THE BRAZILIAN STRUCTURE OF INTERDEPENDENCE: AN INPUT-OUTPUT APPROACH FOR THE PERIOD 1996 - 2002

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TD. Mestrado em Economia Aplicada FEA/UFJF 001/2008

Juiz de Fora
2008

The Brazilian structure of interdependence: an input-output approach for the period 1996 - 2002[♦]

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This paper wants to analyze the Brazilian structure of interdependence among the Brazilian states during the period 1996 – 2002 to classify and identify the role that each state plays in interregional trade. In order to reach this aim we will use the structure of an interregional input-output matrix for the Brazilian economy. We will use the following measures to analyze the structure of interregional trade: a) direct and indirect interregional interdependence – this idea will be developed through the Chenery and Watanabe (1958) coefficients; b) the order of interdependence – we will use the Streit (1969) index; c) Rasmussen (1963) index; and d) the extraction method (Dietzenbacher et al, 1993). The empirical results are based on the 1996 and 2002 interregional input-output table for the Brazilian states. The nature of this type of data enables us to focus on the sectoral as well as the spatial dimension of the interdependence.

1. Introduction

The input-output model enables us to analyze the flows of goods and services in an economy. This model is a suitable framework to identify interdependence among regions in a country. The model can be regional and interregional. In this paper we will deal with the interregional structure that is appropriate to model the trade pattern.

According to Pavia et al (2006) the interregional approach is good to very which are the impacts of a specific region upon others and which region presents the highest multiplier effect. Furthermore it enables us to better understand the degree of interactions among regions.

The literature presents a range of indicators to make the analysis of interaction among regions. We can highlight the contributions from Chenery-Watanabe; Rasmussen, Dietzembacher, and others. The Chenery-Watanabe indicators capture only the direct effect (forward – the dependence of a region by the supply side and backward – the dependence of a region by the demand side).

It is well know that the trade flows between regions can, at the same time, induce transactions in other regions. For example, if region *i* demand inputs from region *j*, that

[♦] We would like to thanks the financial support from FAPEMIG and CNPq to develop this research.
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demand inputs from region *k* to produce demanded inputs by region *i*, the region *i* is indirectly dependent upon region *k*. In order to improve the analysis, Rasmussen constructs a new indicator using the Leontief Inverse. This indicator measures the direct and indirect effects.

This paper will deal with the idea of interdependence using a wide range of indicators: a) Chenery-Watanabe; b) Rasumessen; c) Key sector and d) Extraction Method[6]. It is important to highlight that we will implement the study in an interregional matrix for the Brazilian economy for the years 1996 and 2002. Those matrices were elaborated by FIPE (Fundação Instituto de Pesquisas Econômicas).

2. Methodological Aspects and Database

In a basic interregional input-output model the total demand can be divided into exports to the rest of the country, exports to the rest of total domestic demand (including final and intermediate demand). The supply is classified in imports from the rest of the country, from other countries and total domestic production (including final production and intermediate). Thus the exports of region "*i*" to other countries is denoted by x_i^X, the total domestic demand in region "*i*" is d_i, the imports of region "*j*" to other countries is x_j^I, the local total production of region "*j*" is q_i, and the exports of region "*i*" to region "*j*" is x_{ij} with x_{ii}=0 and the own use of region "I" products is included in d_i. Thus the equilibrium is:

$$\sum_{j=1}^{R} x_{ij} + x_i^X + d_i = x_i = \sum_{j=1}^{R} x_{ji} + x_j^I + q_i \quad (i = 1, \ldots, R) \tag{1}$$

Where *R* represents the number of regions and x_i represents the total demand in the region "*i*". The trade between regions can be expressed by an input-output matrix, where the inter-sectoral transactions are changed by interregional ones. In this way, if an interregional transactions and transfers matrix *RxR* is defined by *T*, a linear relation for *R* of equation (1) can be expressed as:

$$Ax + y = x, \tag{2}$$

Where $A = T\hat{X}^{-1}$ is a matrix of technical coefficients, x is a vector Rx1 of total supply, $\hat{X} = diag(x)$ is a diagonal matrix *RxR* of total regional demand and y is a vector Rx1 of total internal and external demand.

The a_{ij} coefficient of matrix A show the marginal propensity of region "*j*" to import products of region "*i*" and captures the degree of relationship between regions "*j*" and "*i*". This matrix shows the direct effects of interregional trade flows. Thus the Leontief inverse shows the indirect effects.

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[6] For a complete reference about the different types of extraction methodology see Miller and Lahr (2001)

2.1 Chenery-Watanabe Indicators:

The backward effects were calculated by the sum of each column of matrix A and reflect the direct dependence of region "*j*" upon the imports from other regions. In this way, the region that presents a high value for μ_j shows a high degree of dependence of imports from the rest of the country meaning that needs the exports of other regions to satisfy the increase in its own domestic demand. Regions that present, in relative terms, a high value for μ_j will be identified as imports regions. On the other side, regions that present a small value for μ_j will be considered regions with a small imports potential.

