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

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

*This paper was prepared to be presented at the European Regional Science Conference and is in a preliminary format*

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## 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 regions and 56 sectors in each region. 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 method provides a measure of the differences in interindustry structure among regions and also provides a measure of the way in which differences in interindustry structure and final demand distributions differentiate production across.

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 interindustry 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

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

### **Introduction**

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 intersectoral 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 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 interindustry structure among regions and also provides a measure of the way in which differences in interindustry structure and final demand distributions differentiate production across.

This paper is organized as follows. The second section present the literature review. On the first part we examine the state of the art 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 The state of the art of Structural Decomposition Analysis***

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. 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 (Thakur, 2011; Fernández-Vasquez, Los and Ramos-Carvajal, 2008; Guo, Hewings and Sonis, 2006; Dietzenbacher, 2001; Dietzenbacher et al., 2000; Liu and

Saal, 2001; Casler, 2000; Durand and Markle, 1994; Gunluck-Senensen and küçükçi, 1994; Dewhurst, 1993; Gowdy, 1991; Barker, 1990)

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.

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.

## ***2.2 Regional Inequalities in Brazil***

The discussion on regional inequalities in Brazil begins with Furtado (1974). The author 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 find similar results, ie, 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, Lavinás (1997) brings just evidence of growing inequality in the period 1990/94.

### **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 regions and 56 sectors in each region. Appendix I present the list of sectors and 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 interindustry 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<sup>4</sup>***

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

(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:

(2)

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

(3)

(4)

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<sup>4</sup> This section is based on Jackson and Dzikowski (2002).

Interperiod gross output changes can be expressed in one of two ways. Subtracting (3) from (4), then both adding and subtracting to the right hand side of the difference equation provides:

(5)

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

(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.

(7)

(8)

S – represents regions.

M – represents average economy.

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 on the right hand side.



(9)

Or

(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 interindustry structure,  $\bar{A}$ . The second term enables us to calculate the portion of output differences due to the study region,  $\Delta A$ .

There is another way to present the spatial output decomposition. It follows like that:

(10)

Or

(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 interindustry distribution,  $A^s$ . The second term measures the portion of industry output difference due to differences in interindustry coefficients weighted by the final demands. This can be calculated in levels or standardized terms, for the  $\bar{A}$ .

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:

- (12)

Where  $\bar{a}_{ij}$  and  $a_{ij}^s$  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 interindustry coefficients:

$$- \tag{13}$$

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

#### **4. Results<sup>5</sup>**

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” each of the five Brazilian macro-regions. So each Brazilian state will be compared with the “average structure of production of its own macro region and with the other macro regions.” In Figures 1 to 5 we will use the North region as average and are based on equation 12 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:

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<sup>5</sup> In this section we will present only the standardized result.

- a) in SODL final demand analysis, a large positive value for an industry sector in a given Brazilian state identify, 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.

