Synergetic interactions among four regions in the state of Paraná, Brazil: an interregional input-output analysis

Moretto, Antonio Carlos and Guilhoto, Joaquim José Martins

Universidade de São Paulo, Universidade Estadual de Londrina

1999

Synergetic Interactions among Four Regions in the State of Paraná, Brazil: An Interregional Input-Output Analysis

Antonio Carlos Moretto[1] and Joaquim J. M. Guilhoto[2]

Abstract

In the last two decades the economy of the State of Paraná, Brazil, presented higher growth rates than the Brazilian economy such that today it contributes to around 6,5% of the Brazilian GDP. In the State one can find four main pole-regions of economic activity: a) Curitiba; b) Londrina; c) Ponta Grossa; and d) Cascavel. From the national input-output tables for Brazil for the year of 1995, and using information from various national and state economic census, a regional input-output table for the state was constructed and then used to estimate an interregional table at the level of the above four regions. Using this interregional input-output system this paper classifies the types of synergetic interactions that do occur among the four regions such that it is possible to analyze how the transactions happen among the pole-regions and how this may have contributed to the higher growth rates verified in the state.

1. Introduction

Since the 1970's the economy of the Paraná State has gone through a process of transformation in its productive structure. During the 1970's the state gross regional product has grown at an average rate of 13.0% per year, while the Brazilian economy has a whole had an average growth rate of 8.6%, as a consequence of that the share of the state in the Brazilian economy grew from 5.5% in 1970 to 6.3% in 1980 (IPARDES, 1991). In the 1980-89 period the state grow at the annual rate of 5.7% against 2.8% for the Brazilian economy (Lourenço, 1994).

In the 1990's following Lourenço (1994), the state GRP grew at the annual rate of 4.1% in the 1990-93 period, against the rate of 1.4% observed for Brazil. In 1994 and 1995 the state grew respectively at 6.6% and 1.5% while Brazil grew at the rate of 5.7% and 4.2% (Lourenço, 1995 and IPEA, 1999).

[1] State University of Londrina, Brazil. E-mail: acmorett@imagenet.com.br.
[2] University of São Paulo (USP), Brazil and University of Illinois. E-mail: guilhoto@usp.br.

This level of growth has taken the state to have a share of 6.44% of the Brazilian GDP an it is expect to be by the year of 2002 the forth more important economy of the country.

Given the importance of the Paraná State, this work tries to show how the relations take place among the sectors and among four main pole-regions of the State, i.e.: a) Curitiba; b) Londrina; c) Ponta Grossa; and d) Cascavel. To do so it was construct, from the national input-output tables for Brazil for the year of 1995 and from various national and state economic census, a regional input-output table for the State and then it was used to estimate an interregional table at the level of the above four regions. Using this interregional input-output system this paper classifies the types of synergetic interactions that do occur among the four regions such that it is possible to analyze how the transactions happen among the pole-regions and how this may have contributed to the higher growth rates verified in the state.

This paper is organized has follow, in the next section it is presented a brief overview of the Paraná state and its 4 regions, the third section will present the methodology, in the forth section the results will be present, and the conclusions will be made in the last section.

2. The Paraná State and Its 4 Regions

The Paraná state is located in the South region of Brazil (Figure 1) and occupies an area of 199,555 Km^2 which corresponds to 2.34% of the national territory (IBGE, 1997a). The state population, in 1996, was estimated to be around 9 million people, which corresponds to 5.73% of the total Brazilian population. The state share in the economy is around 6.5% and the per capita state GRP is US$ 4.915 against US$ 4.554 for the Brazilian economy (Table 1).

In this study the Paraná state was divided into 4 regions as can be seen in Figure 2 and Table 2: a) Curitiba, with 40.09% of the state GRP; b) Londrina, with 28.77%; c) Ponta Grossa with 15.66%; and d) Cascavel with 15,48%.

Table 1. Main Economical and Geographical Indicators of Brazil and Paraná.

	Brazil	Paraná	Paraná/Brazil (%)
Size (Km^2)	8,511,996	199,555	2.34
Population (1996)	157,079,573	9,003,804	5.73
Urban	123,082,167	7,011,990	5.70
Rural	33,997,406	1,991,814	5.86
Urbanization (%)	78.36	77.88	-
GDP (1995) (US$ Millions)	707,389	43,787	6.19
GDP per capita (US$ Thousand)	4,554	4,915	-

Source: IBGE (1997a and 1997b), Considera and Medina (1998) and Lourenço (1999).

Table 2. Regions Share in Paraná GRP, 1995.

Regional Pole	Agriculture (%/total)	Industry (%/total)	Services (%/total)	GRP (%/total)
Curitiba Regional Pole (CTA)	7,58	53,43	40,79	40,09
Ponta Grossa Regional Pole (PG)	21,74	15,99	13,96	15,66
Londrina Regional Pole (LDA)	43,30	21,45	29,21	28,77
Cascavel Regional Pole (CEL)	27,39	9,14	16,04	15,48
Total	100,00	100,00	100,00	100,00

Source: IPARDES (1998).

Figure 1. Map of Brazil and Paraná

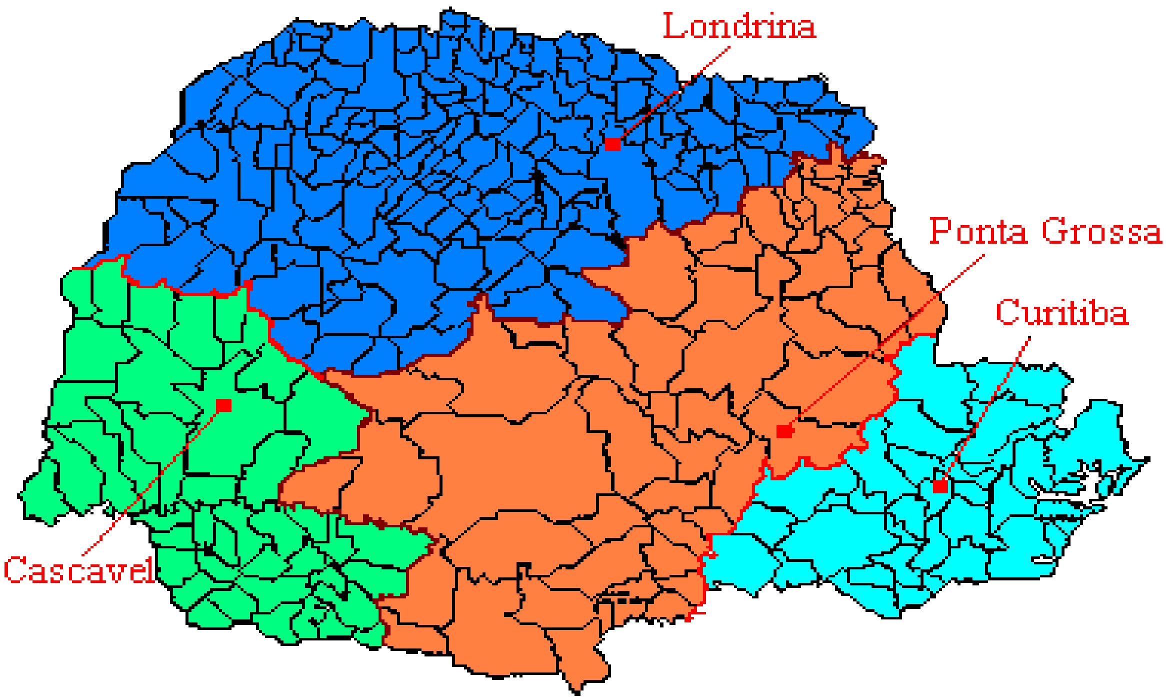


Figure 2. The Paraná Pole-Regions.

3. Theoretical Background

3.1. The Rasmussen/Hirschman Approach

The work of Rasmussen (1956) and Hirschman (1958) led to the development of indices of linkage that have now become part of the generally accepted procedures for identifying key sectors in the economy. Define b_{ij} as a typical element of the Leontief inverse matrix, B; B^* as the average value of all elements of B, and if $B_{\bullet j}$ and $B_{i\bullet}$ are the associated typical column and row sums, then the indices may be developed as follows:

Backward linkage index (power of dispersion):

$$U_j = B_{\bullet j} / n \; / B^* \tag{1}$$

Forward linkage index (sensitivity of dispersion):

$$U_i = B_{i\bullet} / n \; / B^* \tag{2}$$

3.2 The Structure of Production: Economic Landscapes

The view that has been proposed by Sonis, Hewings and Guo (1997) and by Sonis and Hewings (1999) for the interactions among the sectors to be arranged in a normalized hierarchical fashion and presented in a three-dimensional matrix that has been termed an *economic landscape*. This approach provides a consistent and complementary exploration of structure to the more traditional approach associated with Rasmussen and Hirschman. However, in this case, attention is directed to a matrix derived from the product of row and column multipliers extracted from the Leontief inverse matrix. This matrix, the input-output multiplier product matrix (MPM), reveals the *hierarchy* of backward and forward linkages and their associated *economic landscapes,* reflecting the cross-structure of the multiplier product matrix. The developments will be elaborated below.