Backward Effects: $$\mu_j = \frac{\sum_{i=1}^{R} x_{ij}}{x_j} = \sum_{i=1}^{R} a_{ij} \qquad (3)$$

The forward effects are calculated through the sum of rows in the matrix $\hat{X}^{-1}T$.The coefficient ω_i measure the relative importance that the demand for the rest of the country has upon the total demand of region "i" and shows the direct dependence that interregional trade has upon region "i". Thus, a high value for the coefficient means that this regions exports more than the others. The regions that present a high value for this coefficient will be classified as exporter regions. On the other side, regions with small values for the coefficient show a low capacity to export. The coefficient values and its averages enable us to classify them in four groups.

Forward Effects: $$\omega_i = \frac{\sum_{i=1}^{R} x_{ij}}{x_j} \qquad (4)$$

Table 1

Chenery Watanabe - Regional Classification of Trade Flows

	$\mu_j > \bar{\mu}$	$\mu_j < \bar{\mu}$
$\omega_j > \bar{\omega}$	Exporter and Importer regions	Non exporter region and importer region
$\omega_j < \bar{\omega}$	Exporter and non importer regions	Non exporter and importer region

Source: Adpated from Pavia et al

These indicators and its classifications show important information. Despite the information the Chenery-Watanabe coefficients have a range of restrictions: (1) the coefficients do not have weight. They do not take into account the relative potential that each region has to modify the interregional trade flow; (2) The coefficients are unable to differentiate a concentrated trade flow in a small group of regions from disperse trade flows; (3) They measure only the direct effects. (4) It is a general indicator and do not take into account de degree of interactions among regions. Actually we use the Chenery-Watanabe coefficients to show general aspects of dependence instead of show specific aspects.

2.2 Rasmussen Indicator:

Up to this moment, the analysis takes into consideration only the direct effects. In other to have more precise conclusions, the indirect effects have to be incorporated. Rasmussen considers explicitly the indirect effects. For doing this the author uses the Leontief Inverse.

Backward Effects:

$$G_j = \frac{\sum_{i=1}^{R} I_{ij}}{\frac{1}{R}\sum_{j=1}^{R}\sum_{i=1}^{R} I_{ij}} \tag{5}$$

Forward Effects:

$$C_i = \frac{\sum_{j=1}^{R} I_{ij}}{\frac{1}{R}\sum_{i=1}^{R}\sum_{j=1}^{R} I_{ij}} \tag{6}$$

Tem term I_{ij} is the element of Leontief Inverse and means the additional quantity of exports of region "*i*" that is necessary, direct and indirectly, due to an additional unit upon the domestic and external demand in region "*j*".

In this sense, the condition $C_i > 1$ will happen for regions with high capacity to satisfy, through exports, the increase in the domestic demand in all the regions. This kind of region will be considered with a high capacity to impact, forward, the interregional trade. On the other side, regions with $G_j > 1$ are regions that to cover an increase in its domestic demand induces impacts above the average in the interregional trade flows. Those regions are classified with strong backward effects. Using those coefficients is possible to elaborate new regional classifications:

Tabela 2

Rasmusem - Regional Classification of Trade Flows

	$C_i > 1$	$C_i < 1$
$G_j > 1$	Exporter and Importer regions	Non exporter region and importer region
$G_j < 1$	Exporter and non importer regions	Non exporter and importer region

Source: Adpated from Pavia et al

2.3 Extraction Method[7]

Consider the general case of an inter-regional input-output model with N regions and n productive sectors in each region[8]. The model is given by:

$$x = Ax + f \qquad (1)$$

where: x – the nN-element column output vector.
A – the nN x nN matrix of input coefficients.
f – the nN-element column vector of final demand.

The solution of equation (1) will be:

$$x = (I - A)^{-1} f \quad or \quad Lf$$

$$where \;\; L = (I - A)^{-1} \;\; is\ the\ Leontief\ Inverse$$

The output vector is partitioned as follows[9].

$$x = (x^{1'}, \ldots, x^{I'}, \ldots, x^{N'})$$

$$where\ x^I = (x_1^I, .. x_i^I, .. x_n^I)'$$

The coefficient matrix is constructed as follows:

$$A = \begin{bmatrix} A^{11} & \cdots & A^{1N} \\ \vdots & \ddots & \vdots \\ A^{N1} & \cdots & A^{NN} \end{bmatrix} \qquad (2)$$

The extraction method considers the effect of hypothetically isolate one region upon the output of the rest of the economy. Without loss of generality, let's suppose that the first region was extracted. Thus, the remaining N-1 regions will represent the rest of the economy10. Hence, we can write $x = (x^{1'}, x^{R'})'\ with\ x^R = (x^{2'}, \ldots, x^{I'}, \ldots, x^{N'})'$ a n(N-1) element column vector.