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

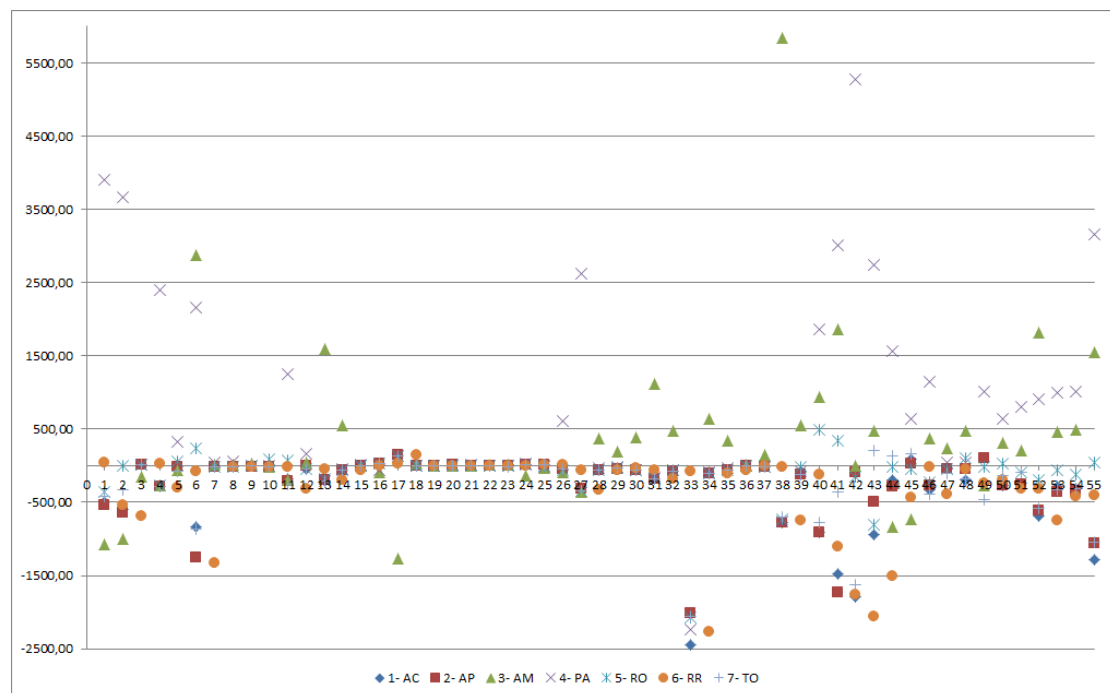
In this version of the paper we will explore only the intra-regional results. This means that we will show the gross output decompositions results in 5 groups. This strategy will enable us to identify which sectors have the largest range of structural variation and which states differ most strongly from the average region. Figures 1 to 5 displays the results by state for each Brazilian macroregions. Figures 1 to 5 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 1 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 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). In sectoral terms we can see that this results occurs more consistently for service sectors (from 40 to 55). We also highlight, for Para, the results obtained by the

primary sectors. (1 to 5). Amazon state presents a similar pattern but we can highlight some industrial results (Sectors 28 to 35).

On the other side we can note the results for Rondonia and Roraima. For these states we can attribute the results to its lower final demand levels. This occurs mainly for the tertiary sectors (trade and services).

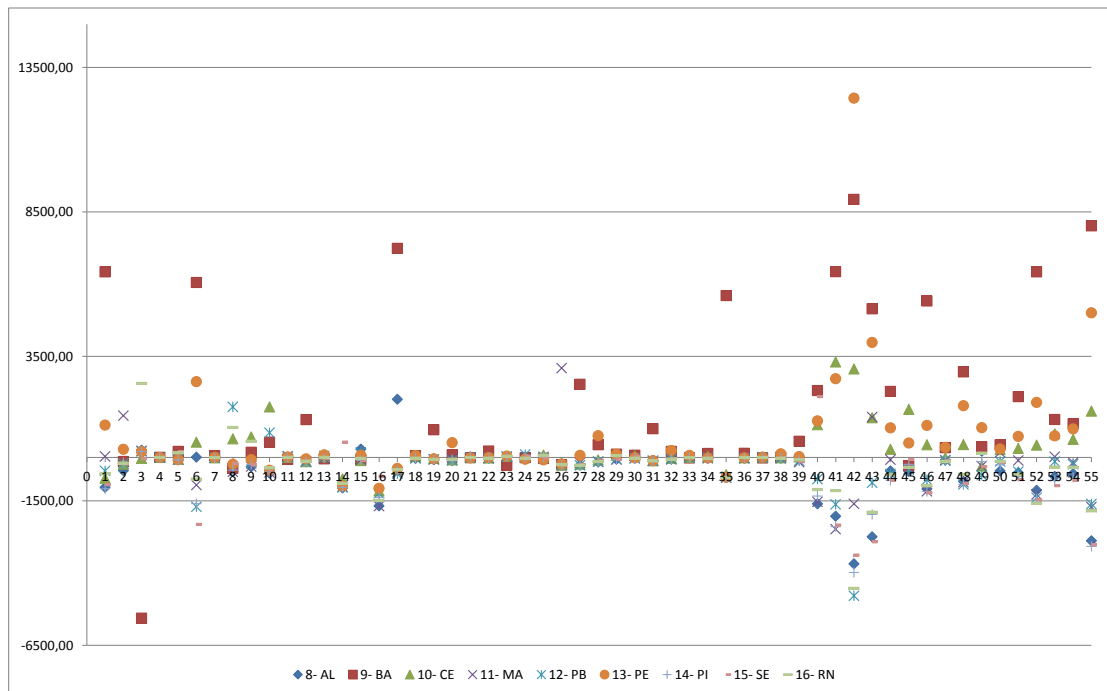
**Figure 1. North Region: Differences in Output due to Final Demand – (SODL approach)**