Consider the column and row multipliers of the Leontief inverse defined in section 3.1 above and define $b_{\bullet\bullet}$ as been the sum over all elements of the Leontief inverse matrix.

Then, the intensity matrix, or the input-output multiplier product matrix (MPM) is defined as:

$$M = \frac{1}{b_{\bullet\bullet}} \left\| b_{i\bullet} b_{\bullet j} \right\| = \frac{1}{b_{\bullet\bullet}} \begin{pmatrix} b_{1\bullet} \\ b_{2\bullet} \\ \vdots \\ b_{n\bullet} \end{pmatrix} \begin{pmatrix} b_{\bullet 1} & b_{\bullet 2} & \cdots & b_{\bullet n} \end{pmatrix} = \left\| m_{ij} \right\| . \qquad (3)$$

One can reorganize the locations of rows and columns of *M* in such a way that the centers of the corresponding crosses appear on the main diagonal. In this fashion, the matrix will be reorganized in such a way that a descending *economic landscape* will be apparent, based on the rank-size sequence of the column and row multipliers. One can reorganize the locations of rows and columns in such a way that a descending *economic landscape* can be apparent. Furthermore, by adopting the rank-size ordering from one economy as the *numeraire*, the economic landscapes can be compared visually; deviations from the smoothly descending landscape of the numeraire economy will reflect differences in economic structure. These differences will reflect variations in the industry mix of regions, variations in the degrees of intraregional intermediation as well as variations in technology.

One of the attractive features of the economic landscape analysis is that the patterns revealed are consistent with the key sector identification procedures associated with Hirschman-Rasmussen. As Sonis, Hewings and Guo (1997) and Sonis and Hewings (1999) have pointed out, the rank-size hierarchies of the Rasmussen/Hirschman indices coincide with the rank-size hierarchies of column and row multipliers of the MPM. This rearrangement also reveals the descending rank-size hierarchies of the Rasmussen/Hirschman forward and backward linkage indices.

Thus, the economic landscape provides a complementary tool in the preliminary elaboration of differences and similarities across economies. It will not replace other techniques but will serve as a first-stage filter that may help in focusing attention on potentially important similarities and differences across economies.

3.3. Synergetic Interactions

A complete description for the 2 regions case is presented in Sonis, Hewings and Miyazawa (1997), which is the basis for this section.

Consider an input-output system represented by the following block matrix, A, of direct inputs:

$$A = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \tag{4}$$

where A_{11} and A_{22} are the quadrate matrices of direct inputs within the first and second regions, and A_{12} and A_{21} are the rectangular matrices showing the direct inputs purchased by the second region and vice versa.

The building blocks of the pair-wise hierarchies of sub-systems of intra/interregional linkages of the block-matrix Input-Output system are the four matrices $A_{11,} A_{12}, A_{21}$ and A_{22}, corresponding to four basic block-matrices:

$$A_{11} = \begin{bmatrix} A_{11} & 0 \\ 0 & 0 \end{bmatrix}; \; A_{12} = \begin{bmatrix} 0 & A_{12} \\ 0 & 0 \end{bmatrix}; \; A_{21} = \begin{bmatrix} 0 & 0 \\ A_{21} & 0 \end{bmatrix}; \; A_{22} = \begin{bmatrix} 0 & 0 \\ 0 & A_{22} \end{bmatrix} \tag{5}$$

This section will usually consider the decomposition of the block-matrix (4) into the sum of two block-matrices, such that each of them is the sum of the block-matrices (5) $A_{11,}A_{12}, A_{21}$ and A_{22}. From (5) 14 types of pair-wise hierarchies of economic sub-systems can be identified by the decompositions of the matrix of the block-matrix A (see Figure 2).

Consider the hierarchy of input-output sub-systems represented by the decomposition $A = A_1 + A_2$. Introducing the Leontief block-inverse $L(A) = L = (I - A)^{-1}$ and the Leontief block-inverse $L(A_1) = L_1 = (I - A_1)^{-1}$ corresponding to the first sub-system. The possibilities for the A_1 matrix are presented in Figure 3.

Consider the hierarchy of input-output sub-systems represented by the decomposition $A = A_1 + A_2$ and their Leontief block-inverse $L(A) = L = (I - A)^{-1}$ and the Leontief block-inverse $L(A_1) = L_1 = (I - A_1)^{-1}$ corresponding to the first sub-system. If f is the vector of final demand and x is the vector of gross output, then it is possible to generate the decomposition of gross output into two parts: $x_1 = L_1 f$ and the increment $Dx = x - x_1$. Such a decomposition is important for the empirical analysis of the structure of actual gross output and the contribution that the relations among the regions have to the total gross output.

For the n regions case the number of decompositions increases dramatically as one increases the number of regions, such that from the 15 decompositions (including the whole system) for the 2 regions case, one goes to: a) 511 decompositions for the three regions case; b) 65,535 decompositions for 4 regions; c) 33,554,431 decompositions for the 5 regions; and so on.

In this way, the question representation of the system for the n regions case becomes very complex, so what is presented here is a general idea of how the system works, as can be seen in a schematic way for 4 regions case, as it is presented in Figure 4. From this figure one can see that in the 4 regions case one has 16 matrices. At first, one has to consider each matrix isolated, the next step is to consider the 16 matrices combined 2 at time, then 3 at time, and so fort, until one gets to the whole system. To measure the contribution of each combination for the production in the productive process one has to subtract from the result of the combination of k matrices all the possible lower level combinations of these matrices, e, g., the result of a set of 4 matrices must be subtracted from the results of all the possible combination of these four matrices at the level of 3, 2, and 1 matrices (Guilhoto, 1999).

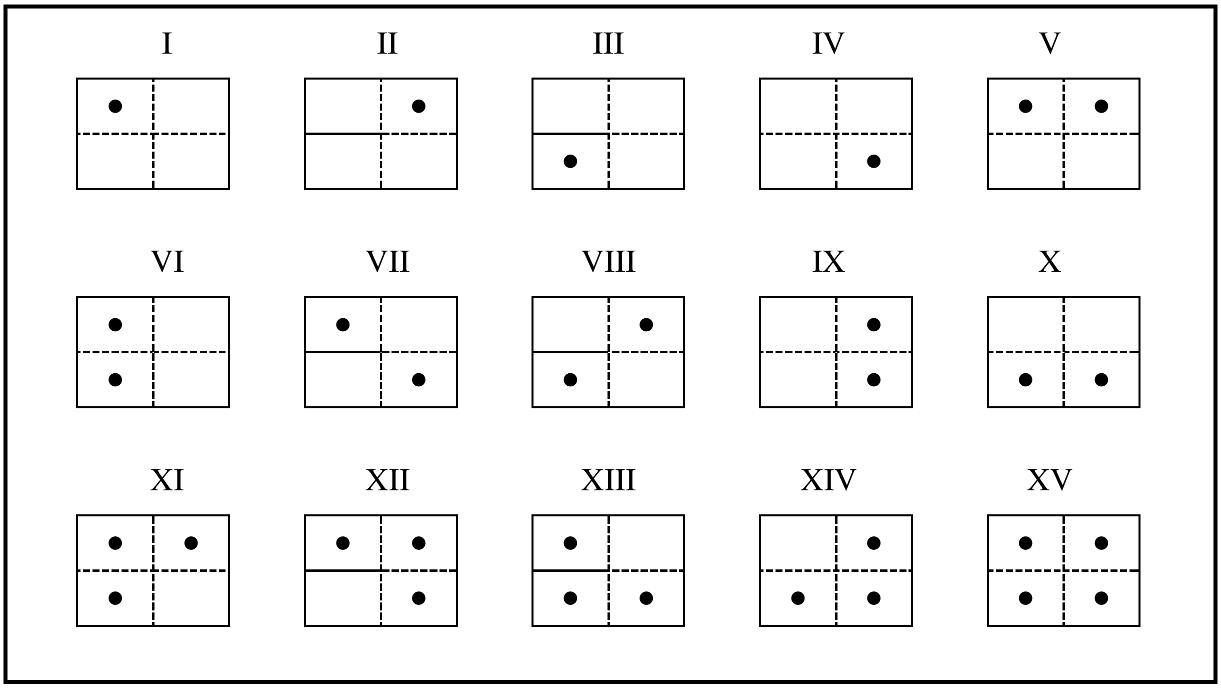


Figure 3. Schematic Representation of the Possible Forms of the A_1 Matrix – 2 Regions Case