In a similar way, we have:

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[7] This section is based on Dietzenbacher, *et al* (1993) and Dietzenbacher (1997).
[8] The regions will be represented by superscripts *I,J= 1,…,N* and the products by subscripts *i, j= 1,…, n.*
[9] The vector *f* can be partitioned in the same way.
[10] In order to represent these regions we will use the superscript *R*.

$$A = \begin{bmatrix} A^{11} & A^{1R} \\ A^{R1} & A^{RR} \end{bmatrix} \quad (3)$$

Analogous to the equation (3), the Leontief inverse in its partitioned form is given by

$$L = (I - A)^{-1} = \begin{bmatrix} L^{11} & L^{1R} \\ L^{R1} & L^{RR} \end{bmatrix} \quad (4)$$

Based on the equation (4) we have:

$$x^1 = L^{11} f^1 + L^{1R} f^R \quad (5a)$$
$$x^R = L^{R1} f^1 + L^{RR} f^R \quad (5b)$$

With the hypothetical extraction of region 1, the model in equation (1) will be reduced and will assume the form:

$$\bar{x}^R = A^{RR} \bar{x}^R + f^R$$

The vector $\bar{x}^R$ represents the product of the rest of the economy for the reduced model. The solution of the reduced equation is:

$$\bar{x}^R = (I - A^{RR})^{-1} f^R \quad (6)$$

The difference between x^R (equation 5b) and $\bar{x}^R$ (equation 6) will give the extraction effect of region 1 upon the product of the rest of the economy. In order to interpret the elements of vector $x^R - \bar{x}^R$, we have to calculate the matrix L as the inverse of partitioned matrix as follows:

$$L^{1R} = L^{11} A^{1R} (I - A^{RR})^{-1} \quad (7a)$$
$$L^{R1} = (I - A^{RR})^{-1} A^{R1} L^{11} \quad (7b)$$
$$L^{RR} = (I - A^{RR})^{-1} + (I - A^{RR})^{-1} A^{R1} L^{11} A^{1R} (I - A^{RR})^{-1} \quad (7c)$$

Hence we have:

$$x^R - \bar{x}^R = L^{R1} f^1 + \left[L^{RR} - (I - A^{RR})^{-1} \right] f^R \quad (8a)$$
$$= (I - A^{RR})^{-1} A^{R1} L^{11} \left[f^1 + A^{1R} (I - A^{RR})^{-1} f^R \right] \quad (8b)$$

The interpretation of the expression $x^R - \bar{x}^R$ can be divided into two parts: a) the first one $\left(L^{R1} f^1\right)$ describes the production in the rest of the economy that is necessary to satisfy the final demand f^1 in region 1 and b) the second part, $\left[L^{RR} - (I - A^{RR})^{-1}\right] f^R$, describes the production in the rest of the economy $L^{RR} f^R$ that is necessary to satisfy the final demand in the rest of the economy f^R.

We can observe that the elements of vector $x^R - \overline{x}^R$ show the interdependence between the region 1 and the other regions. According to Dietzenbacher et al (1993), these interdependencies are fundamentally backward in their nature. These can be demonstrated using the matrix A^{R1} (whose elements indicate the backward dependence of 1 on R) and A^{1R} (whose elements indicate the backward dependence of R on 1).

In order to better understand the expression $x^R - \overline{x}^R$, we will use the equation (8b) and examine this equation using the idea of interregional spillover effect and interregional feedback effects developed by Miller and Blair (1985).

To satisfy the final demand f^1 in region 1, this region must produce $L^{11} f^1$. Region 1 does not have all the inputs necessary to reach this level of production. So, with the aim of achieving this production, it is necessary that region 1 purchases inputs direct from the other regions. The amount of inputs purchased will be $A^{R1} L^{11} f^1$. To provide these inputs, the production in the rest of the economy is required to become $\left(I - A^{RR}\right)^{-1} A^{R1} L^{11} f^1$. The same analysis can be made for the demand in the rest of the economy f^R.

Applying the traditional idea of inter-regional feedbacks to region 1, it is possible to affirm that the feedbacks for this region will be obtained by comparing the outputs of region 1 within the inter-regional model to the outputs of region 1, within the single-region model. In a mathematical form we have:

$$x^1 - \overline{x}^1 = L^{11} f^1 + L^{1R} f^R - \left(I - A^{11}\right)^{-1} f^1 \qquad (9)$$

Taking the equations (7) and (8) and interchanging the superscripts 1 and R we will have:

$$x^1 - \overline{x}^1 = \left(I - A^{11}\right)^{-1} A^{1R} L^{RR} \left[f^R + A^{R1} \left(I - A^{11}\right)^{-1} f^1 \right] \qquad (10)$$

Based on the regional extraction framework it is possible to affirm that the vector $x^1 - \overline{x}^1$ measures the backward dependence of the rest of the economy on the region 1. In other words, the vector enables us to measure the impact of extracting, from the economy, all the N-1 regions in R upon the output of the remaining region 1.

3. Results

3.1 Chenery-Watanabe

We can verify that during the period 1996 to 2002 the indicator presents significant changes in the pattern of interregional trade. Minas Gerais, during the period presents an increase in the imports indicator meaning that the state has a high degree of dependence in the exports of the rest of the country to satisfy its domestic demand. On the other side, states as Goias and Santa Catarina do not need the demand from the other states. We can verify that, in 2002, Pernambuco state leaving the cluster (exporter region and non importer region) in 1996 to classify in the cluster no importer and exporter region. Despite the existence of Zona Franca de Manaus, Amazonas states present an exports index below the national average. São Paulo presents a high index of exports and a small imports index meaning that the state has a high degree of self-sufficiency.