Source: Elaborated by the authors

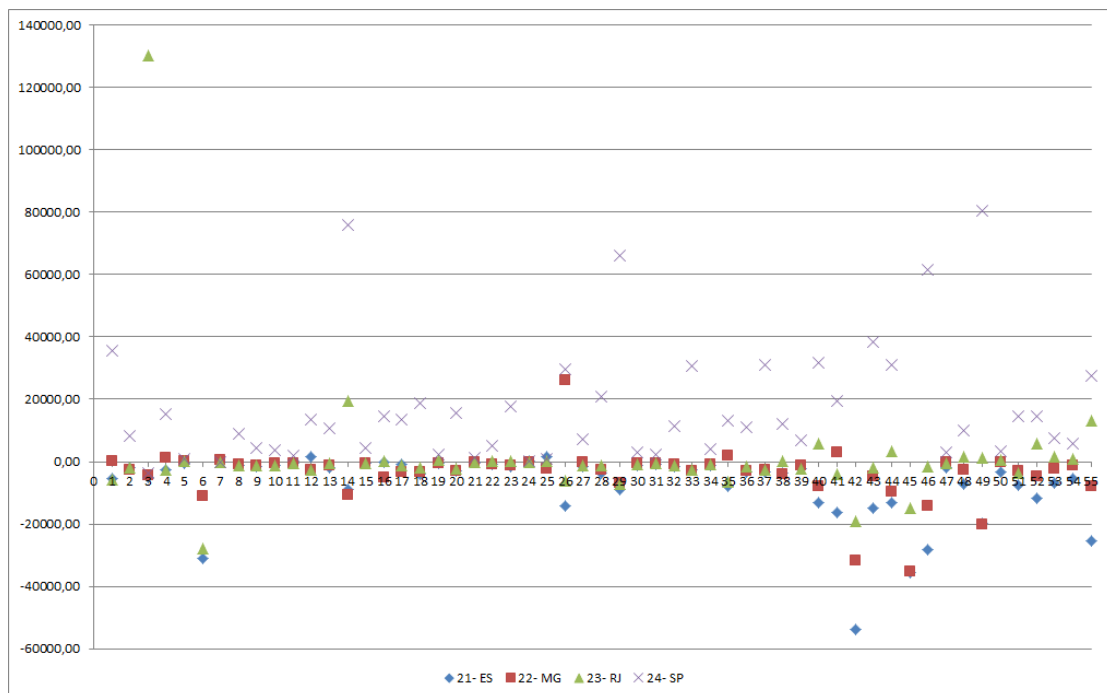
Figure 2 shows a comparison between the states located within the northeast region. We can see that Bahia state dominates the results in terms of final demand levels, especially for tertiary sectors. For those sectors we can also point that Pernambuco and Ceara states present results greater than average. For this group of sectors it is possible to affirm that the region presents a dichotomous result. On the other side (lower final demanders) we can call the attention to Alagoas, Maranhão, Paraíba, Piauí, Sergipe and Rio Grande do Norte states. The region presents more similar results for the industrial sector (18 to 39)