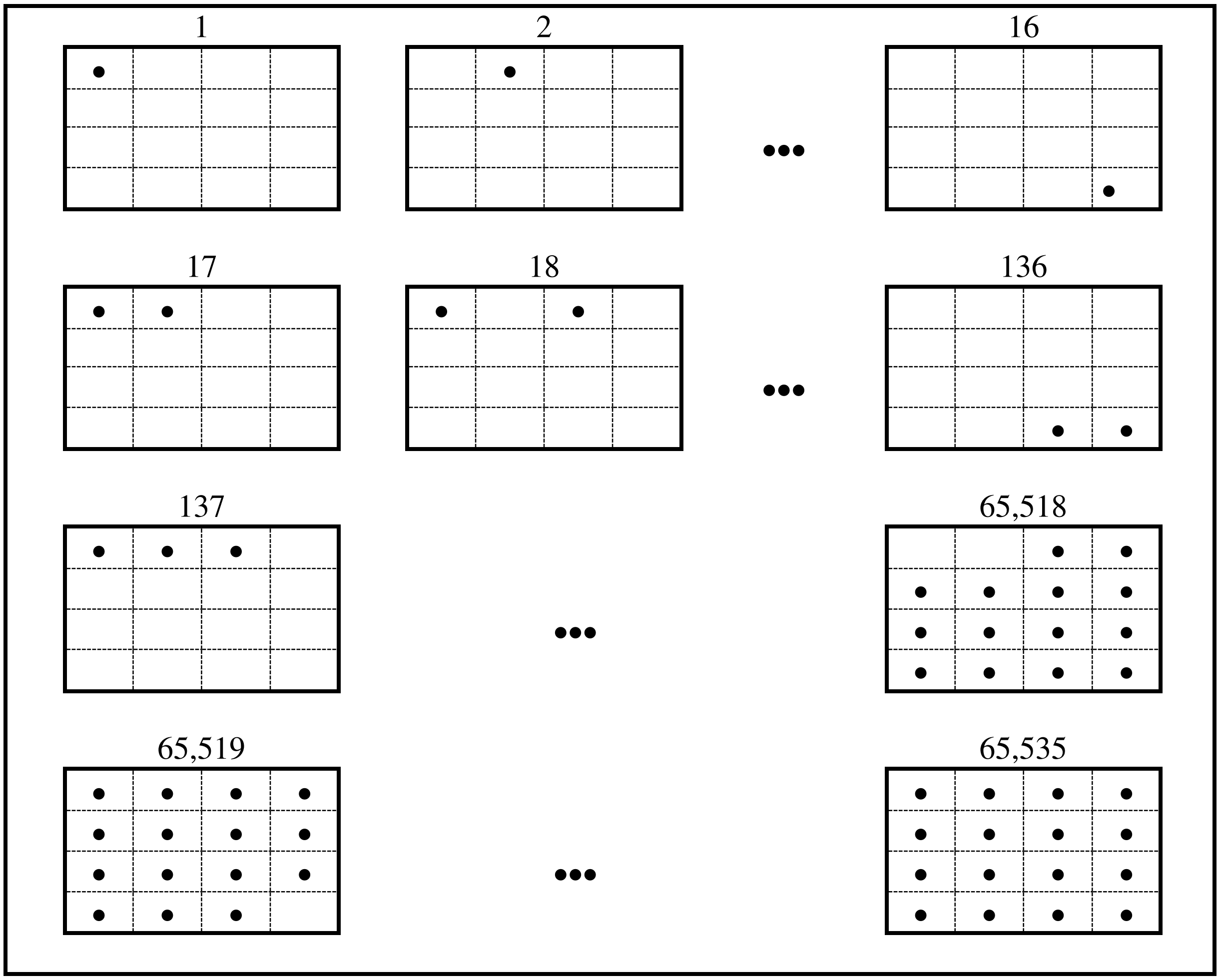


Figure 4. Schematic Representation of the Possible Forms of the A_1 Matrix – 4 Regions Case

4. Results for the Brazilian Economy

4.1 The Rasmussen-Hirschman Approach

The results for Rasmussen/Hirschman indexes are presented into Table 3 and in Figures 6 to 9. In general the Curitiba and Londrina regions show a greater number of sectors with values greater than 1 for the backward and forward linkages, being that an indication that these regions have a more complex productive structure than the other regions.

The key sectors that have the value of the backward and forward linkages greater than one (McGilvray, 1977) are the sectors: a) Non-Metallic Minerals (3), Transport Equipment (7) and Pulp, Paper and Printing (9) for the Curitiba region; b) Pulp, Paper and Printing (9) for Ponta Grossa; and c) Textile (14) for Londrina.

In general one can say that in terms of forward linkages the most important sectors for the regions are: a) Chemicals (11), Trade (26), Transport Equipment (7) and No-Metallic Minerals (3) for the Curitiba region; b) Agriculture (1), Pulp, Paper and Printing (9), and Public Utilities (24) for Ponta Grossa; c) Agriculture (1), Textile (14), and Trade (26) for Londrina; and d) Agriculture (1), Public Utilities (24) and Trade (26) for Cascavel. As consequence of that, in terms of forward linkages, the sectors of Chemicals (11), Agriculture (1), Pulp, Paper and Printing (9), and Trade (26) seems to be the most important for the state of Paraná economy.

On the backward side, the demand for inputs for industrial processing in all of the regions is concentrated on the food industry and more specifically in the sectors Vegetal Oil (21) and Meat Products (18).

From Figure 9 one can see that the most important regions for the system are the regions of Curitiba and Londrina as they seem to have a more complex productive structure.

Table 3. Rasmussen - Hirschman Linkages for Paraná Interregional System, 1995.

Regions and Sectors	Curitiba		Ponta Grossa		Londrina		Cascavel	
	Back	Forward	Back	Forward	Back	Forward	Back	Forward
1 Agriculture	0.909	0.799	0.909	3.497	0.909	5.172	0.909	3.276
2 Mining	0.934	0.898	0.934	0.718	0.934	0.647	0.934	0.650
3 Non-Metallic Minerals	1.053	1.632	1.053	0.697	1.053	0.776	1.053	0.688
4 Metal Products	0.885	1.130	0.885	0.772	0.885	0.760	0.885	0.730
5 Machinery and Equipment	0.822	1.574	0.822	0.675	0.822	0.726	0.822	0.663
6 Electrical/Electronic Equipment	0.943	1.369	0.944	0.626	0.943	0.676	0.944	0.627
7 Transport Equipment	1.023	1.802	1.023	0.643	1.023	0.670	1.023	0.633
8 Wood and Wood Products	1.098	0.841	1.098	0.891	1.098	0.834	1.098	0.729
9 Pulp, Paper and Printing	1.198	1.229	1.208	2.348	1.198	0.711	1.199	0.673
10 Rubber	0.875	0.652	0.874	0.636	0.875	0.650	0.874	0.643
11 Chemicals	0.937	5.207	0.938	0.832	0.938	1.204	0.937	0.656
12 Pharmaceutical and Cosmetics	0.985	0.655	0.987	0.626	0.985	0.630	0.986	0.626
13 Plastics	0.967	1.040	0.969	0.645	0.967	0.861	0.967	0.645
14 Textile	1.049	0.782	1.050	0.816	1.050	1.721	1.050	0.782
15 Clothing, Footwear, Leather and Skins	1.030	0.659	1.030	0.632	1.031	0.747	1.030	0.674
16 Coffee Products	1.025	0.738	1.024	0.666	1.024	0.826	1.025	0.638
17 Vegetal Products	1.190	0.642	1.191	0.759	1.190	0.794	1.190	0.762
18 Meat Products	1.330	0.632	1.328	0.716	1.332	0.756	1.330	0.734
19 Dairy Products	1.196	0.630	1.197	0.680	1.197	0.683	1.196	0.676
20 Sugar Products	1.203	0.630	1.203	0.633	1.205	0.829	-	-
21 Vegetal Oil	1.410	0.747	1.411	0.949	1.410	0.983	1.410	0.924
22 Other Food Products	1.202	0.762	1.203	0.765	1.203	0.912	1.201	0.750
23 Other Industrial Products	0.999	1.025	0.998	0.646	0.997	0.659	0.998	0.638
24 Public Utilities	0.947	0.849	0.947	1.571	0.947	1.068	0.948	1.859
25 Construction	0.872	0.790	0.872	0.690	0.872	0.740	0.872	0.701
26 Trade	0.870	1.878	0.870	1.190	0.870	1.703	0.870	1.468
27 Transport	0.900	1.442	0.900	1.135	0.900	1.331	0.900	1.196
28 Communication	0.737	0.857	0.737	0.697	0.737	0.790	0.738	0.731
29 Financial Institutions	0.807	1.622	0.807	0.701	0.807	0.840	0.808	0.711
30 Public Administration	0.855	0.916	0.855	0.711	0.855	0.782	0.856	0.714
31 Other Services	0.792	1.569	0.792	1.379	0.793	1.355	0.792	1.024
Average	1.001	1.161	1.002	0.934	1.002	1.027	0.995	0.874