Table 1

Chenery - Watanabe - Regions Classification 1996 and 2002

1996	
Chenery - Watanabe - Regions Classifications	
Exporter and Importer regions	Non exporter and importer regions
GO PR SC	AC AL DF MA MS MT RN RO RR SE TO
Exporter and non Importer regions	Non exporter and non importer regions
BA MG PE RJ RS SP	AM AP CE ES PA PB PI

2002	
Chenery - Watanabe - Regions Classifications	
Exporter and Importer regions	Non exporter and importer regions
MG PR	AC AL AP DF GO MS MT PB RN RO RR SC TO
Exporter and non Importer regions	Non exporter and non importer regions
BA RJ RS SP	AM CE ES MA PA PE PI SE

Source: Elaborated by the authors

Table 2

Rasmusem - Regions Classifications 1996 and 2002

1996	
Rasmusem - Regions Classifications	
Exporter and Importer regions	Non exporter and importer regions
GO PR SC	AC AL DF MA MS MT RN RO RR TO
Exporter and non Importer regions	Non exporter and non importer regions
MG RJ RS SP	AM AP BA CE ES PA PB PE PI SE

2002	
Rasmusem - Regions Classifications	
Exporter and Importer regions	Non exporter and importer regions
MG PR	AC AL AP DF GO MS MT PB RN RO RR SC TO
Exporter and non Importer regions	Non exporter and non importer regions
BA RJ RS SP	AM CE ES MA PA PE PI SE

Source: Elaborated by the authors

The results presented above enables us to classify the Key regions. These regions are regions that have their imports and exports affected by variations in the domestic demand or in the demand of the other regions. In the year 1996, Goiás, Paraná and Santa Catarina were classified as key region. In the year 2002, Minas Gerais was classified as Key region but Goias and Santa Catarina were not. Amapá and Paraíba presented in 2002 imports index above the national average meaning that those states are dependent from the exports of the rest of the country.

3.2 Extraction Method[11]

In this section we will present the results for the extraction method. There is a wide range of results. The methodology enables us to verify the following aspects:
a) Which is the impact upon all the sectors and regions due to the extraction of industry?
b) Which is the impact upon all the sectors and regions due to the extraction of agriculture?
c) Which is the impact upon the industry sector located at a specific region due to the extraction of industry sector?
d) Which is the impact upon the agriculture sector located at a specific region due to the extraction of agriculture sector?

It is also relevant to consider the differences between the bilateral linkages of two states. Thus, in this paper we present results for net backward and net forward dependencies. It is important to emphasize that these dependencies are calculated, for this paper, in intra-sectoral terms. More specific we present the differences between linkages of two states for the industrial sector.

The literature affirms that the effect on a small state (or region, or country) of isolating a large state is larger than the reversed effect. For example, if a state *F* depends more on state *I* than the other way round, it is possible to affirm that *F* shows a net dependence on *I*. The net dependence at Brazilian economy is given in Tables 3 to 6.

We would like to emphasize that all the results could be checked upon request.

3.2.1 Net Backward Dependence 1996 – 2002(Demand side or buying side)

We can view the structure of net dependencies for industry by the demand side on Tables 3 and 4. We can highlight that: a) For 1996 and 2002 each state shows a net dependence on São Paulo; b) In contrast, Roraima is at the other end and shows a net dependence on each other state; c) We can note that, for 1996 and 2002, the states located at regions Southeast and South are the states that show a good result in terms of net dependence. In other words the majority of other Brazilian states (located at Northeast, North and Center-west) show a net dependence on those states and d) The structure of dependencies do not present a big change during the period. It should be emphasized that this structure of bilateral dependencies is quite remarkable. Since there are no cycles, the linkages show a clear hierarchical structure of net dependencies.

At the bilateral level of the backward application, we found for the year 1996 and 2002 a clear hierarchy of net dependencies between the Brazilian states, with São Paulo being

[11] A first application of this method to the Brazilian economy was Perobelli, et al (2006).

at the top and Roraima being at the bottom. For example, the net backward dependence of Roraima on São Paulo in Table 3 and 4 expressed that, in absolute numbers, Roraima dependes more on São Paulo inputs than the São Paulo depends on Roraima inputs.

3.2.2 Net Forward Dependence 1996 – 2002 (Supply side or selling side)

Tables 5 and 6 show the results for net forward dependence for the period 1996 and 2002. It is important to emphasize that this approach is make using the output side. In other words the suppllier's point of view is taken, implying the use of output coefficients. Thus the main results are: a) the hierarchy is quite different from the backward dependence; b) For the year 1996 and for the year 2002 Roraima is located on the top meaning that Roraima do not supply any good for the rest of the economy; c) São Paulo show a net dependence on the majority of the other Brazilian states meaning that the state is an important supplier of goods for the rest of the country.