**Figure 2. Northeast Region: Differences in Output due to Final Demand – (SODL approach)**



Source: Elaborated by the authors

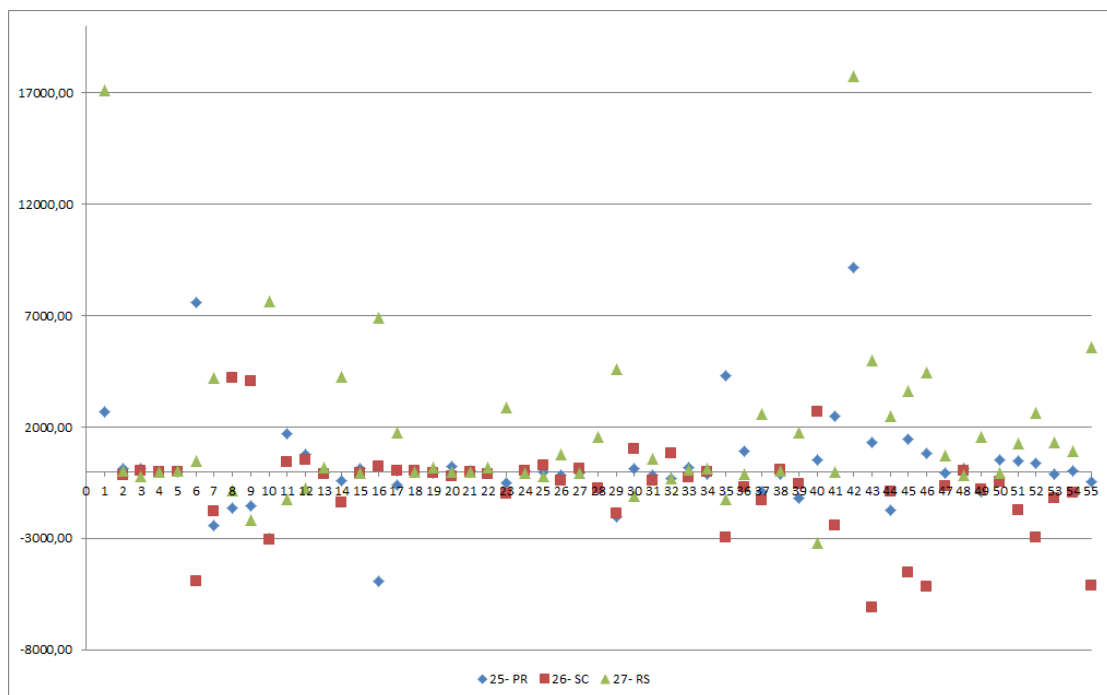
**Figure 3. Southeast Region: Differences in Output due to Final Demand – (SODL approach)**



Source: Elaborate by the authors

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. On the other side we have the Espirito Santo state that presents final demand level consistently lower than the average.

