm that the region present a dichotomous result (Bahia, Ceará and Pernambuco above the average and the other states below the average). Thus, we can affirm that the nature of the production in tertiary sector appears to be most dissimilar. For this range of sector final demand do not play an important role in terms of output variation. On the other hand there is a pattern of similarity in some industrial sectors (from 20 to 25 and from 29 to 34). On the other side (lower final demanders) we can call the attention to Alagoas, Maranhão, Paraíba, Piauí, Sergipe and Rio Grande do Norte states.

North and Northeast Region: Differences in Output due to Final Demand – (SODL approach)
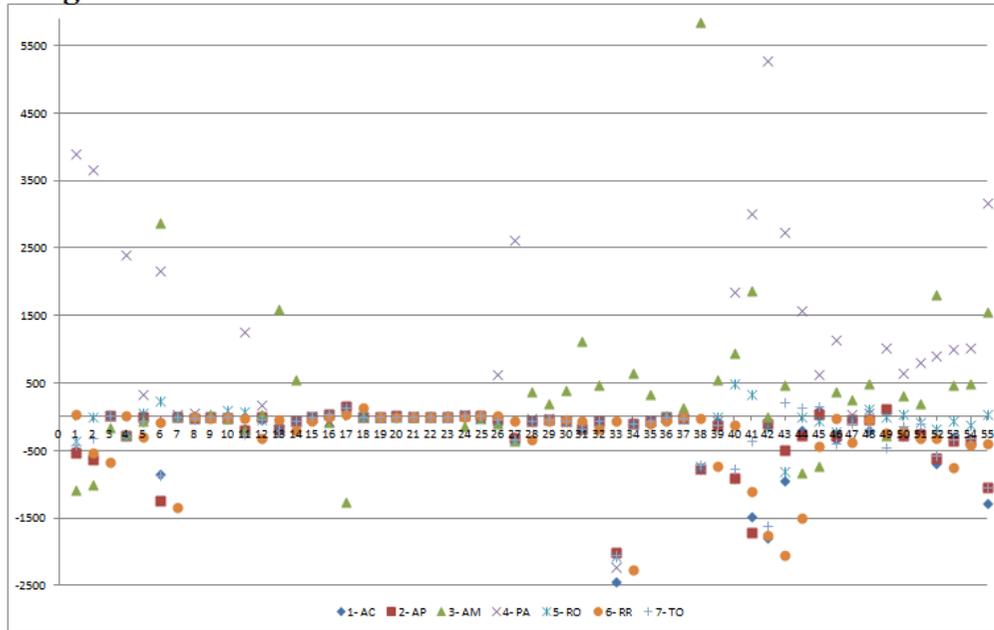
Figure 1A   - AVERAGE IS NORTH REGION

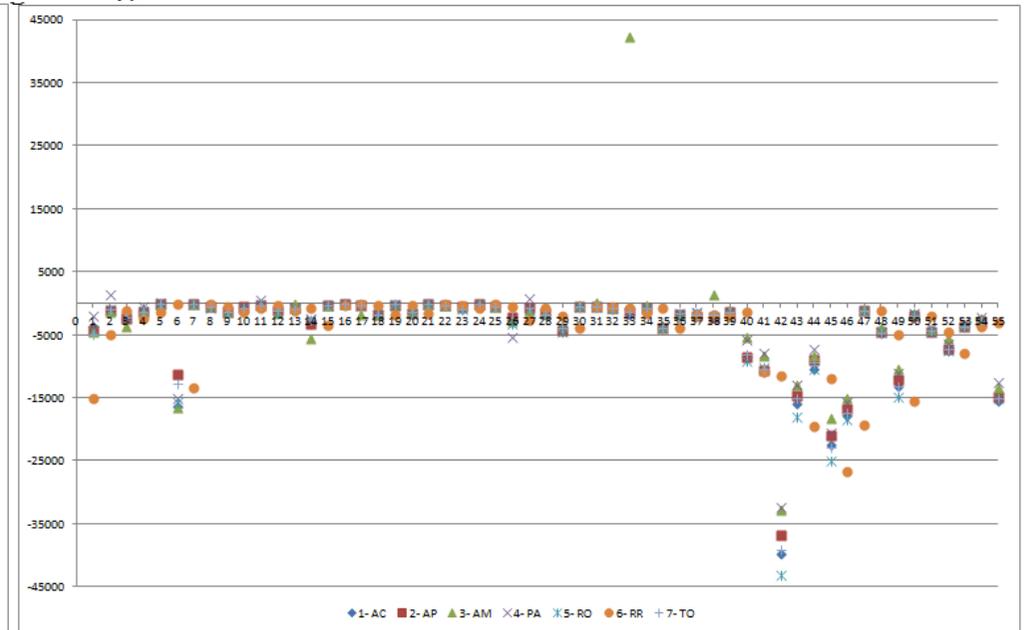## Figure 1B – AVERAGE IS SOUTHEAST REGION