Source: Estimated by the authors

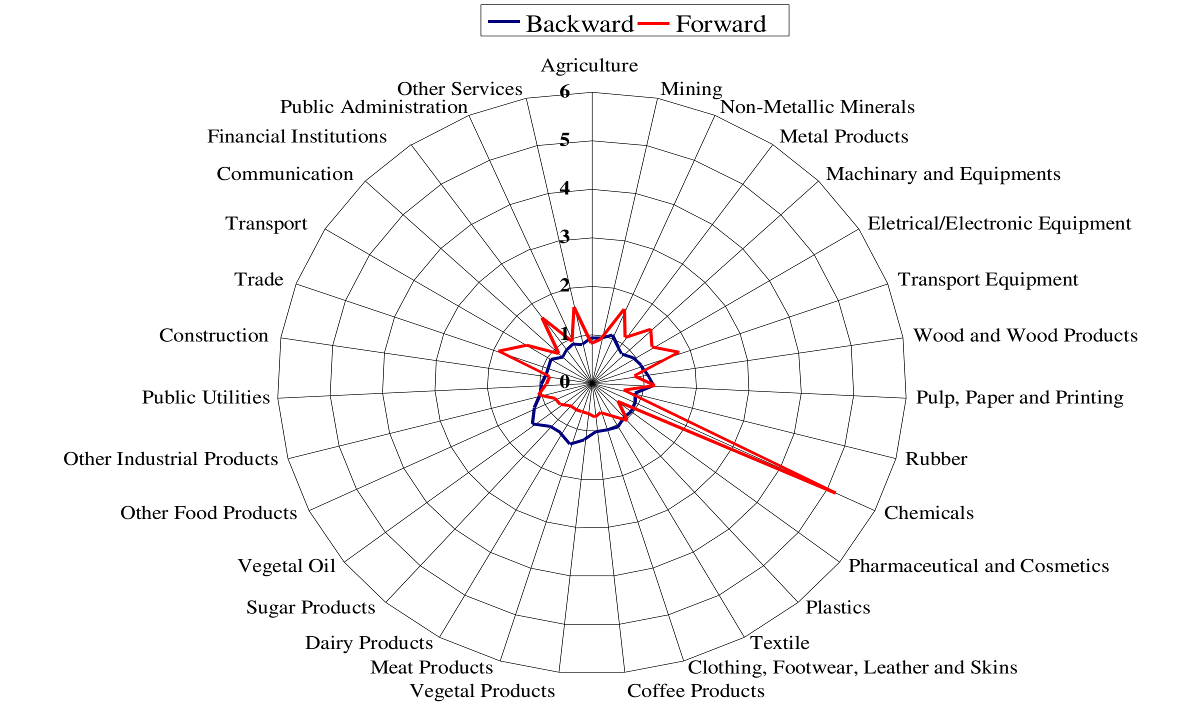


Figure 5. Hirschman-Rasmussen Linkages, **Curitiba Regional Pole**, 1995.

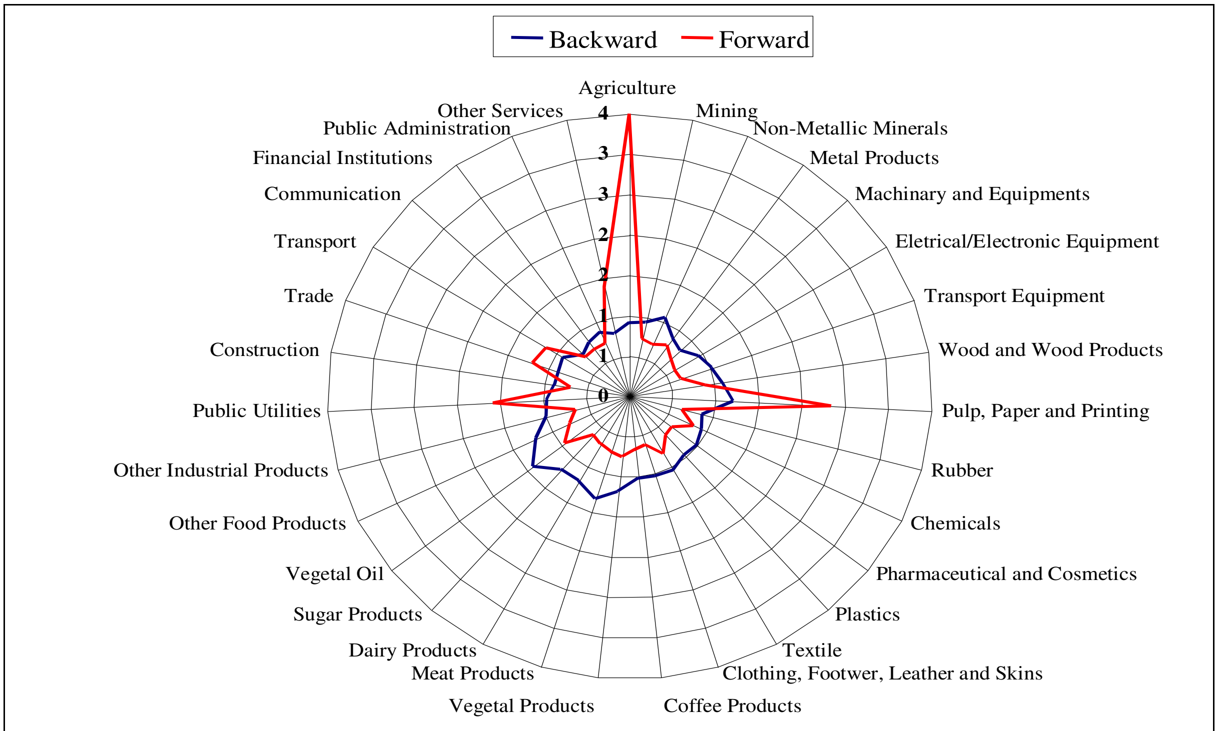


Figure 6. Hirschman-Rasmussen Linkages, **Ponta Grossa Regional Pole**, 1995.

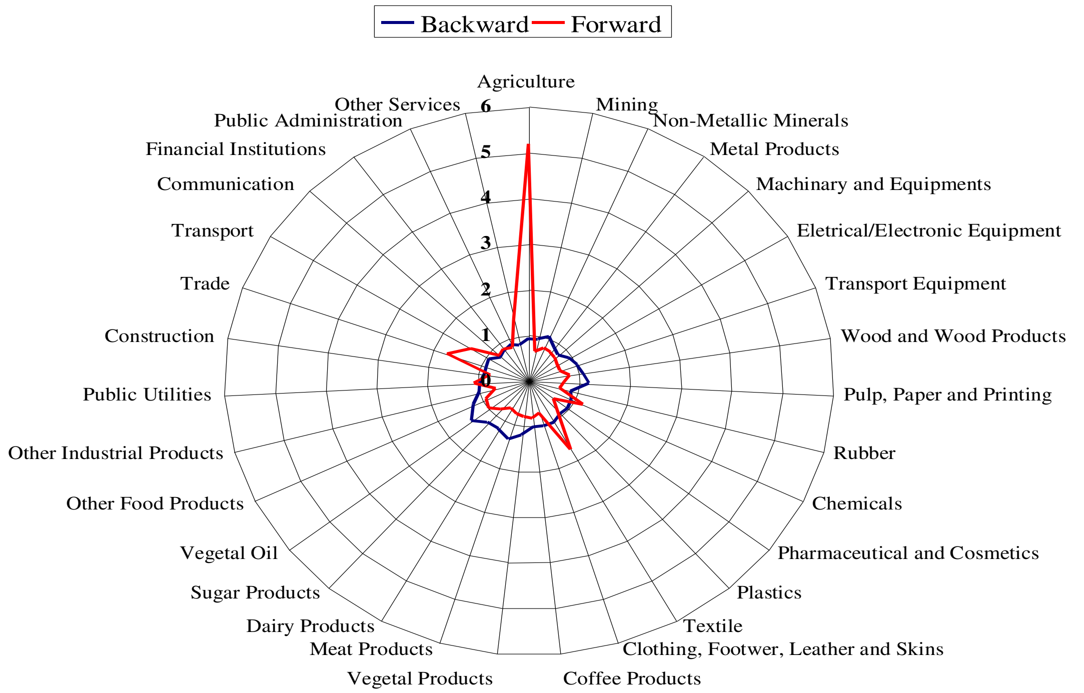


Figure 7. Hirschman-Rasmussen Linkages, **Londrina Regional Pole**, 1995.