**Figure 4. South Region: Differences in Output due to Final Demand – (SODL approach)**



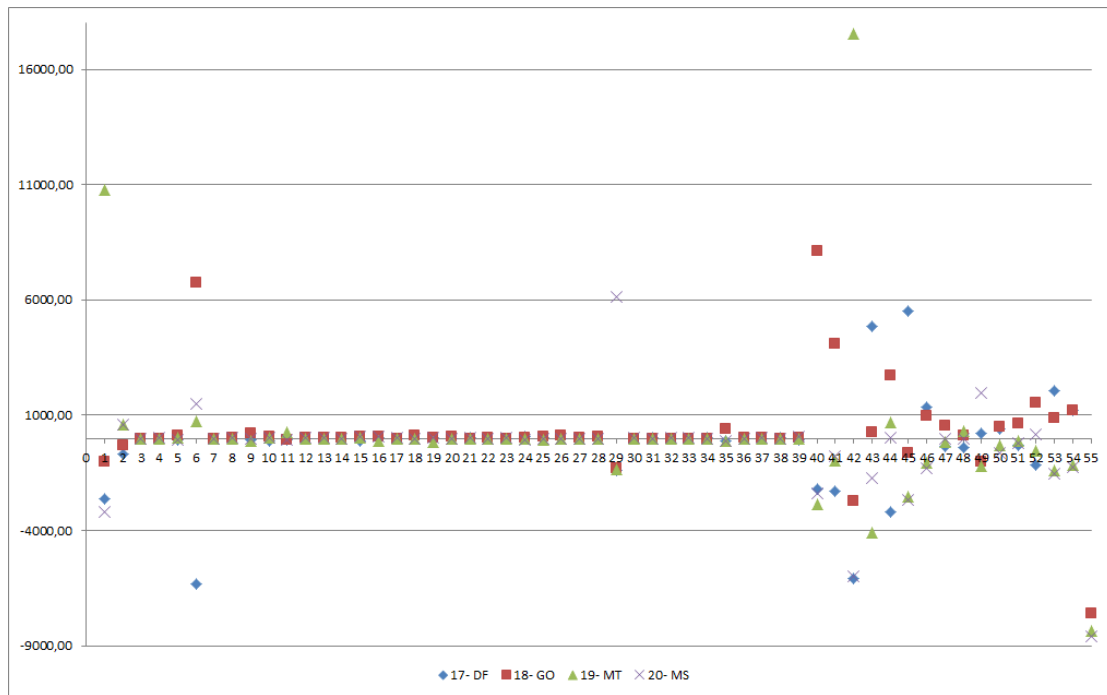
Source: Elaborated by the authors

Observing Figure 4 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 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 contribution of Santa Catarina's final demand level is consistently below the average.

Figure 5 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 macroregions, a higher level of similarity of the contribution of final demand for the output differences among the states.

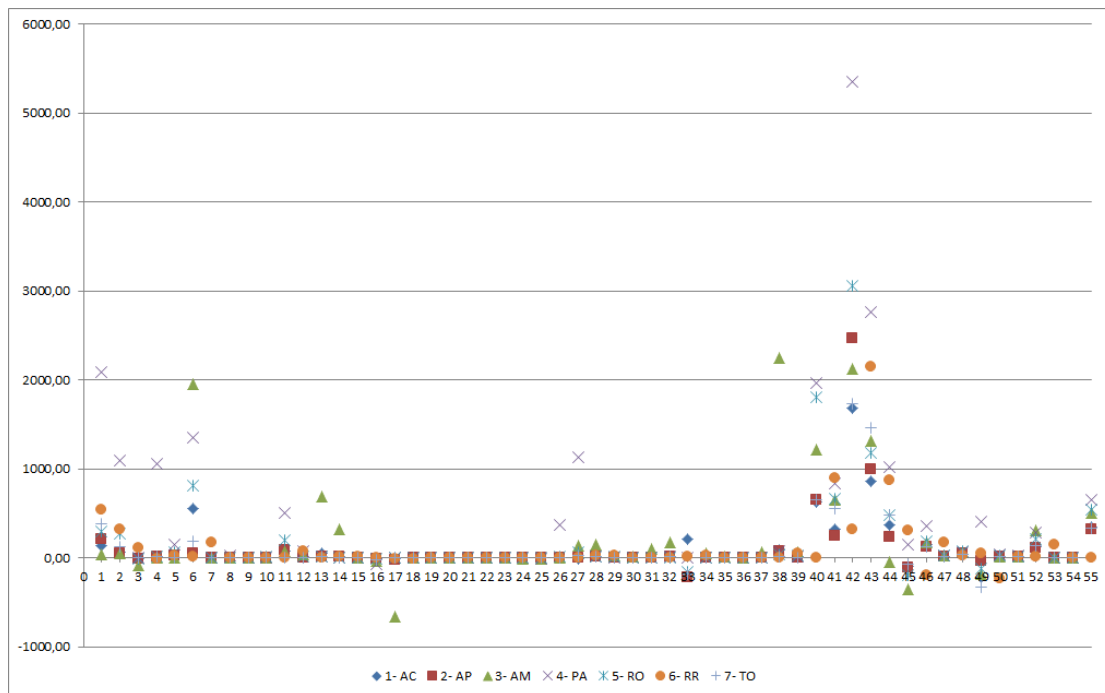
**Figure 5. Center-west Region: Differences in Output due to Final Demand – (SODL approach)**



Source: Elaborated by the authors

The analysis of Figure 6 to 10 will enable us to concentrate in the analysis of the interindustry structure of the Brazilian states. We will explore this theme in intraregional terms as we did for final demand. The interpretation of those Figures is more straightforward. Sectors that present larger positive values are more strongly oriented to interindustry, 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 interindustry 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.