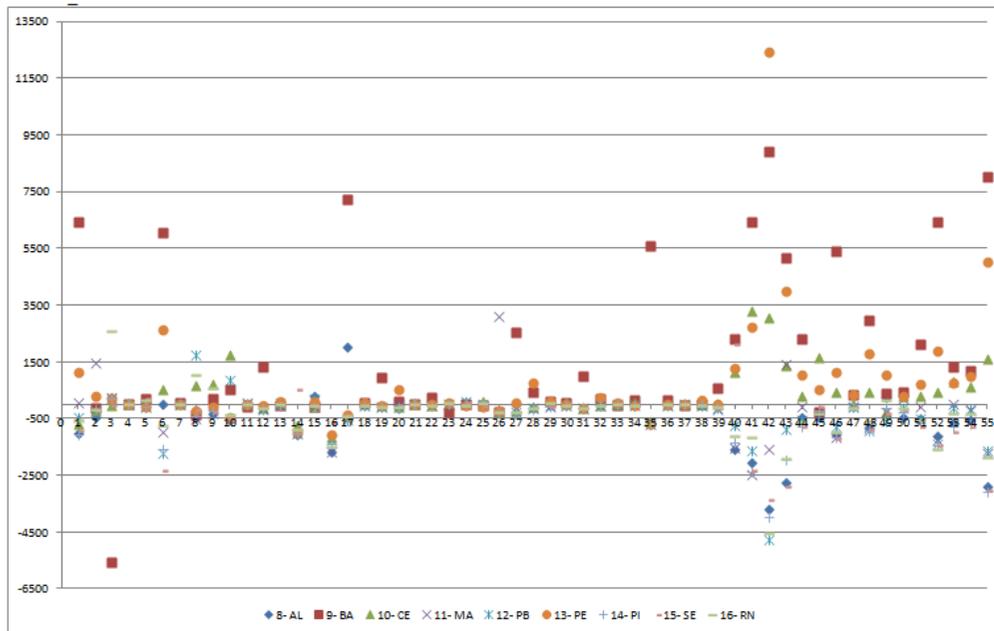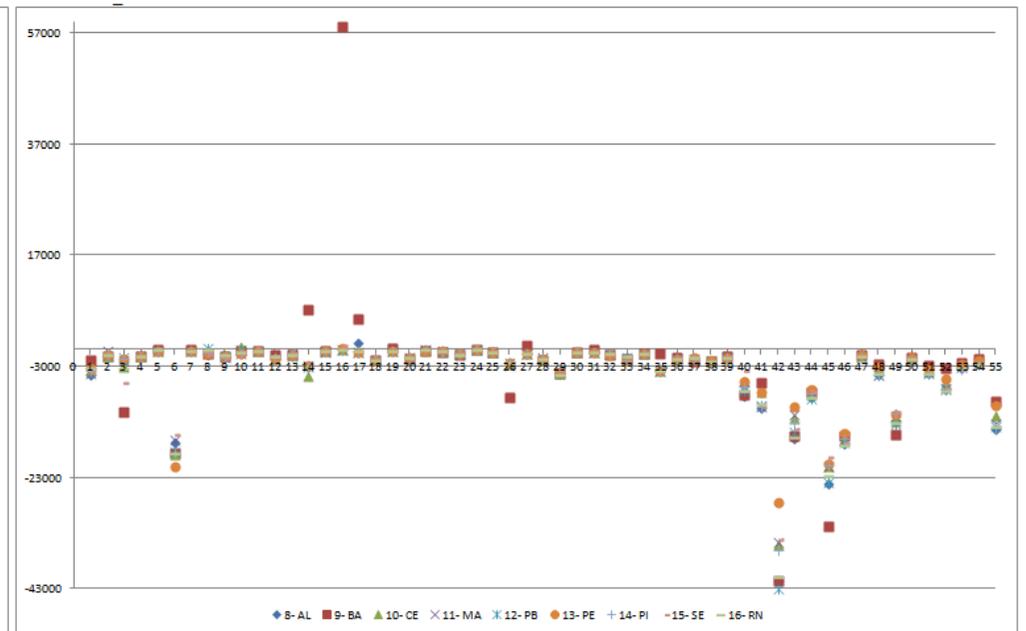## Figure 2A   - AVERAGE IS NORTHEAST REGION

## Figure 2B – AVERAGE IS SOUTHEAST REGION

Source: Elaborated by the authors

Observing Figure 2B is possible to affirm that only Bahia state present positive values for some sectors. This means that for those industries the Bahia's final demand is greater than average final demand (e.g. Southeast as average). On the other hand we can affirm that for the service and trade sector the final demand for the states located at the Northeast region is lower than the average final demand (Southeast).

The most important feature of Figure 3 is the dominance of Sao Paulo state in terms of final demand levels. This result is due to the size of Sao Paulo's economy. This leads to a final demand level consistently greater than the average. It is important to observe the broadly relevance of São Paulo's final demand for the majority of sectorial output. This relative importance goes from primary to tertiary sectors. On the other side we have the Espirito Santo state that presents final demand level consistently lower than the average. For Rio de Janeiro state we can shed light to sector 3 (Oil and and natural gas). This is due, in part, to the importance of petrochemical sector located in this state.

Figure 3. Southeast Region: Differences in Output due to Final Demand – (SODL approach)
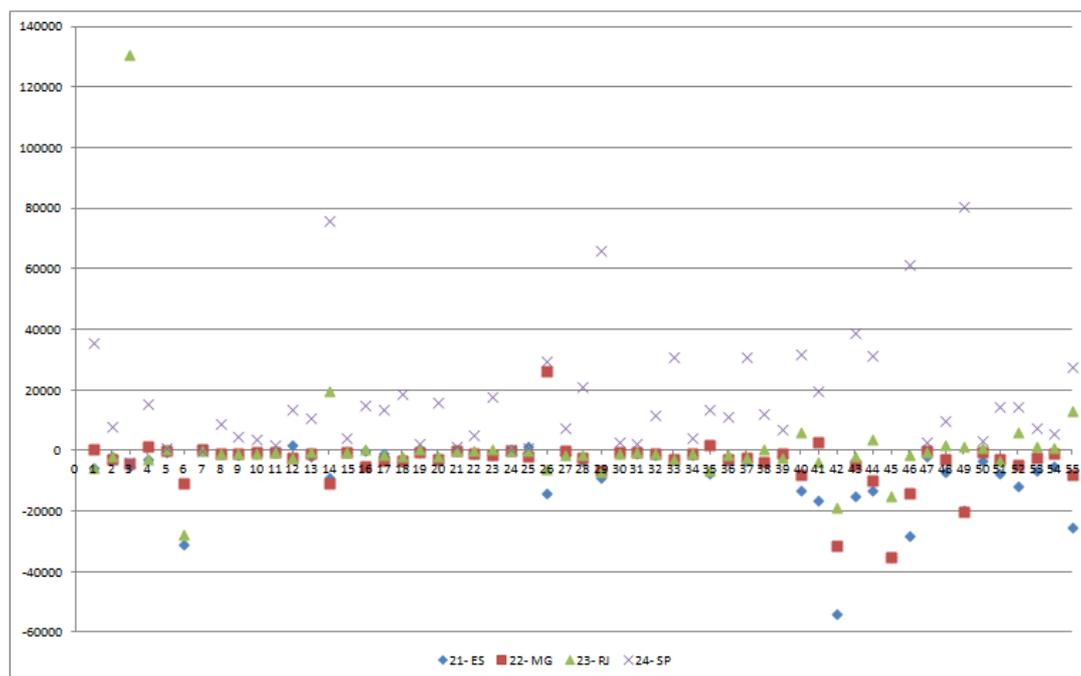
Source: Elaborated by the authors

Observing Figure 4A we can verify that Rio Grande do Sul and Paraná state present a dominance in the results. In other words, we can affirm that final demand levels are important for the variation in output of these states for a wide range of sectors. This dominance occurs, mainly, for industrial and tertiary sectors. It is important to shed light to the results presented by the primary sector (1 to 5). In this group of sectors we find the higher degree of similarity among the states. The greater level of dissimilarity occurs, mainly, for the tertiary sectors (from 40 to 55). The contribution of Santa Catarina's final demand level is consistently below the average.

