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PRODUCTIVE STRUCTURE AND TRADE RELATIONS: THE CASE OF THE WESTERN BORDER REGIONS OF PARANÁ STATE, BRAZIL

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The Case of the Western Border Regions of Paraná State, Brazil

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Abstract. The aim of this paper is to analyze the productive structure and the trade relations, national and international, of the Western Border Regions of Paraná state in Brazil. As so, based on the input-output database from the University of São Paulo Regional and Urban Economics Lab – NEREUS, we have estimated: a) an interregional input-output model for 6 regions (5 in Paraná and the remaining of Brazil), for 2008; and b) the external trade relations of these regions. The results also point out the importance for the Western border regions of traditional sectors of the state economy, however, in some situations, the sectors that most contribute to output, income, value added, and employment generate many of these benefits outside the regions, mainly due to the spillovers. These findings certainly need to be considered by policy makers when designing policies for the development of the analyzed region.

1. Introduction

Paraná is one of the major states of Brazil regarding agricultural and industrial production. According to IPARDES (2013) Paraná's economy is the fifth largest in the country. The state production represents 5.84% of the national GDP, with a per capita income of R$ 20,800 in 2010, above the national average of R$ 19,700. The Value Added for Paraná state is divided into 8.48% from agriculture, 27.46% from industry and 64.06% from trade and services.

In 2012, the share of Paraná in the national exports was 7.3%, the fourth position among the Brazilian states. Regarding imports, the largest suppliers of goods to Paraná were China, Nigeria, Argentina and the United States, amounting to US$ 8.6 billion.

Besides the importance for the country's economy, Paraná has a peculiar feature, with the presence of 139 municipalities in the "Western border strip", setting limits with Paraguay and Argentina. This feature requires from Paraná policy makers differentiated strategies to promote the growth and the development of this region, due to specific characteristics of these municipalities caused by the proximity from the border, or by the distance of this region from major economic centers of the state and the country.

In this context, the aim of this paper is to analyze: a) the economic structure of the Western border region of Paraná, pointing out their similarities and their differences with the rest of the country; b) the interdependence of the regions, concerning production, employment and value added, and identifies how production can spill over from one region to another and to the rest of the country; c) identify the relationship of the Western border region of Paraná State with neighboring countries, Paraguay and Argentina.

The paper highlights the importance of identifying sectors where the stimulus to regional final demand increases production, mostly within the border regions, and also to identify sectors where the increasing in the national final demand can spill over dynamism to the economy of the border region.

In order to achieve the proposed objective, the paper, besides this introduction, is divided into 6 other sections. In section 2 the characterization of the border region is presented. In section 3 some concepts of regions and regional development are approached. Section 4 presents the methodological aspects, and the database is presented in section 5. The results are presented in section 6, while the final comments are made into the last section.

2. Concept and Characterization of the Border Region

The meaning of "border" may be associated with the common sense of the end of a country or region, mingling with the concept of limit. To Hissa (2002) the limit, as territory, is facing inwards. On the other hand, the border view from the same place, is facing outwards. The limit encourages the idea of distance and separation, while the border moves reflection about the contact and integration.

To Rolim (2004) places on the border, while permitting a common economic space, establish barriers to integration, i.e., provide conditions for the existence of a flow of people, capital and at the same time create restrictions so that it can happen. Parsley and Wei (2000) analyze the volatility of prices in a three-dimensional panel data with 27 products, 88 quarters across 96 cities in the U.S. and Japan. The results showed a very high volatility of relative prices. The high volatility in prices is attributed to factors such

as distance, unit shipping cost and fluctuations in exchange rates, which are known in the literature as "border effect".

Turrini and Ypersele (2010) investigated the role played by differences in the judicial system to deal with "border effect". In this context, the asymmetries in the procedures to resolve trade disputes contribute greatly to reducing the trade between two cities with the presence of an international border between them.

Morshed (2003) shows that the variation of the prices in equidistant cities located in two different countries is systematically larger than that for the cities within the same country. The Nontariff barriers and exchange rate variability are the proximate causes of this systematic difference in consumer price variability. The author, using data from developing countries with large nontariff barriers and more volatile exchange rate suggests that those claims are overemphasized in these countries.

Despite the relevance of the "border effect" Holmes and Stevens (2012) related distance, the presence of borders and the size of the company to explain the difficulties of trade between regions. According to the authors, the fact that large manufacturing plants export relatively more than small plants has been the foundation of much work in the international trade literature. However, they show that this fact is not entirely an international trade phenomenon.