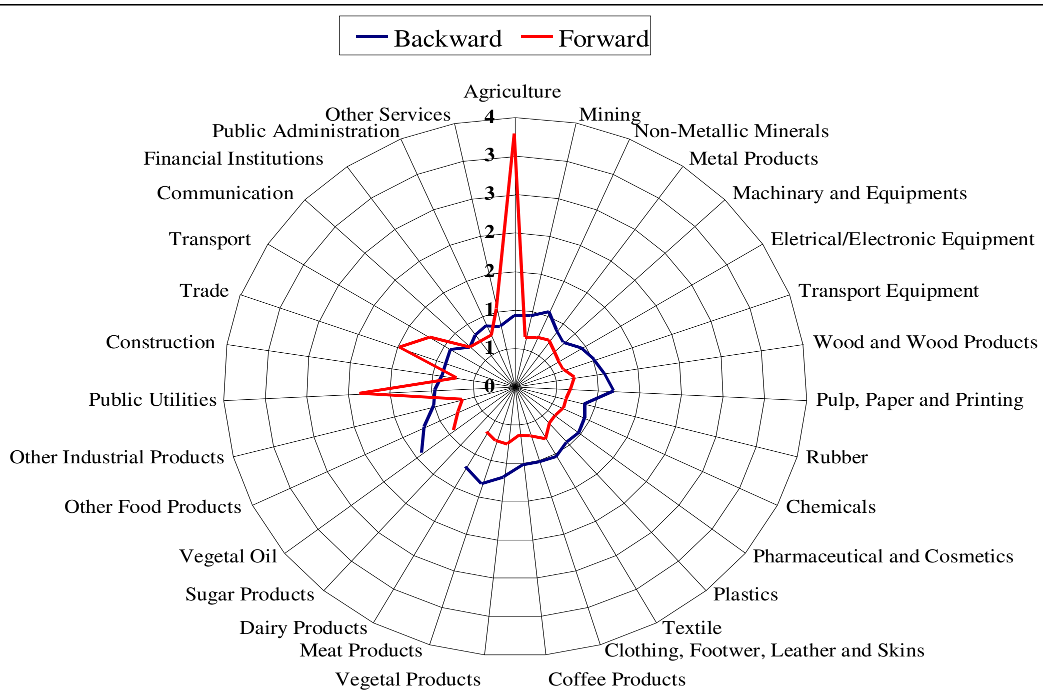


Figure 8. Hirschman-Rasmussen Linkages, **Cascavel Regional Pole**, 1995.

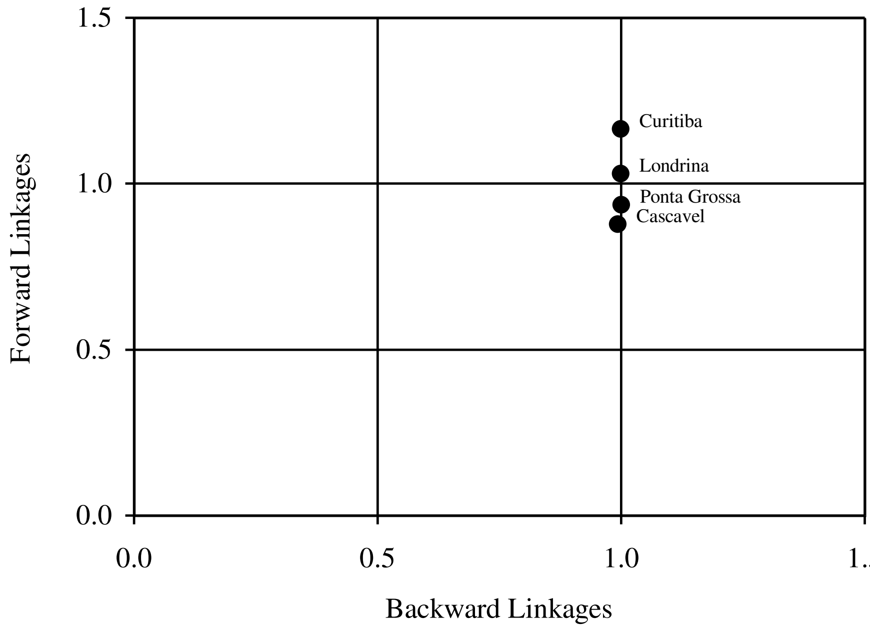


Figure 9. Hirschman-Rasmussen Linkages for **Paraná Interregional System**, 1995

4.2 Intensity Matrices - Applications to the Paraná Interregional System

As a way to compare the productive structure of the region it was constructed the MPM matrices for Brazil, for Paraná State and for each one of its regions. The base hierarchy of the matrices is based on the state of Paraná hierarchy. The results are show in Figures 10 to 15.

From the analysis of the figures one can see that the productive structure of the Ponta Grossa, Londrina and Cascavel regions are very similar to the one for the Paraná state. The Curitiba region seems to be the one that presents more differences when compared to the state. Also the Brazilian economy presents a productive structure different from the one of the state of Paraná and its regions.

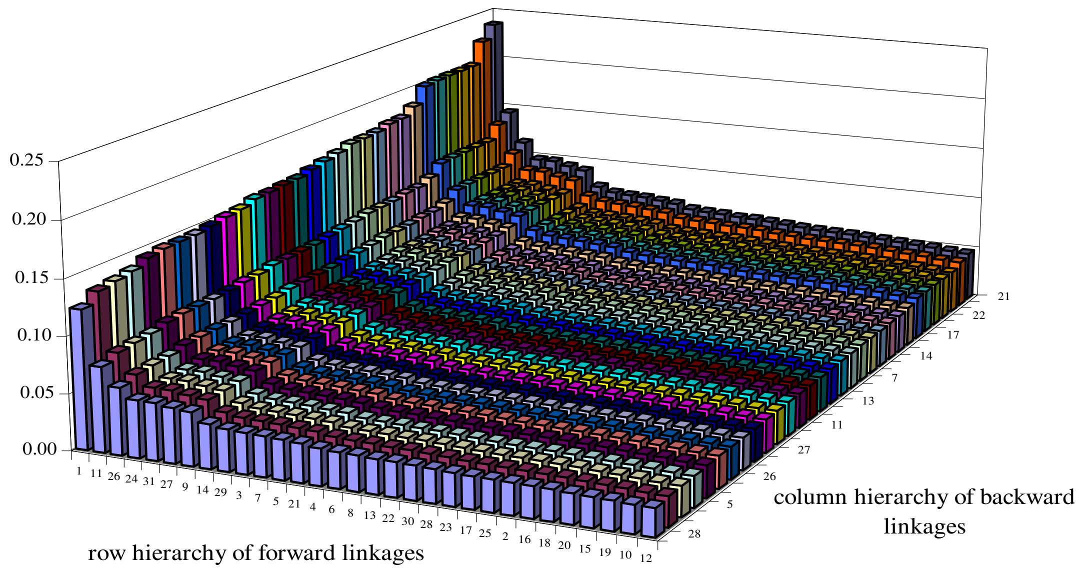


Figure 10. **Paraná: Cross-structure "landscape" for first order intensity field**

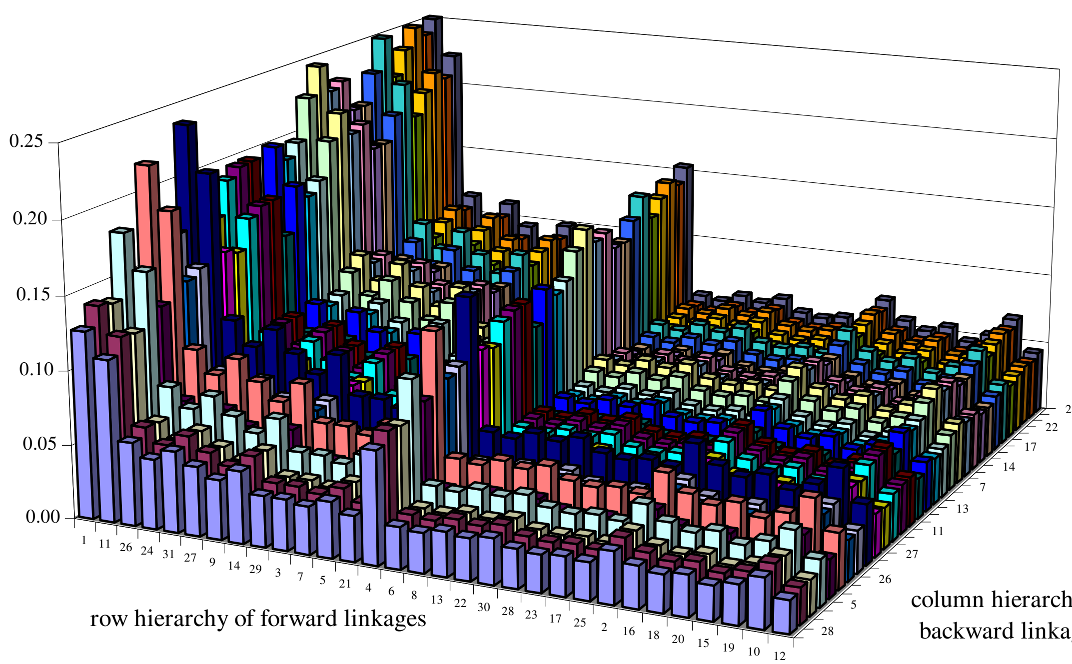


Figure 11. **Brazil: Cross-structure "landscape" using Paraná imposed hierarchy**