Figure 5A presents the results for Center-west region. The results are very interesting. In this region we have Distrito Federal where the Brazilian capital city is located and the other three states are mainly agriculture based. Thus, the observation of the results shows that for industrial sector there is, among all the Brazilian macro regions, a higher level of similarity of the contribution of final demand for the output differences among the states.

The pattern of similarity also occurs for the industrial sector. On the other hand, for service sector (from 40 to 55) we can observe that the nature of production in this group of sectors appears to be more dissimilar. This result is influenced, in part, by the structure of Distrito Federal service sector final demand.

South and Center-west Region: Differences in Output due to Final Demand – (SODL approach)

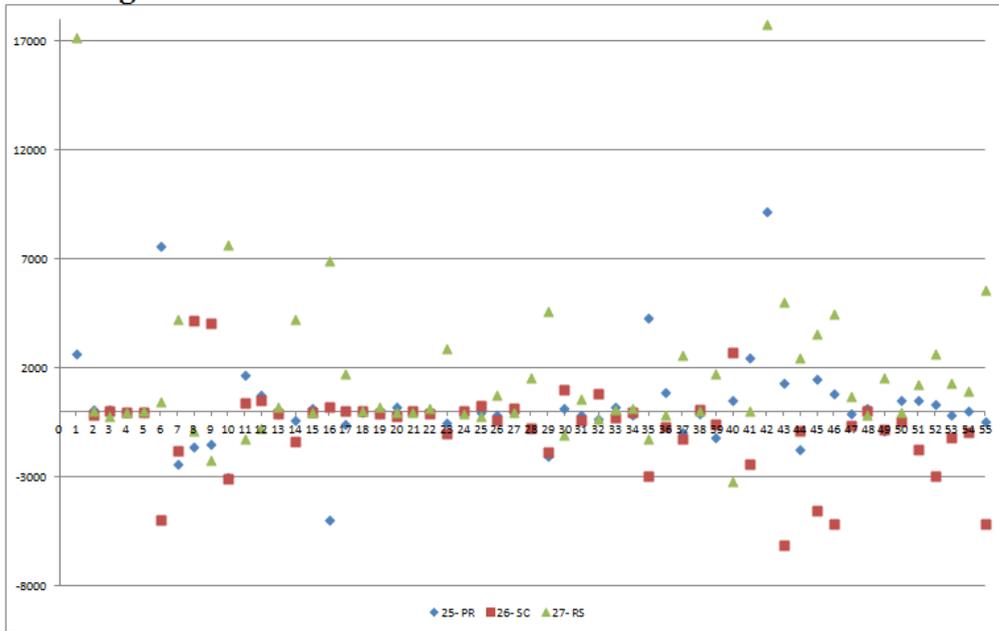## Figure 4A - AVERAGE IS SOUTH REGION
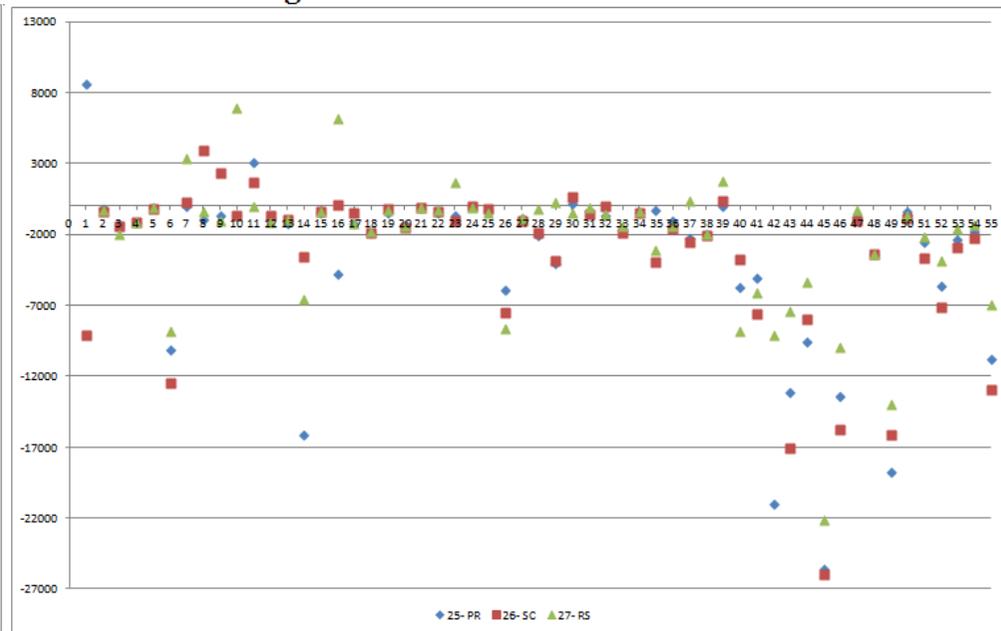
Figure 4B – AVERAGE IS SOUTHEAST