Table 3. Net backward dependencies – 1996

	Net Backward dependence of												
	SP	MG	RJ	PR	SC	RS	BA	ES	PE	AM	PA	GO	CE
SP	0	124989	140436	146346	166647	170609	174908	181818	185195	183979	186934	187094	187204
MG	0	0	15447	21357	41659	45620	49919	56829	60206	58990	61946	62106	62551
RJ	0	0	0	5910	26211	30173	34472	41382	44759	43543	46498	46658	47138
PR	0	0	0	0	20302	24263	28562	35472	38849	37633	40589	40749	41235
SC	0	0	0	0	0	3961	8260	15170	18548	17331	20287	20447	20933
RS	0	0	0	0	0	0	4299	11209	14586	13370	16326	16486	16955
BA	0	0	0	0	0	0	0	6910	10287	9071	12027	12187	12672
ES	0	0	0	0	0	0	0	0	3377	2161	5117	5277	5785
PE	0	0	0	0	0	0	0	0	0	0	1739	1899	2370
AM	0	0	0	0	0	0	0	0	1216	0	0	3116	3620
PA	0	0	0	0	0	0	0	0	0	1168	0	160	675
GO	0	0	0	0	0	0	0	0	0	0	0	0	514
CE	0	0	0	0	0	0	0	0	0	0	0	0	0
MT	0	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0	0	0	0	0	0	0	0
DF	0	0	0	0	0	0	0	0	0	0	0	0	0
MA	0	0	0	0	0	0	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0	0	0	0	0	0	0
RN	0	0	0	0	0	0	0	0	0	0	0	0	0
PB	0	0	0	0	0	0	3465	0	0	3145	0	0	0
AL	0	0	0	0	0	0	0	0	0	0	0	0	0
RO	0	0	0	0	0	0	0	0	0	0	0	0	0
PI	0	0	0	0	0	0	0	0	0	0	0	0	0
AP	0	0	0	0	0	0	0	0	0	0	4124	0	0
AC	0	0	0	0	0	0	0	0	0	0	0	0	0
TO	0	0	0	0	0	0	0	0	0	0	0	0	0
RR	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Table 3. Net backward dependencies – 1996

	Net Backward dependence of													
	MT	MS	DF	MA	SE	RN	PB	AL	RO	PI	AP	AC	TO	RR
SP	191003	191102	191287	191602	191581	192014	192184	192154	193773	193538	194161	194230	194189	194381
MG	66014	66113	66298	66613	66593	67025	67195	67165	68784	68549	69172	69242	69200	69392
RJ	50567	50666	50851	51166	51145	51578	51748	51718	53337	53102	53725	53794	53753	53945
PR	44657	44756	44941	45256	45236	45669	45839	45808	47427	47192	47816	47885	47843	48035
SC	24355	24454	24639	24955	24934	25367	25537	25507	27126	26890	27514	27583	27542	27733
RS	20394	20493	20678	20993	20973	21405	21575	21545	23164	22929	23553	23622	23580	23772
BA	16095	16194	16379	16695	16674	17107	0	17246	18866	18630	19254	19323	19281	19473
ES	9185	9284	9469	9785	9764	10197	10367	10336	11956	11720	12344	12413	12371	12563
PE	5808	5907	6092	6407	6386	6819	6989	6959	8578	8343	8966	9036	8994	9186
AM	7024	7123	7308	7624	7603	8036	0	8175	9795	9559	10183	10252	10210	10402
PA	4068	4167	4352	4668	4647	5080	9374	5220	6839	6603	0	7296	7255	7446
GO	3908	4007	4192	4508	4487	4920	5090	5060	6679	6443	7067	7136	7095	7286
CE	3389	3486	3671	3993	3985	4403	20601	4542	6156	5929	6544	6614	6575	6764
MT	0	99	284	599	579	1011	1181	1151	2770	2535	3159	3228	3186	3378
MS	0	0	185	500	480	912	1082	1052	2671	2436	3059	3129	3087	3279
DF	0	0	0	315	294	727	897	867	2486	2251	2874	2944	2902	3094
MA	0	0	0	0	0	412	4848	552	2171	1935	2559	2628	2587	2779
SE	0	0	0	21	0	0	603	573	2192	1956	2580	2649	2608	2799
RN	0	0	0	0	539	0	170	140	1759	1523	2147	2216	2175	2367
PB	0	0	0	0	0	0	0	2561	0	1353	2025	0	2267	1387
AL	0	0	0	0	0	0	0	0	1619	1384	2007	2077	2035	2227
RO	0	0	0	0	0	0	5065	0	0	0	388	457	416	608
PI	0	0	0	0	0	0	0	0	235	0	624	693	651	843
AP	0	0	0	0	0	0	0	0	0	0	0	69	28	220
AC	0	0	0	0	0	0	1073	0	0	0	0	0	0	150
TO	0	0	0	0	0	0	0	0	0	0	0	42	0	192
RR	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Table 4 – Backward Dependencies – 2002