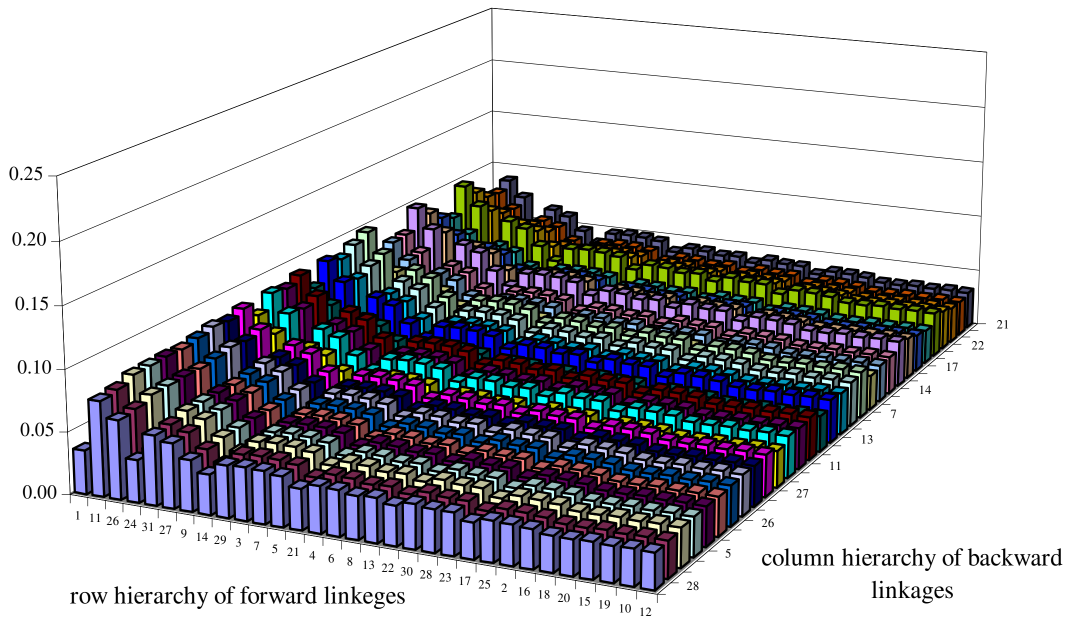


Figure 12. **Curitiba: Cross-structure "landscape" using Paraná imposed hierarchy**

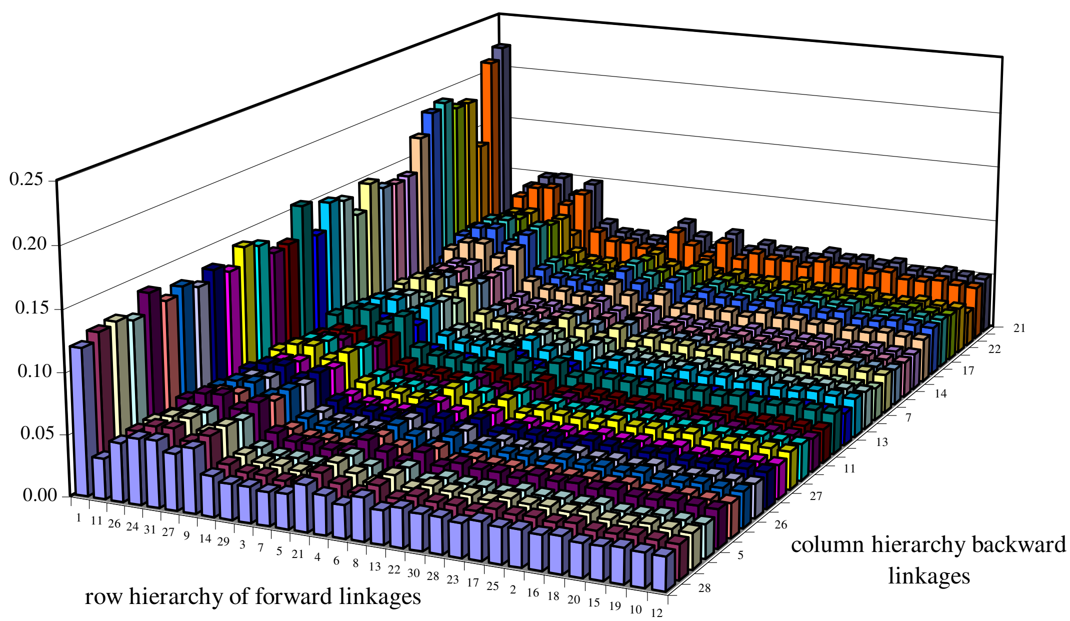


Figure 13. **Ponta Grossa: Cross-structure "landscape" using Paraná imposed hierarchy**

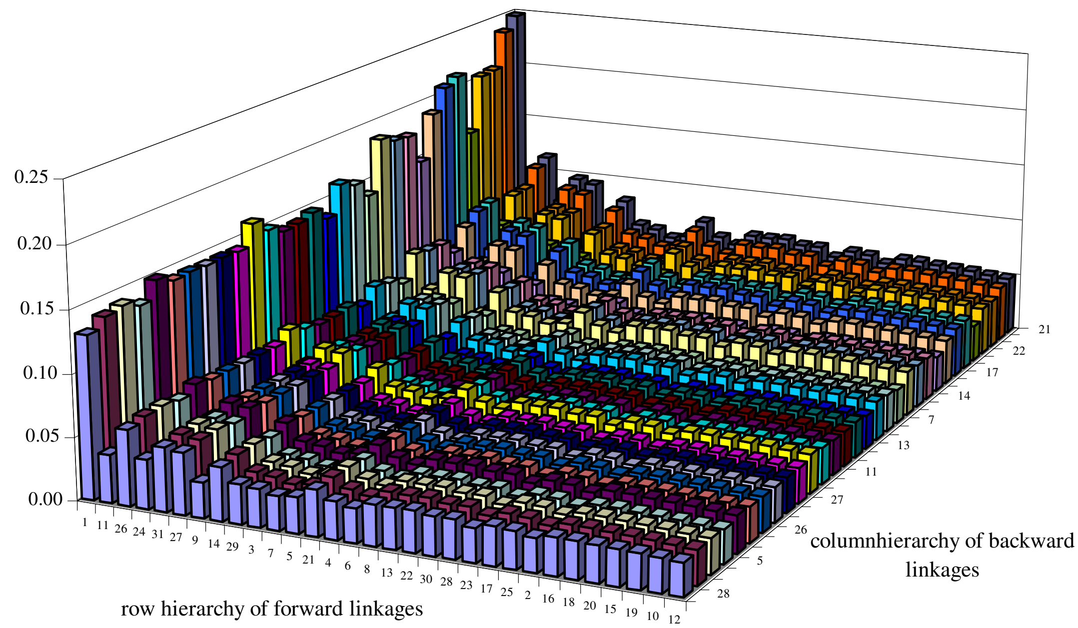


Figure 14. **Londrina: Cross-structure "landscape" using Paraná imposed hierarchy**

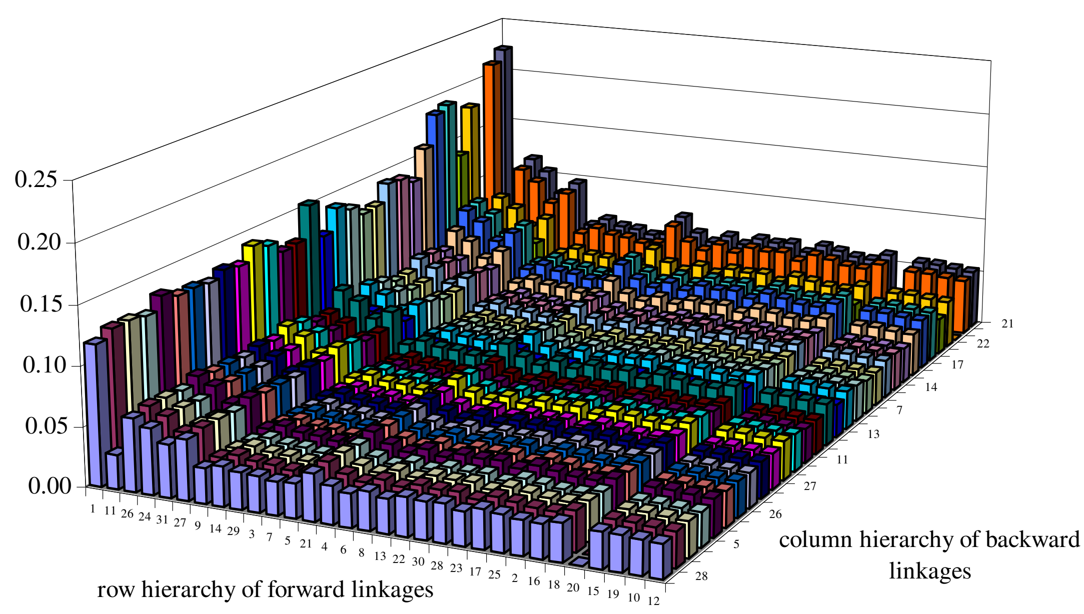


Figure 15. **Cascavel: Cross-structure "landscape" using Paraná imposed hierarchy**

4.3. Synergetic Interactions among Regions

The results for the synergetic interaction among the regions are presented into Tables 4 and 5 and into Figures 16 to 19.