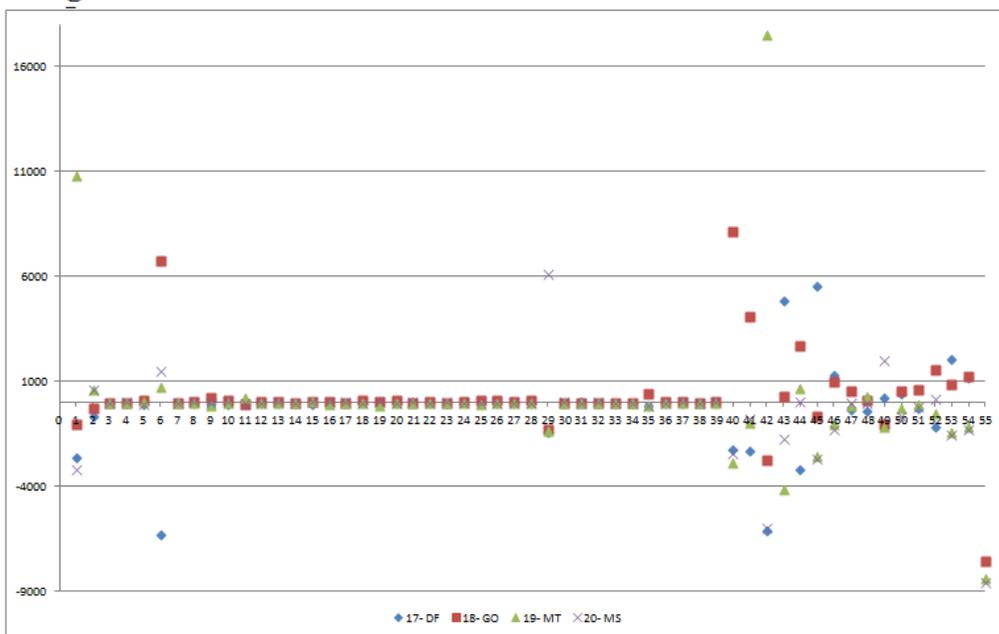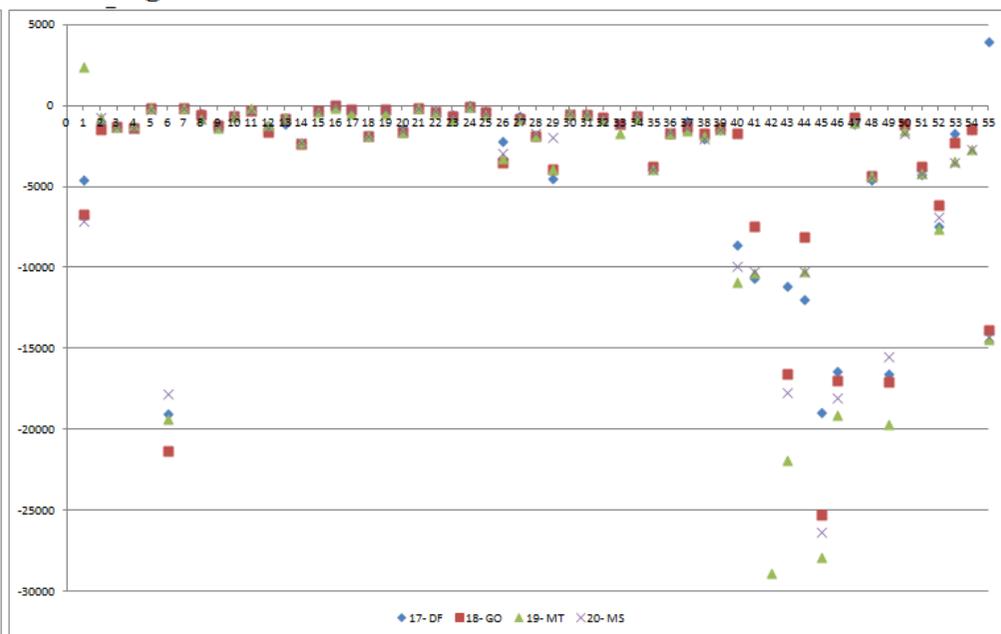## Figure 5A - AVERAGE IS CENTER-WEST REGION

Figure 5B – AVERAGE IS SOUTHEAST REGION

Source: Elaborated by the authors

The comparison between southeast region, as an average with south region (Figure 4B) enables us to verify the relative importance of South's final demand for some sectors. The positive results enable us to affirm that for those sectors the South's final demand is bigger than the Southeast average. This occurs for seven sectors located at Rio Grande do Sul state, five sectors located at Parana state and two sectors at Santa Catarina State. It is interesting to observe that for service and trade sectors the average final demand is bigger than the South's final demand.

Figure 5B shows the following pattern: as an exception for one sector located at Mato Grosso and one sector located at Distrito Federal for all the other sectors the final demand of Center-west states is smaller than the average.

The comparison showed in Figures 1A, 1B to 5A, 5B enables us to affirm that there is a huge difference between the Southeast final demand and the final demand from the rest of the country. We can affirm that this occurs, mainly for the service and trade sectors. As we can observe on the Figures, for those group of sector we have the major negative numbers.

The analysis of Figure 6A and B to 10A and B will enable us to concentrate in the analysis of the inter industry structure of the Brazilian states. We will explore this theme in intraregional terms as we did for final demand and also in inter regional terms. The interpretation of those Figures is more straightforward. Sectors that present larger positive values are more strongly oriented to inter industry, intrastate sales than their average region counterpart. We can make a correlation of this result with the Key sector analysis proposed by Hirschman-Rasmussen. We can affirm that sectors that are more heavily interdependent play an important role in regional economies. According to Jackson, *et al*. (1989) and Hewings, (1998) regions that are characterized by high levels of inter industry interaction are more complex, in the sense that more interaction is required. Regions whose industries are tightly interconnected through sales and purchases typically will have large multipliers.

Observing Figure 6A we can highlight the following results: Para is the state that presents the highest number of Key sector. Call the attention the results for primary sectors, not only for Para but also for the remaining states. This result occurs, mainly, for sector 1 and 2. Thus, we can conclude that there is a relative importance in this kind of activity among the states located at the North. On the other words it is possible to affirm that for these two sectors the region is more strongly oriented to inter industry, interstate sales. Amazon is the state that presents the second top results in terms of Key sectors. The majority of these sectors are located at the tertiary structure.

On the other hand, when we implement a comparison with the Southeast region (Figure 6B) the picture changes a lot. As we can observe only one sector can be classified as key. It is located at Amazon state. This puts in the evidence the spatial difference in Brazilian inter industry sales.

The results presented on Figure 7A shows that the results are highly correlated with the relative importance of the state in Northeast region economy. We can observe that Bahia, Ceara and Pernambuco are the states that present the highest number of Key sectors and they are the most important states in terms of the contribution to the regional GDP. The highest values are obtained by the Bahia state. These are: Petroleum refinery; Chemical products and trade.

For a comparison with the Southeast we verify that only three sectors (14 – Oil refining and coke, 16 – Chemicals and 17 Manufacture of resin and elastomers) located at Bahia state can be considered as Key-sector. This result corroborated the idea of the spatial heterogeneity in Brazil. This is a very interesting result because we can compare the degree of the orientation of inter industry, interstate sales of one region (e.g. Northeast) with the orientation of the most important region in terms of GDP. As far as the result is showing we are addressing that the spatial dimension of heterogeneity still persists in Brazil.