	Net Backward dependence of												
	SP	MG	RS	PR	RJ	SC	BA	GO	ES	AM	CE	PA	PE
SP	0	181	184	194	205	205	213	222	223	225	227	227	227
MG	0	0	4	13	25	27	32	41	42	44	46	46	46
RS	0	0	0	9	21	24	28	37	39	41	42	43	43
PR	0	0	0	0	12	14	19	28	29	31	33	33	33
RJ	0	0	0	0	0	3	7	16	18	20	21	22	22
SC	0	0	0	0	0	0	5	13	15	17	18	19	19
BA	0	0	0	0	0	0	0	9	10	13	14	14	14
GO	0	0	0	0	0	0	0	0	1	4	5	5	5
ES	0	0	0	0	0	0	0	0	0	2	4	4	4
AM	0	0	0	0	0	0	0	0	0	0	1	2	2
CE	0	0	0	0	0	0	0	0	0	0	0	0	0
PA	0	0	0	0	0	0	0	0	0	0	0	0	0
PE	0	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0	0	0	0	0	0	0	0	0
MT	0	0	0	0	0	0	0	0	0	0	0	0	0
MA	0	0	0	0	0	0	0	0	0	0	0	0	0
PB	0	0	0	0	0	0	0	0	0	0	0	0	0
AL	0	0	0	0	0	0	0	0	0	0	0	0	0
RN	0	0	0	0	0	0	0	0	0	0	0	0	0
PI	0	0	0	0	0	0	0	0	0	0	0	0	0
DF	0	0	0	0	0	0	0	0	0	0	0	0	0
RO	0	0	0	0	0	0	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TO	0	0	0	0	0	0	0	0	0	0	0	0	0
AC	0	0	0	0	0	0	0	0	0	0	0	0	0
AP	0	0	0	0	0	0	0	0	0	0	0	0	0
RR	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Table 4 – Backward Dependencies – 2002

	Net Backward Dependece of													
	MS	MT	MA	PB	AL	RN	PI	DF	RO	SE	TO	AC	AP	RR
SP	229	229	230	232	232	232	233	233	233	234	235	235	235	235
MG	48	48	49	51	51	51	52	53	53	53	54	54	54	54
RS	44	45	46	48	48	48	49	49	49	49	50	50	51	51
PR	35	35	37	38	38	39	39	40	40	40	41	41	41	41
RJ	23	24	25	27	27	27	28	28	28	28	29	29	30	30
SC	20	21	22	24	24	24	25	25	25	25	26	26	27	27
BA	16	16	18	19	19	20	20	21	21	21	22	22	22	22
GO	7	7	9	10	10	11	12	12	12	12	13	13	13	13
ES	6	6	7	9	9	9	10	10	10	11	11	12	12	12
AM	3	4	5	7	7	7	8	8	8	9	9	10	10	10
CE	2	2	4	5	5	6	7	7	7	7	8	8	8	8
PA	2	2	3	5	5	5	6	6	6	7	7	8	8	8
PE	2	2	3	5	5	5	6	6	6	7	7	8	8	8
MS	0	0	2	3	3	4	5	5	5	5	6	6	7	7
MT	0	0	1	3	3	3	4	4	4	5	5	6	6	6
MA	0	0	0	2	2	2	3	3	3	4	4	4	5	5
PB	0	0	0	0	0	0	1	1	1	2	2	3	3	3
AL	0	0	0	0	0	0	1	1	1	2	2	3	3	3
RN	0	0	0	0	0	0	1	1	1	2	2	1	3	3
PI	0	0	0	0	0	0	0	0	0	1	1	2	2	2
DF	0	0	0	0	0	0	0	0	0	0	1	1	2	2
RO	0	0	0	0	0	0	0	0	0	0	1	1	2	2
SE	0	0	0	0	0	0	0	0	0	0	1	3	1	1
TO	0	0	0	0	0	0	0	0	0	0	0	0	1	1
AC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RR	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Table 5 – Forward Dependencies – 1996

	Net Forward Dependencies of												
	RR	BA	PB	AP	AL	CE	RO	PE	AC	MA	PI	RN	MT
RR	0	0	132	2	5	64	3	0	2	19	4	16	0
BA	49	0	0	2910	0	0	828	18495	1206	7420	5593	13977	0
PB	0	1747	0	156	0	353	0	71399	176	434	3945	4686	364
AP	0	0	0	0	284	100	0	0	0	0	16	0	104
AL	0	61344	9557	0	0	10638	11	55421	77	0	4861	0	0
CE	0	18190	0	0	0	0	4327	19319	1452	0	0	7792	842
RO	0	0	16	77	0	0	0	0	1537	0	0	48	2594
PE	122	0	0	531	0	0	968	0	403	0	0	2127	411
AC	0	0	0	0	0	0	0	0	0	222	28	26	1113
MA	0	0	0	51	757	4093	2908	9506	0	0	7	0	0
PI	0	0	0	0	0	1451	1577	2171	0	0	0	0	45
RN	0	0	0	155	502	0	0	0	0	144	337	0	0
MT	117	25793	0	0	4938	0	0	0	0	6565	0	1256	0
MS	0	0	0	0	2005	0	0	0	0	375	0	1127	621
SE	0	0	9520	0	0	22668	0	64049	0	0	3685	0	0
DF	0	0	0	0	0	0	0	0	0	0	0	349	660
AM	7	0	0	0	0	0	184	0	0	470	92	0	0
TO	0	4764	317	0	291	0	0	0	0	1187	0	0	0
PA	0	0	0	0	0	0	0	5020	0	0	0	0	0
GO	0	0	0	0	0	0	0	0	75	0	0	0	12601
ES	0	0	0	0	0	0	0	0	0	0	0	0	0
PR	0	0	0	0	0	0	0	0	0	0	0	0	0
MG	0	0	0	0	0	0	0	0	0	0	0	0	0
RJ	0	0	0	0	0	0	0	0	0	0	0	0	0
SP	0	0	0	0	0	0	0	0	0	0	0	0	0
SC	0	0	0	0	0	0	0	0	0	0	0	0	0
RS	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Table 5 – Forward Dependencies – 1996