For the Curitiba region the six more important relations answer for 98.18% of its production, while for the Ponta Grossa and Londrina regions the 5 more important relations are responsible for 97.90% of the production, while for the Cascavel region they are responsible for 98.29% of the production.

In the Curitiba region: a) 73.77% of the production is explained by the relations inside the region; b) 7.95% of the production is explained by the sales to the Ponta Grossa region; c) 7.69% of the production is explained by the sales to the Londrina region; and d) 6.23% of the production is explained by the sales to the Cascavel region. When compared to the other regions the Curitiba region is the one that is the more dependent on the other regions.

In the Ponta Grossa region: a) 74.84% of the production is explained by the relations inside the region; b) 13.29% of the production is explained by the sales to the Curitiba region; c) 4.47% of the production is explained by the sales to the Londrina region; and d) 2.88% of the production is explained by the sales to the Cascavel region.

In the Londrina region: a) 78.81% of the production is explained by the relations inside the region; b) 10.51% of the production is explained by the sales to the Curitiba region; c) 3.58% of the production is explained by the sales to the Ponta Grossa region; and d) 3.17% of the production is explained by the sales to the Cascavel region. When compared to the other regions the Londrina region is the one that is the more closed.

In the Cascavel region: a) 77.70% of the production is explained by the relations inside the region; b) 13.42% of the production is explained by the sales to the Curitiba region; c) 3.01% of the production is explained by the sales to the Londrina region; and d) 2.18% of the production is explained by the sales to the Cascavel region.

In general one can observe that in terms of links with the other regions the Curitiba region is the most important, followed by the Londrina region.

Table 4. Contribution (%) of the Combination 1, 2, 3, 4 e 5 Block Matrices to the Production in each Region, Paraná, 1995.

Number of Matrices	Pole-Region of Curitiba	Pole-Region of Ponta Grossa	Pole-Region of Londrina	Pole-Region of Cascavel
1	88.53	84.39	87.70	87.75
2	7.98	12.34	9.88	10.13
3	3.07	2.88	2.21	1.94
4	0.37	0.32	0.15	0.11
5	0.04	0.07	0.06	0.06
Residual	0.01	0.01	0.01	0.01
Total	100.00	100.00	100.00	100.00

Source: Estimated by the authors

Table 5. Contribution (%) of Each Block Matrix to the Total Share of $(x_1\text{-}f)$ in x for regions, Paraná, 1995.

Pole-Region of Curitiba

	CTA	PG	LDA	CEL	Total
CTA	73.77	7.95	7.69	6.23	95.63
PG	0.21	1.13	0.09	0.06	1.48
LDA	0.19	0.09	1.41	0.08	1.78
CEL	0.14	0.03	0.03	0.89	1.10
Total	74.31	9.20	9.21	7.27	99.99

Pole-Region of Ponta Grossa

	CTA	PG	LDA	CEL	Total
CTA	2.42	0.21	0.25	0.19	3.07
PG	13.29	74.84	4.47	2.88	95.48
LDA	0.11	0.04	0.75	0.04	0.94
CEL	0.06	0.02	0.02	0.41	0.50
Total	15.88	75.11	5.49	3.52	99.99

Pole-Region of Londrina

	CTA	PG	LDA	CEL	Total
CTA	1.83	0.25	0.26	0.22	2.56
PG	0.11	0.60	0.04	0.03	0.78
LDA	10.51	3.58	78.81	3.17	96.08
CEL	0.07	0.02	0.01	0.48	0.58
Total	12.53	4.45	79.12	3.90	99.99

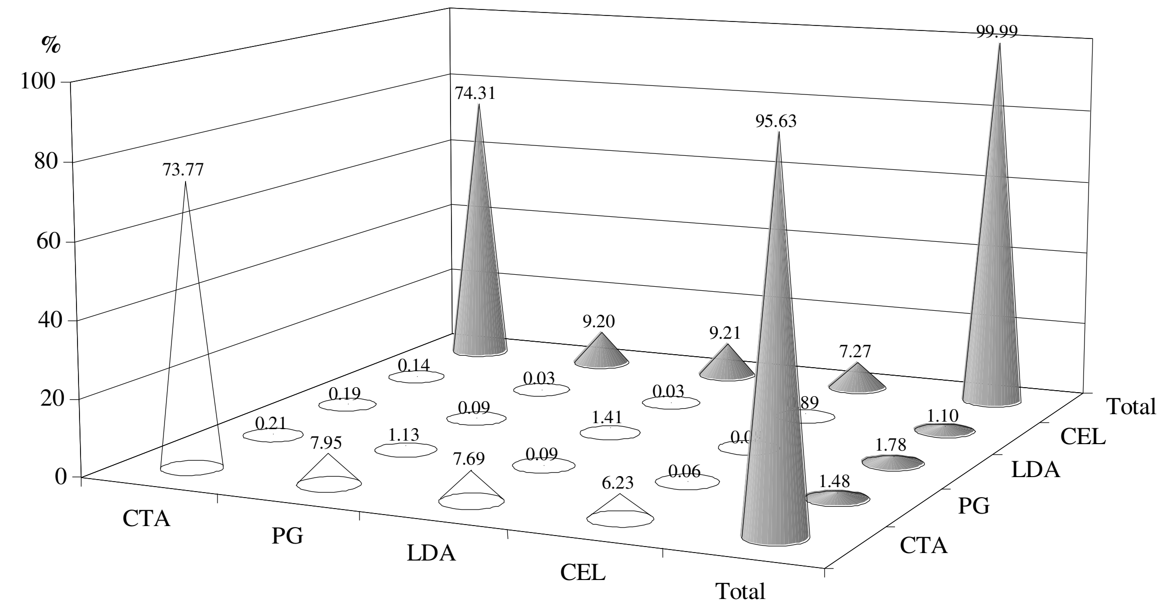
Pole-Region of Cascavel

	CTA	PG	LDA	CEL	Total
CTA	2.18	0.20	0.24	0.18	2.81
PG	0.05	0.27	0.02	0.01	0.36
LDA	0.12	0.02	0.55	0.02	0.71
CEL	13.42	1.98	3.01	77.70	96.11
Total	15.77	2.48	3.82	77.92	99.99

Shares of Main Relations

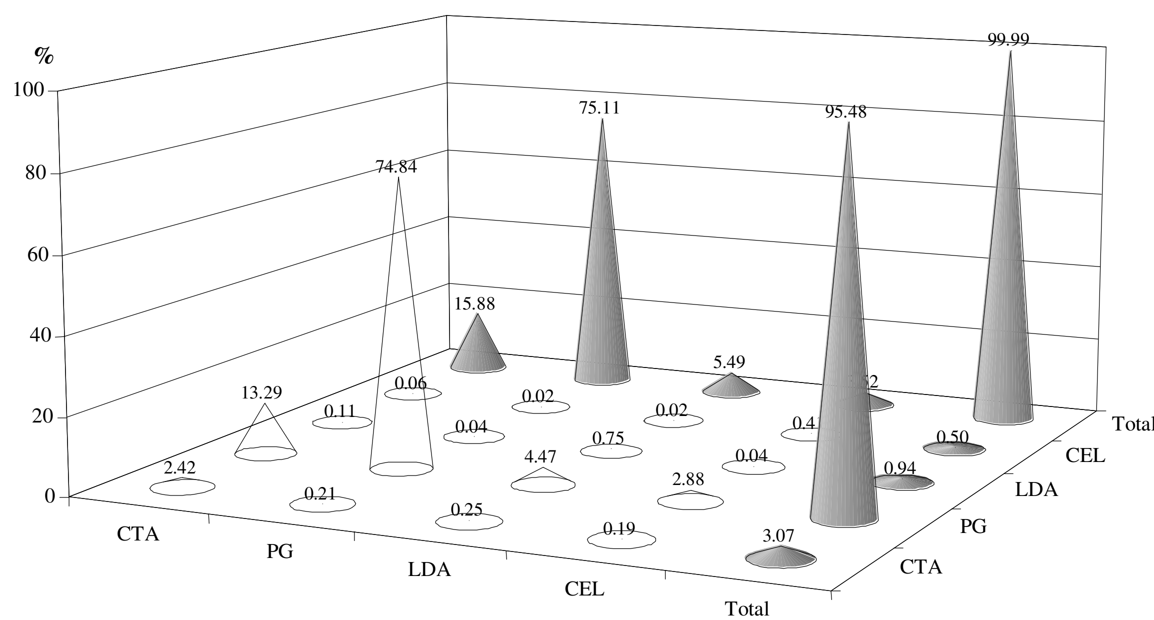
	CTA	PG	LDA	CEL
N. of Matrices	6	6	5	5
% Prod.	98.18	97.90	97.90	98.29