North and Northeast Region: Output Differences Due to Interindustry Structure
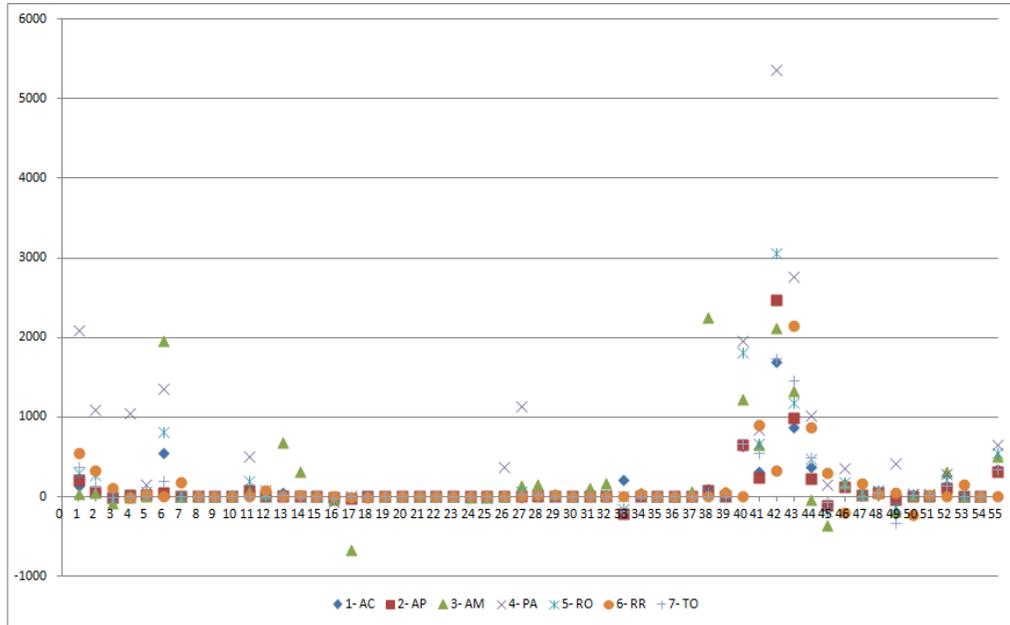
Figure 6A North Region as average

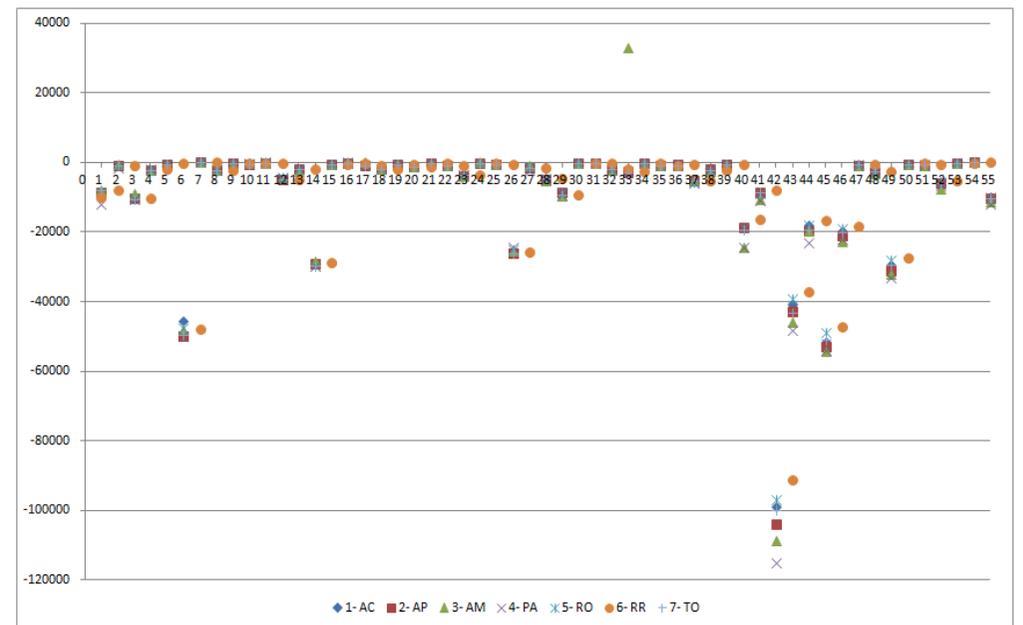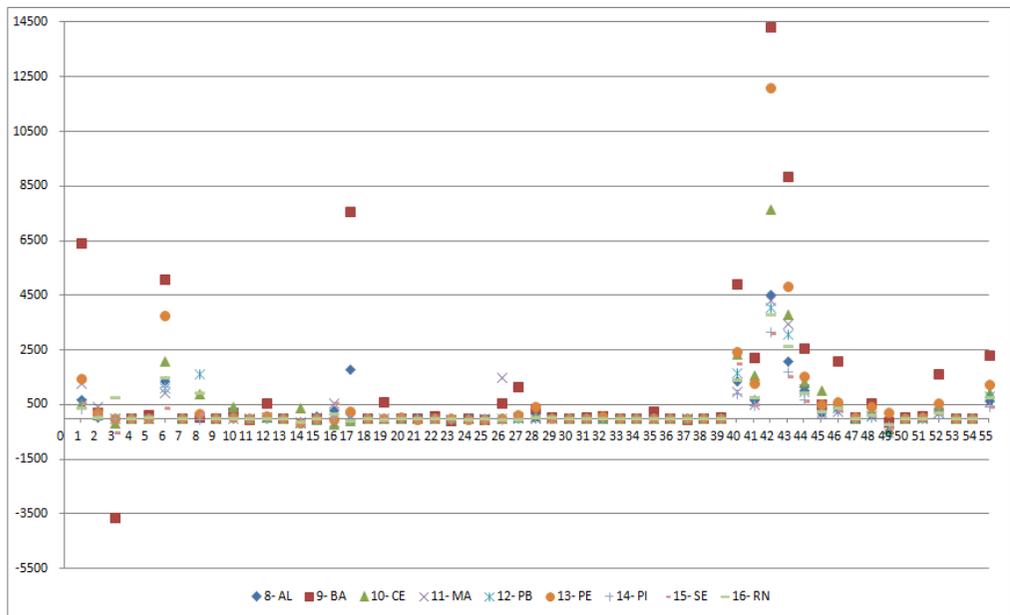## Figure 6B Southeast Region as average