	Net Forward Dependence of													
	MS	SE	DF	AM	TO	PA	GO	ES	PR	MG	RJ	SP	SC	RS
RR	13	46	8	0	4	12792	56	10	220	274	1156	1782	800	674
BA	2517	21220	5685	28685	0	2116	35008	23887	131346	230391	151443	4023534	149904	123762
PB	572	0	2897	1563	0	1676	1975	1226	6857	38958	11531	104725	14223	259821
AP	181	101	110	63	14	66	435	119	378	1062	1090	11242	2269	1614
AL	0	6825	893	1253	0	619	6071	6317	6608	1585	14009	1048339	13645	259608
CE	1558	0	2355	10868	2238	5385	4826	994	156707	94370	26751	381394	41020	32745
RO	1264	417	56	0	56	1460	1044	24	2063	2222	19507	20806	6644	5328
PE	1568	0	942	10182	581	0	4293	2399	49959	19254	32210	384843	31080	22412
AC	818	105	22	0	20	2424	0	37	997	653	2840	7493	3102	2615
MA	0	1164	1956	0	0	2063	2652	1069	1777	32301	10199	141130	15004	20570
PI	227	0	7283	0	331	1416	670	214	4709	4909	2836	36887	3346	7092
RN	0	866	0	291	136	238	112	223	2899	3030	8698	42154	4589	7835
MT	0	2478	0	2793	289	54514	0	1401	25660	32119	169006	113505	42333	80823
MS	0	1133	0	1877	246	28048	2850	471	12630	14106	124474	163679	43102	87029
SE	0	0	0	0	0	23	3474	1873	755	14408	28557	172981	1093	12894
DF	2862	321	0	0	73	0	6313	407	4656	9545	12165	45530	8228	6358
AM	0	495	82	0	144	8875	0	0	0	0	8174	65869	13049	10618
TO	0	65	0	0	0	0	3421	62	0	2879	848	7881	1861	7267
PA	0	0	690	0	971	0	4623	2300	68360	84298	10967	117439	0	13185
GO	0	0	0	272	0	0	0	0	6140	17015	26006	101844	16757	23645
ES	0	0	0	305	0	0	2472	0	5344	47989	0	187634	7068	167863
PR	0	0	0	6247	305	0	0	0	0	18324	79304	1555693	178609	120644
MG	0	0	0	2954	0	0	0	0	0	0	50357	131684	46815	102069
RJ	0	0	0	0	0	0	0	3983	0	0	0	199785	0	51521
SP	0	0	0	0	0	0	0	0	0	0	0	0	67098	226489
SC	0	0	0	0	0	48922	0	0	0	0	18098	0	0	0
RS	0	0	0	0	0	0	0	0	0	0	0	0	3143	0

Source: Elaborated by the authors

Table 6 – Forward Dependencies – 2002

	Net Forward Dependence of												
	PA	RR	MA	AC	PB	PI	DF	MT	AL	TO	GO	RO	SC
PA	0	0	47675	639	6519	2903	5436	10760	4095	2896	39058	2827	80772
RR	33	0	77	112	274	42	24	0	171	25	509	1113	695
MA	0	0	0	840	1987	0	0	0	103	944	6418	5364	723
AC	0	0	0	0	0	0	1	738	313	98	0	0	4713
PB	0	0	0	1842	0	11702	3665	3563	0	361	2969	1326	0
PI	0	0	3670	275	0	0	1045	937	0	1543	4170	3480	9826
DF	0	0	9748	0	0	0	0	2080	616	0	18311	1509	35653
MT	0	169	7107	0	0	0	0	0	1731	266	9319	286	21540
AL	0	0	0	0	6837	3700	0	0	0	0	1035	0	10920
TO	0	0	0	0	0	0	317	0	657	0	0	0	542
GO	0	0	0	4422	0	0	0	0	0	5792	0	1859	40810
RO	0	0	0	193	0	0	0	0	431	337	0	0	0
SC	0	0	0	0	15806	0	0	0	0	0	0	86	0
MS	0	0	0	0	0	0	0	0	880	553	0	0	5839
RN	0	0	0	0	49628	3091	0	0	0	0	0	0	0
PR	0	0	18723	0	0	0	0	15641	0	0	0	2963	308301
AP	0	0	0	0	0	0	0	0	8491	0	0	0	0
SE	0	0	0	0	0	336	15918	0	0	0	0	0	0
ES	0	0	0	0	1883	0	0	5463	0	0	273347	0	0
CE	0	0	0	0	0	2618	0	0	0	3826	0	3229	0
PE	0	0	0	0	0	0	0	0	0	0	0	289	0
RS	0	0	0	0	0	0	0	0	0	0	0	0	157315
RJ	0	0	0	0	0	0	0	0	0	0	1293775	0	0
AM	0	0	0	0	0	0	0	0	0	0	0	0	0
SP	0	0	0	0	0	0	0	0	0	0	0	0	0
MG	0	0	0	0	0	0	0	0	0	0	7666	0	0
BA	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Table 6 – Forward Dependencies – 2002