**Figure 6. Output Differences Due to Interindustry Structure – North Region**



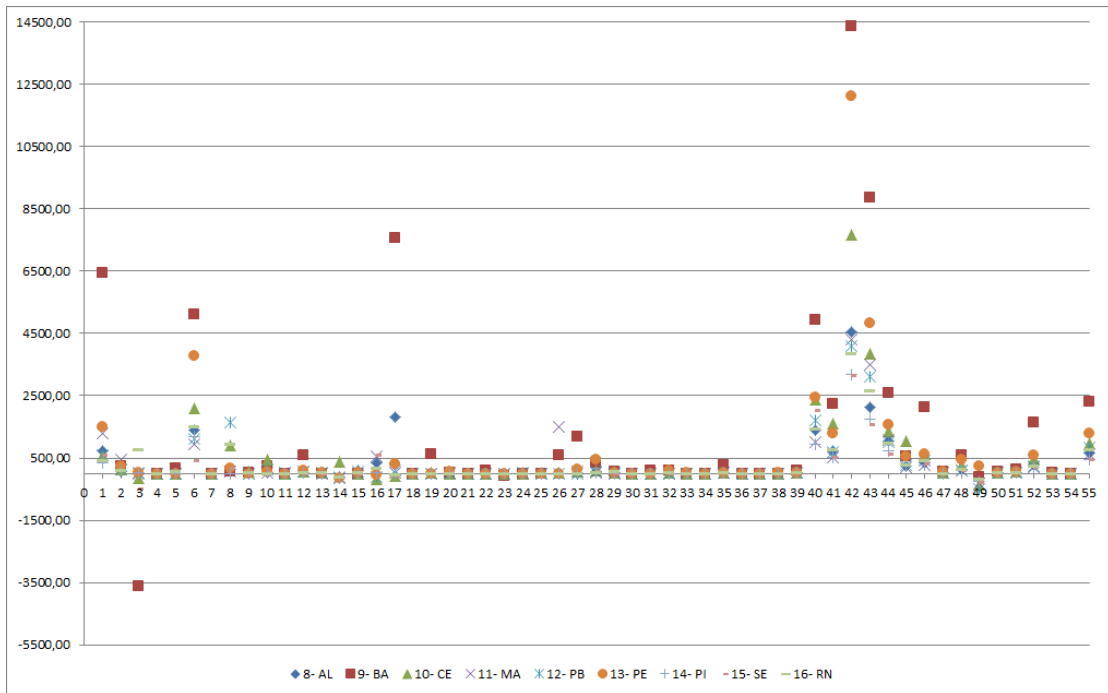
Source: Elaborated by the authors

Observing Figure 6 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. 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.

The results presented on Figure 7 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.