Figure 7A Northeast Region as average

Figure 7B Southeast Region as average
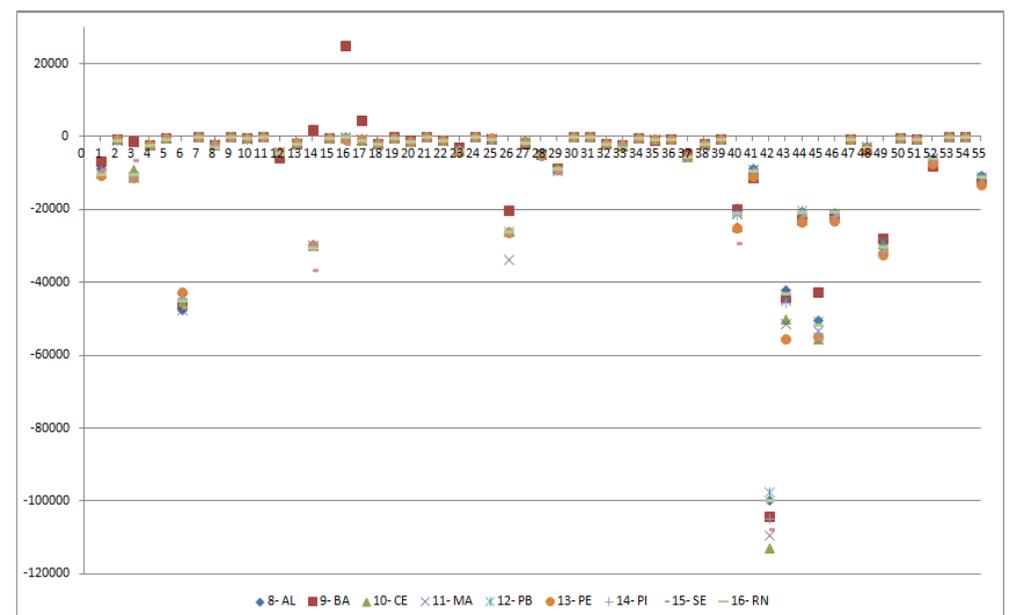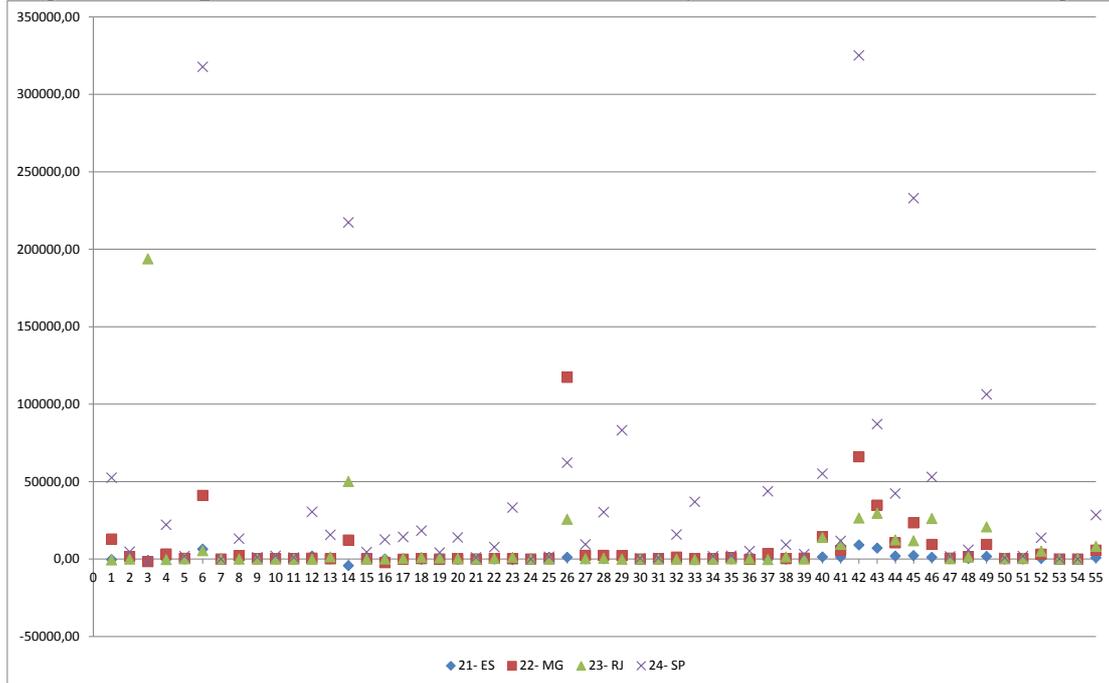

Source: Elaborated by the authors

Figure 8. Output Differences Due to Interindustry Structure – Southeast Region

Source: Elaborated by the authors

The comparison among the southeast regions shows the dominance of São Paulo state. The state presents the highest number of key sectors and these results is spread through the productive structure. Minas Gerais and Rio de Janeiro state have 10 sectors classified as key-sector. The two most important for Minas Gerais are sector 26 and 42 and for Rio de Janeiro are sector 3 (Oil and natural gas) and 14 (Oil refining and coke).

The analysis of Figure 9A enables us to affirm that Paraná and Rio Grande do Sul state are more strongly oriented to inter industry, intrastate sales than their average region counterpart. These result are spread thorough the economic sectors located on those states. We can highlight the results for Agriculture (PR); Food and Beverages (RS); Petroleum refinery (PR and RS); Machinery and equipment (RS) and Transport (PR and RS).

The methodology enables us to affirm that Rio Grande do Sul has the greatest number of Key-sector among the South's state. The state has 19 key-sector, Santa Catarina presents 16 and Paraná 12 sectors. The result enables us to affirm that there is diversity in terms of key-sector and in terms of intrastate sales.

Using Southeast region as an average (Figure 9B) we observe that agriculture sector is a key one for all the three states located at the South; Rio Grande do Sul and Paraná present three sectors classified as key; the major difference occurs for the Service sectors.

The Centre-west region presents a very interesting result. We can divide the analysis in two groups. The first one formed by Agriculture and Service sectors and the second one formed by Industrial sector. The analysis of Figure 10A shows that for the first group there is an orientation to inter industry, intrastate sales greater than average region counterpart. We can highlight some key sectors in this group. They are: a) 1 (Agriculture, forestry, logging) and 2 (Livestock and Fisheries) (MT, MS and GO); b) 40 (Electricity, gas, water, sewage and cleaning); 41 (Construction); 42 (Trade); 43 (Transport, storage and mail); 45 (Financial intermediation and insurance) for all the states. On the other hand, we can affirm that Industrial sector presents, for the majority of industries, a weak orientation to inter industry, intrastate sales. Figure 10B show the high difference between these two regions. In other words, there is no sector classified as Key when the comparison is made with the Southeast part of the country.