Source: Estimated by the authors



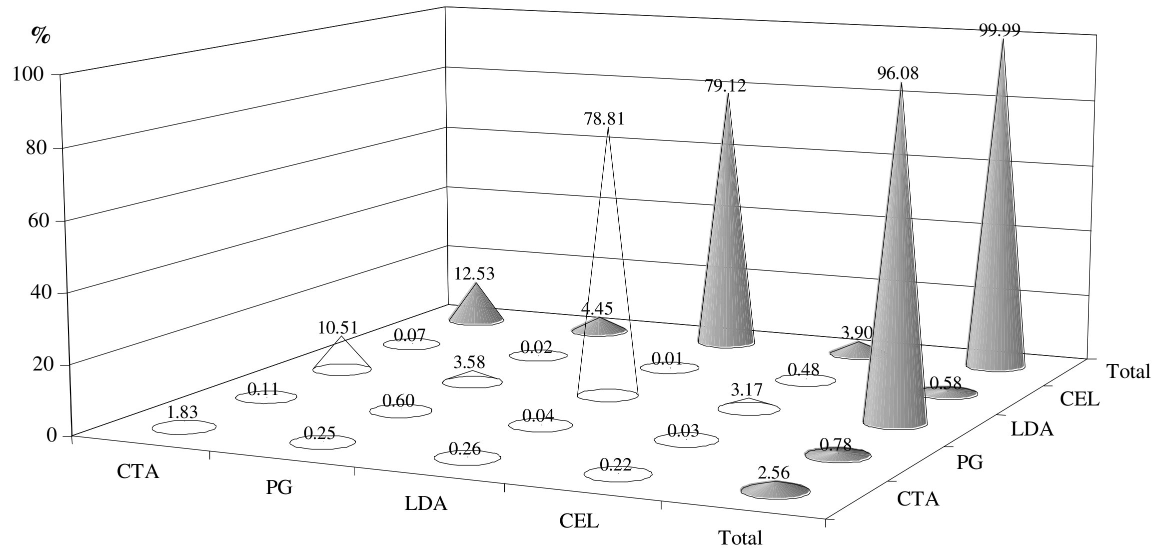
REGIONAL-POLE OF CURITIBA

Figure 16. Contribution (%) of Each Block Matrix to the Total Share of (x_1-f) in x for regions, Paraná, 1995.



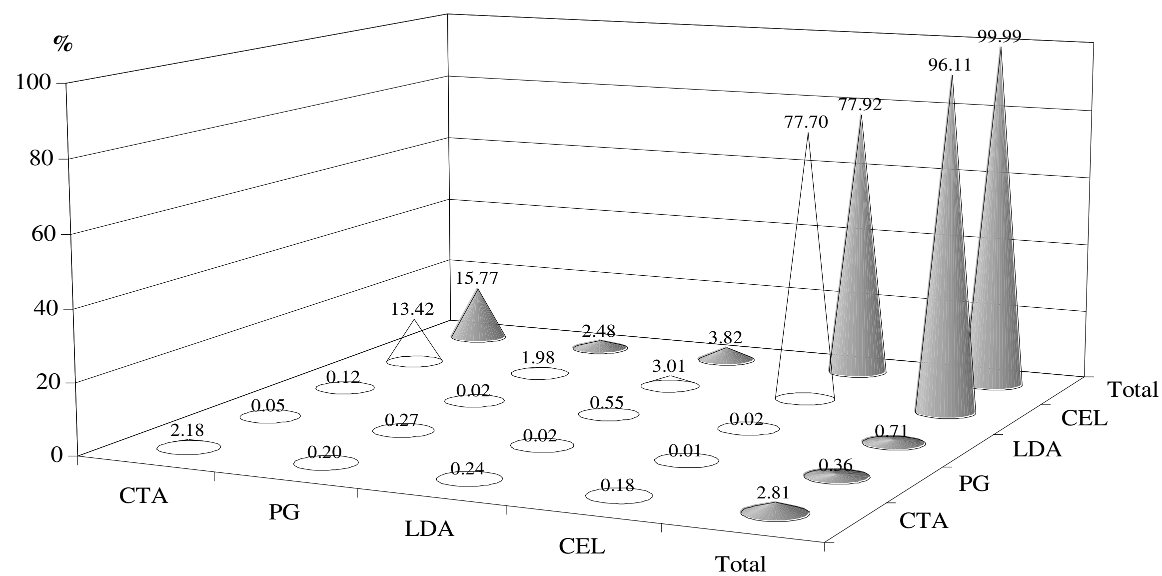
REGIONAL-POLE OF PONTA GROSSA

Figure 17. Contribution (%) of Each Block Matrix to the Total Share of (x_1-f) in x for regions, Paraná, 1995.



REGIONAL-POLE OF LONDRINA

Figure 18. Contribution (%) of Each Block Matrix to the Total Share of (x_1-f) in x for regions, Paraná, 1995.



REGIONAL-POLE OF CASCAVEL

Figure 19 Contribution (%) of Each Block Matrix to the Total Share of (x_1-f) in x for regions, Paraná, 1995.

5. Conclusions

The analysis of the interindustry relations and the identification of key sectors, using the Hirschman-Rasmussen approach, shows that the Curitiba and the Londrina regions are the ones that present the more complex productive structure of the four regions.

In relation to key sectors, the ones that have the value of the backward and forward linkages greater than one are the sectors: a) Non-Metallic Minerals (3), Transport Equipment (7) and Pulp, Paper and Printing (9) for the Curitiba region; b) Pulp, Paper and Printing (9) for Ponta Grossa; and c) Textile (14) for Londrina. Using this criterion, the region of Cascavel does not show any key sector.

From the analysis of the economic landscape derived from the intensity matrices one can see that the productive structure of the Ponta Grossa, Londrina and Cascavel regions are very similar to the one for the Paraná state. The Curitiba region seems to be the one that presents more differences when compared to the State. Also the Brazilian economy presents a productive structure different from the one of the state of Paraná and its regions.

The analysis or the synergetic interaction among the regions shows that: a) when compared to the other regions the Curitiba region is the one that is the more dependent on the other regions; b) the Londrina region is the one that is the more closed; and c) in general one can observe that in terms of links with the other regions the Curitiba region is the most important, and despite the fact that the Londrina region is the more closed it is showed to be the second most important region for the system.

6. References

CONDIRERA, C. M.; MEDINA, M. H. **PIB por unidade da federação:** valores correntes e constantes – 1985/96. Rio de Janeiro: IPEA, 1998. (Texto para Discussão, 610).

GUILHOTO, J. J. M.; SONIS, M.; HEWINGS, G. J. D.; MARTINS, E. B. Índices de ligações e setores-chave na economia brasileira: 1959/80. **Pesquisa e Planejamento Econômico**. v.24, n.2, p.287-314, ago. 1994

GUILHOTO, J. J. M. Decomposition & synergy: a study of the interactions and dependence among the 5 brasilian macro regions. Dublin, Irland: 39th European Congress of the ERSA / RSAI, 1999. 23p.

HIRSCHMAN, A. O. **The strategy of economic development**. New Haven: Yale University Press, 1958.

IBGE. **Anuário estatístico do Brasil** – 1996. Rio de Janeiro: v.56. 1997a.

IBGE. Contagem da população – 1996. Rio de Janeiro, 1997b.

IPARDES. **Diagnóstico da base produtiva do Paraná** – anos 80. Curitiba, 1991. 127p.

IPARDES. **Produto Interno Bruto do Paraná:** dados municipais - 1995. Curitiba, jul. 1998.

IPEA. Dados obtidos via Internet.

LOURENÇO, G. M. Evolução recente e perspectivas das economias regionais segundo a F.G.V. **Análise Conjuntural.** Curitiba, v.16, n.1-2, p.3-6, jan/fev. 1994.

LOURENÇO, G. M. Expansão recente da economia paranaense: componentes estruturais e conjunturais. **Análise Conjuntural.** Curitiba, v.17, n.3-4, p.20-25, mar/abr. 1995.

LOURENÇO, G. M. O PIB paranaense em 1998. **Análise Conjuntural.** Curitiba, v.21, n.3-4, p.3-5, mar/abr. 1999.

McGILVRAY, J. Linkages, key sectors and development strategy. In: LEONTIF, W. (ed.). **Structure, system and economc policy.** Cambridge: University Press, 1977. P.49-56.

RASMUSSEN, P. **Studies in intersectoral relations**. Amsterdam, North Holland, 1956.

SONIS, M.; HEWINGS, G. J. D. "Economic Landscapes: Multiplier Product Matrix Analysis for Multiregional Input-Output Systems," *Hitotsubashi Journal of Economics* 40(1), pp. 59-74. 1999.

SONIS, M.; HEWINGS, G. J. D; GUO, J. "Input-output multiplier product matrix." *Discussion Paper* 94-T-12 (revised, 1997), Regional Economics Applications Laboratory, University of Illinois. 1997

SONIS, M.; HEWINGS, G. J. D; MIYAZAWA, K. Synergetic interctions within the pair-wise hirarchy of economic linkges sub-sistems. **Hitotsubashi Journal of economics**, n. 38, p. 2-17, dez. 1997.