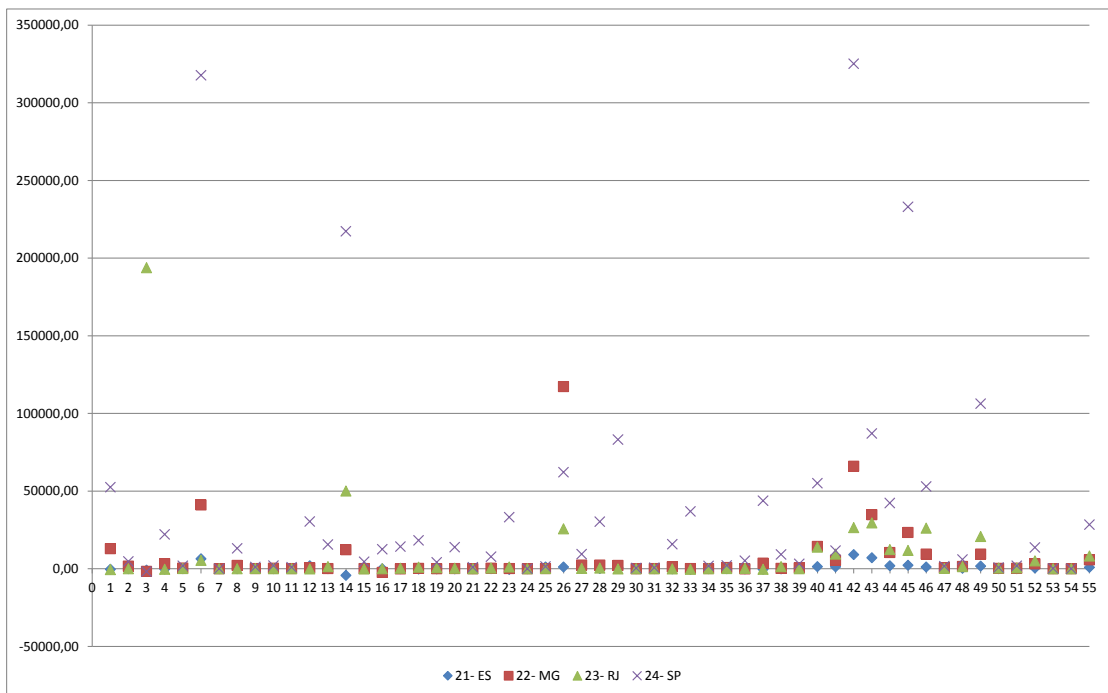


**Figure 7. Output Differences Due to Interindustry Structure – Northeast Region**



Source: Elaborated by the authors

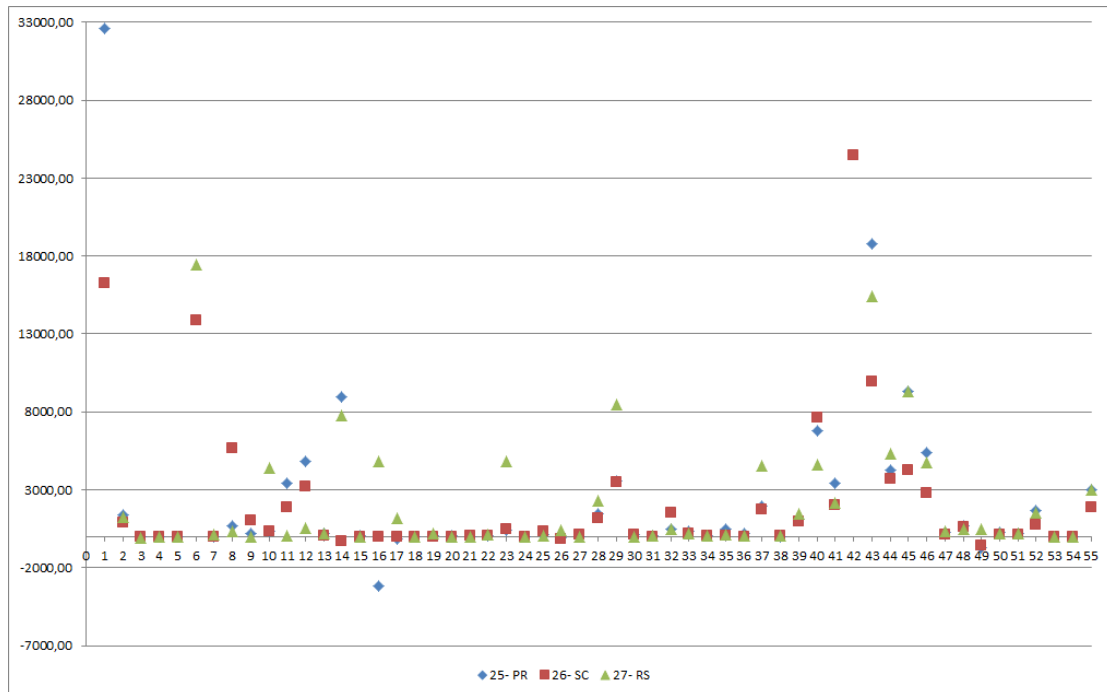
**Figure 8. Output Differences Due to Interindustry Structure – Southeast Region**