South and Center-west Region: Output Differences Due to Inter industry Structure
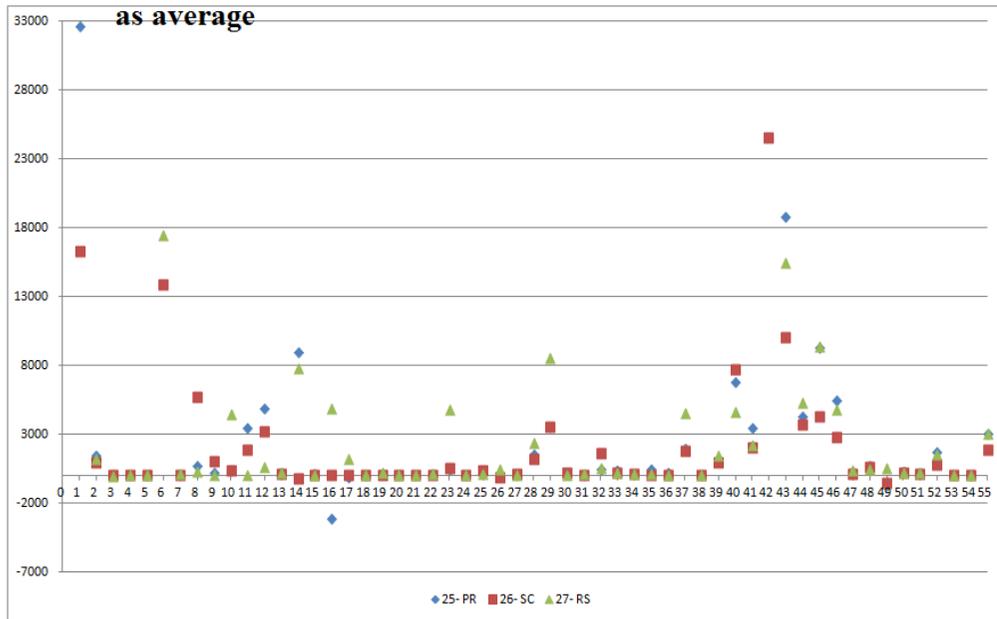
Figure 9A South Region as average
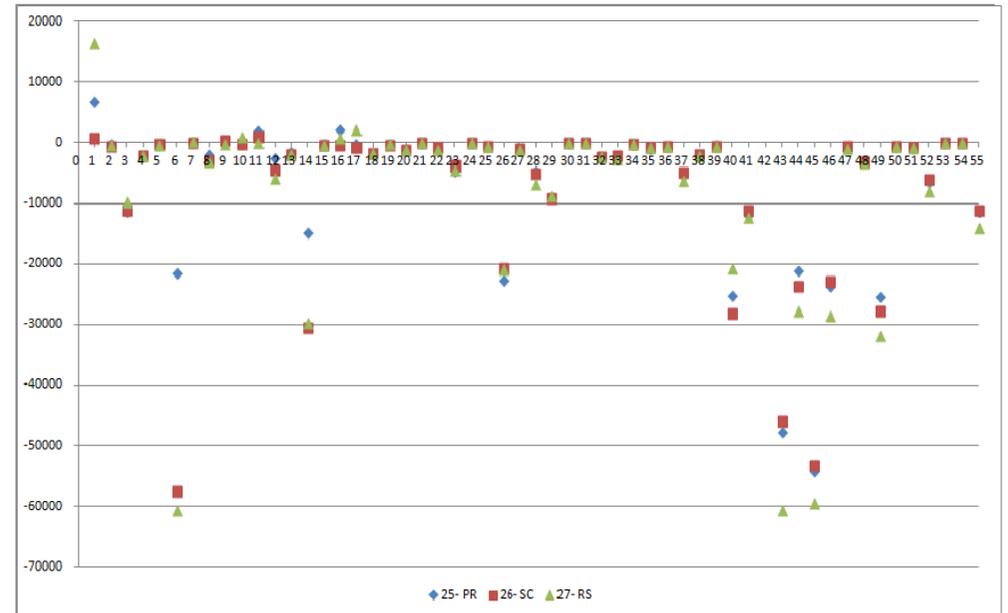

Figure 9B Southeast Region as average

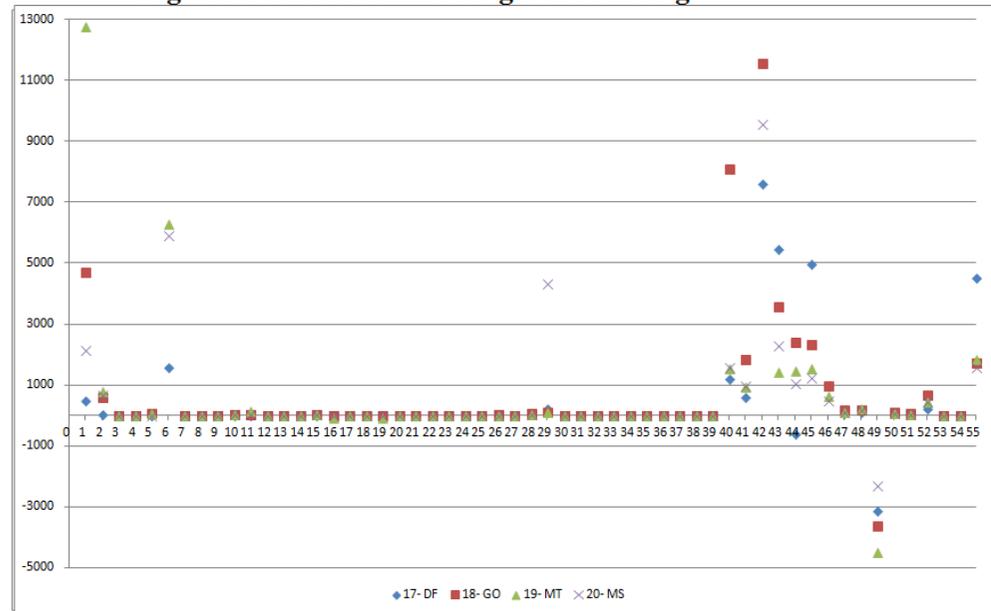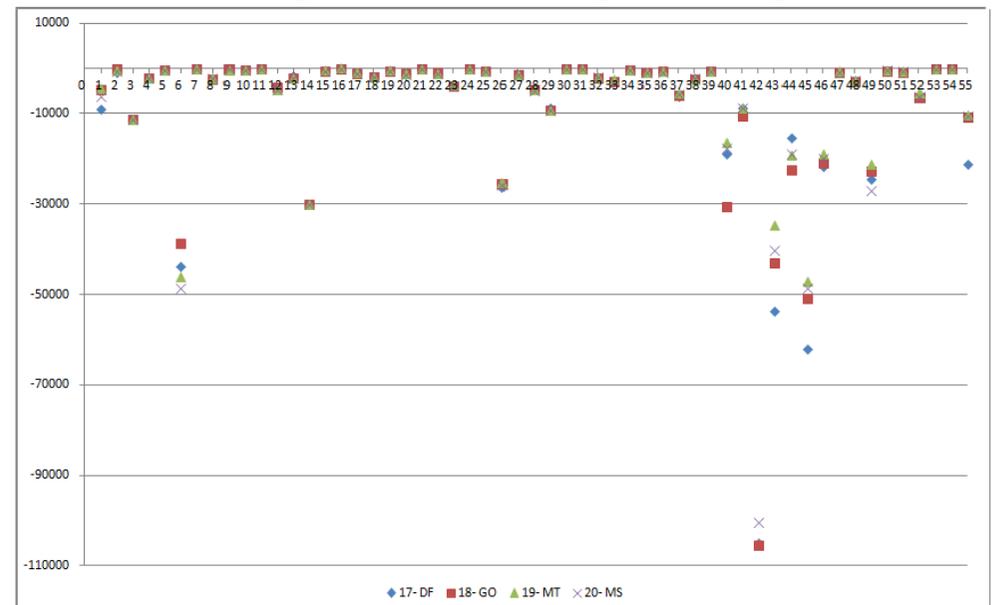### Figure 10A Center-west Region as average