	Net Forward Dependence of													
	MS	RN	PR	AP	SE	ES	CE	PE	RS	RJ	AM	SP	MG	BA
PA	13607	12789	113884	944	11256	23366	24905	20971	88374	196857	117151	801226	852242	97173
RR	176	399	1083	167	323	485	590	430	3103	5452	3505	18442	3102	6901
MA	522	3984	0	428	4594	209	2075	1491	20383	22641	36126	373592	67980	47250
AC	1091	769	6863	287	702	1216	95	1941	2529	16908	17033	66230	2038	10549
PB	8452	0	25561	479	1387	0	7706	123278	7824	120898	15501	399326	200935	110639
PI	2625	0	29713	35	0	1928	0	7989	18843	42681	6081	132725	35171	2658
DF	29778	3308	49561	326	0	27524	10665	9572	55544	52330	31133	412694	11196	73090
MT	25937	8709	0	200	9692	0	6613	9584	2669	257326	59203	647422	28737	136210
AL	0	2749	21179	0	3492	3049	11137	22595	69972	68822	26153	1212395	25143	273749
TO	0	439	3058	147	813	3683	0	273	9094	7489	10261	83214	7174	28223
GO	9146	13131	78199	223	21269	0	30363	427	99998	0	112980	2266545	0	198844
RO	894	2949	0	858	3562	184	0	0	4827	72816	11505	227406	20822	27754
SC	0	10957	0	2415	81887	5578	92690	48598	0	1153445	321452	394995	187026	543048
MS	0	8163	58536	4885	10623	0	0	3341	29721	0	298527	1074588	40260	131609
RN	0	0	42930	0	0	326	53563	153976	18603	61161	19726	480635	175103	80435
PR	0	0	0	0	289600	161663	0	0	282251	4364304	383537	1339597	291792	571141
AP	0	450	5642	0	0	492	344	0	8977	17538	68548	19343	4410	5524
SE	0	642	0	472	0	2862	13411	13645	0	29407	0	394393	29656	34334
ES	33791	0	0	0	0	0	32639	0	190567	11120	46010	1943667	528324	194553
CE	1147	0	116668	0	0	0	0	69288	0	92692	10325	0	133358	109949
PE	0	0	72294	1097	0	1246	0	0	0	172375	20328	688959	53998	68247
RS	0	0	0	0	54343	0	33877	49756	0	0	97126	2544373	492611	562951
RJ	130405	0	0	0	0	0	0	0	377975	0	0	13593551	0	95070
AM	0	0	0	0	71	0	0	0	0	122060	0	0	67705	96165
SP	0	0	0	0	0	0	147222	0	0	0	2363046	0	2518773	3753254
MG	0	0	0	0	0	0	0	0	0	853641	0	0	0	497494
BA	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Elaborated by the authors

Final Remarks

The study of economic networks is important, because changing network dynamics are invariably an expression of changes in productivity and competitiveness. This paper tried to understand the role played by the interactions (Brazilian states network) in a broad sense. We use a range of indicators to better understand the Brazilian structure of trade.

In this sense we could verify the importance of São Paulo as an exporter and also an importer. The results also emphasize the differences among the Brazilian regions. This difference does not change during the period of analysis.

It is important to highlight that this paper is under construction and we can discuss all the other results generated by the extraction methodology.

References

Dietzenbacher, E and Van Der Linder, J.A. Sectoral and Spatial Linkages in the EC production structure. *Journal of Regional Science,* vol 37, n.2, pp 235-257. (1997)

Dietzenbacher, E; Van Der Linden, J.A. and Steenge, A. E. The Regional Extraction Method: EC Input-Output Comparisons. *Economic Systems Research,* vol 5, n. 2. pp 185-205 (1993).

Miller, R. E and Lahr, M.L A Taxonomy of Extractions. **Regional Science in Economic Analysis.** Chapter 21. pp 407-441. Elservier Science B.V (2001)

Pavía, J.M; Cabrer, B and Vila, L.E. Interregional trade linkages and the commercial role: the Spanish case. *International Advances in Economic Research*, n. 12 p. 91-103. (2006)

Perobelli, F.S; Haddad, E.A and Domingues, E.P. Interdependência entre os estados brasileiros: uma análise de insumo-produto. Economia. Edição SELECTA. (2006).