Source: Elaborated by the authors

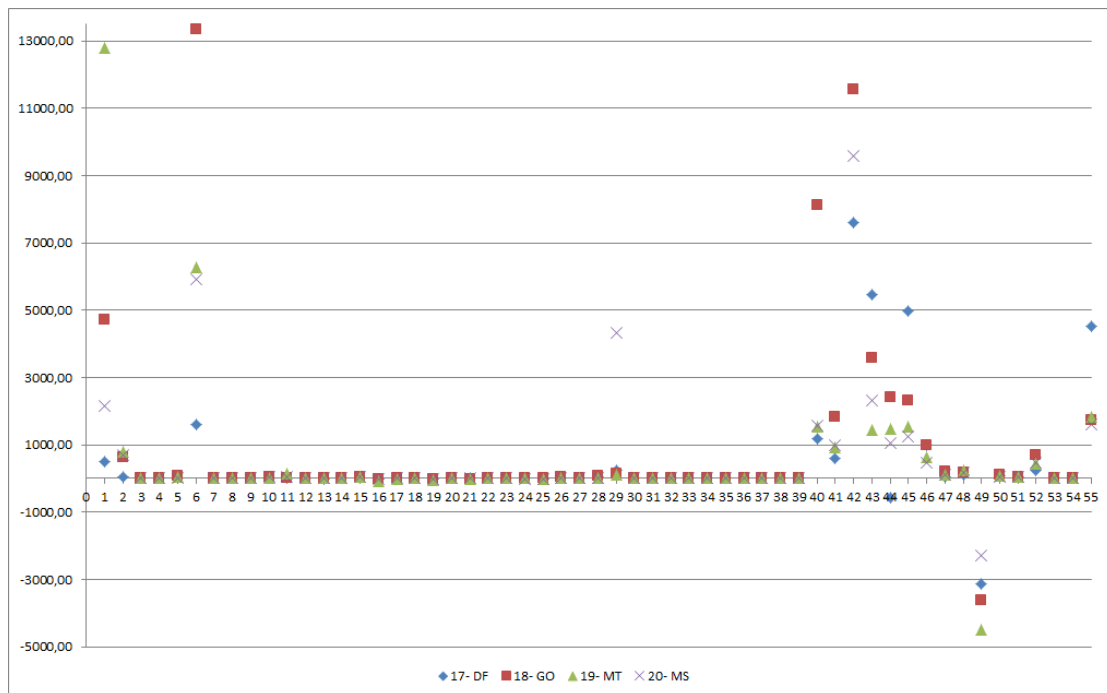
The comparison among the southeast sectors shows the dominance of São Paulo state. The state presents the highest number of key sectors and these results is spread through the productive structure.

**Figure 9. Output Differences Due to Interindustry Structure – South Region**



Source: Elaborated by the authors

**Figure 10. Output Differences Due to Interindustry Structure – Centre-west Region**



Source: Elaborated by the authors

The key sectors are concentrated in service group sector. In all the states in this region sectors 40 to 46 are classified as key-sector.

### **Final Remarks**

The idea behind the paper was going deep in 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 macroregions. This analysis gave us a complete picture of the intra-regional situation. It is important to highlight that the results are in comparative terms and its comparison was implemented with a regional “average”.

Thus all the debate was in regional terms. We know that if we use another measure of average, suppose São Paulo, or the whole country some results will change. This will be one of the extensions of the paper. This extension will enables us to measure the inter-regional differences. In other words for final demand we will have an idea of the influence of final demand in northeast upon the output of an external region.

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