Figure 10B Southeast Region as average

Source: Elaborated by the authors

Observing Figures 6B to 10B enables us to affirm that there is a strong difference between the orientations of the regions. The comparison with Southeast region shows that, for the majority of the sectors the results are located bellow the zero line. Thus the Southeast region is more oriented to inter industry, intrastate sales than the other Brazilian states. This emphasizes the difference in the degree of development inside the Brazilian economy.

Final Remarks

The idea behind the paper was going deep in the analysis of the differences in output changes for the Brazilian economy. In order to get this aim we implement a spatial decomposition analysis for all the 5 Brazilian macro regions. This analysis gave us a complete picture of the intra-regional and also inter regional disparities and similarities among the Brazilian states/regions and productive sectors. It is important to highlight that the results are in comparative terms and its comparison was implemented with a two averages. The comparison with the Southeast region enables us to shed light to the spatial heterogeneity among the Brazilian regions.

We can observe that the both intra and inter-regional differences are still established for the Brazilian economy. Observing the comparison with Southeast region as an average highlights the spatial heterogeneity in the Brazilian economy. For all the comparisons implemented is easy to see the superiority of Southeast region. This can be observed by the decrease in the number of key-sectors; by the scale results.

It is important to emphasize that the Southeast's results is highly pulled by the Sao Paulo state and the relative importance of this state persists up to recent period.

The use of inter-regional input-output table enables us to well address the topic of this paper and contributes to better understand the differences in sector scale. For this specific case we can call the attention to the results from service and trade sector. As the literature shows as far as a region grows the service sector tends to became relatively more important. The majority of negative results occurs for this group of sectors and is common to all Brazilian macro regions.

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APPENDIX 1 – REGIONS AND STATES OF BRAZIL

Number of Identification	Acronym	States	Regions
1	AC	Acre	North
2	AP	Amapá	
3	AM	Amazonas	
4	PA	Para	
5	RO	Rondônia	
6	RR	Roraima	
7	TO	Tocantins	
8	AL	Alagoas	Northeast
9	BA	Bahia	
10	CE	Ceará	
11	MA	Maranhão	
12	PB	Paraíba	
13	PE	Pernambuco	
14	PI	Piauí	
15	SE	Sergipe	
16	RN	Rio Grande do Norte	
17	DF	Distrito Federal	Center-West
18	GO	Goiás	
19	MT	Mato Grosso	
20	MS	Mato Grosso do Sul	
21	ES	Espírito Santo	Southeast
22	MG	Minas Gerais	
23	RJ	Rio de Janeiro	
24	SP	São Paulo	
25	PR	Paraná	South
26	SC	Santa Catarina	
27	RS	Rio Grande do Sul	

Source: Elaborated by the authors

APPENDIX 2 – SECTORS OF INPUT-OUTPUT MATRIX 55X55 (BRAZIL).

Number of Identification	Sectors
1	Agriculture, forestry, logging
2	Livestock and Fisheries
3	Oil and natural gas
4	Iron Ore
5	Other extractive Industry
6	Food and Beverage
7	Tobacco products
8	Textiles
9	Articles of apparel and accessories
10	Artifacts of leather and footwear
11	Wood products - excluding furniture
12	Pulp and paper products
13	Newspapers, magazines, records
14	Oil refining and coke
15	Alcohol
16	Chemicals
17	Manufacture of resin and elastomers
18	Pharmaceuticals
19	Agricultural chemicals
20	Perfumery, hygiene and cleaning
21	Paints, varnishes, enamels and lacquers
22	Chemical products and preparations
23	Rubber and plastic
24	Cement
25	Other products of non-metallic mineral
26	Manufacture of steel and steel products
27	Metallurgy of non-ferrous metals
28	Metal products - except machinery and equipment
29	Mach. and equipment, including maintenance and repairs
30	Appliances
31	Office machinery and computer equipment
32	Machinery, equipment and electronic material
33	Electronic material and communication equipment
34	Equipment / medical instruments and hospital
35	Cars, vans and utilities
36	Trucks and buses
37	Parts and accessories for vehicles
38	Other transport equipment
39	Furniture and products of various industries
40	Electricity, gas, water, sewage and cleaning
41	Construction
42	Trade
43	Transport, storage and mail
44	Information services
45	Financial intermediation and insurance
46	Real estate services and rental
47	Maintenance and Repair
48	Accommodation services and meals
49	Business services
50	Private Education
51	Private Health
52	Other Services
53	Public Education
54	Public Health
55	Public administration and social security

Source: Elaborated by the authors