They examined this hypothesis using Census microdata on plant shipments from the Commodity Flow Survey and found that part of this effect can be due to the distance effect, apart from any border effect. Export destinations tend to be farther than domestic destinations, and large plants tend to ship farther distances, even to domestic locations compared with small plants.

Portes and Rey (2005) using a panel data set of bilateral gross cross-border equity flows between 14 countries in the period of 1989–1996 found that the gross transaction flows depend on market size in source and destination countries, as well as trading costs, in which both information and the transaction technology play a role. They say that the geography of information is the main determinant of the pattern of international transactions.

Leasing Jr. and Azevedo (2009) analyzed the border effect in Brazil and found that, despite the country having participated in major trade agreements, such as Mercosur, still has a high border cost. The results indicate that trade among Brazilian states is 33 times higher than the international trade of these states, in the specific case of Paraná, for the year 1999, the intra-national trade accounted for 86.09% of the total trade in the state.

In Brazil, mainly for strategic purposes of national security, the Brazilian Institute of Geography and Statistics - IBGE considers "border" a 150Km strip along the border, parallel to the landline part of the national territory. In this region, it is forbidden to grant lands, open transport routes, build bridges and airfields and install media, besides the exploration of industries which represent a threat to the national security needs a special authorization from the federal government.

The reach of the Brazilian international border strip has 15,719 kilometers where about 30 million inhabitants live. It is divided into three major regions and 17 sub-regions as shown in Figure 1.

Figure 1. Brazilian international Western Border
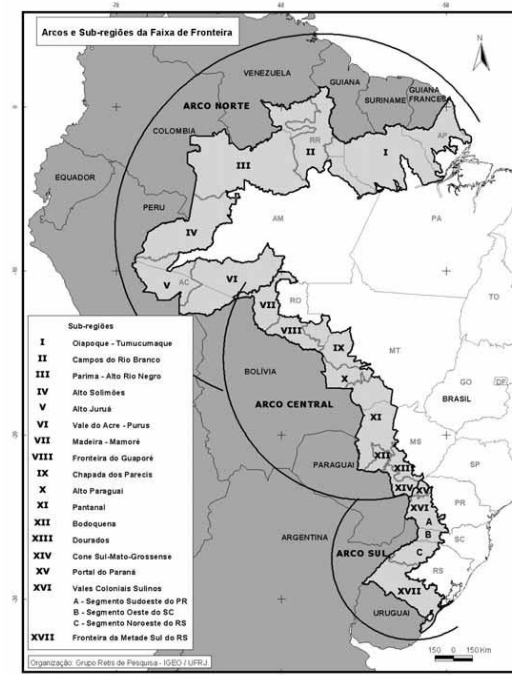
Source: Regional core of integration of border track (2012)

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The Northern arc corresponds to the territory of the Western Amazon, considering the states of Rondônia, Acre, Amazonas and Roraima, Pará and Amapá. The Central arc comprises the states of Mato Grosso and Mato Grosso do Sul, and finally, the Southern arc, with the states of Rio Grande do Sul, Santa Catarina and Paraná, where the sub-region object of this study is inserted.

According to IBGE the border strip is composed of 570 municipalities, 98 in the Northern Region, 69 in the Midwest Region and 403 in the South, as shown in Table 1.

Table 1. Federative Units and municipalities in the Western Border

State	Number of Municipalities on the border
Rondônia	27
Acre	22
Amazonas	21
Roraima	15
Pará	5
Amapá	8
Total Northern Arc	**98**
Mato Grosso	44
Mato Grosso do Sul	25
Total Central Arc	**69**
Paraná	139
Santa Catarina	82
Rio Grande do Sul	182
Total Southern Arc	**403**
Total Brasil	**570**

Source: Brazilian Institute of Geography and Statistics.

The Southern region is the one with more municipalities along the border, about 70% of the total, and Paraná is the second state with the most municipalities in that range.

The Western border of Paraná consists of 139 municipalities, representing 35% of municipalities in the state. Concerning the population, the region has about 2.3 million inhabitants, which corresponds to 23% of Paraná population, as presented into Table 2.

Table 2. Population and GDP for Paraná and Western Border of Paraná in 2010

Variables	State Municipalities		Border Municipalities	
	Total	Average	Total	Average
GDP (R$ million)	217,290	545	41,790	303
Population (Thousand)	10,445	26	2,369	17

Source: IPARDES (2013)

The Western border of Paraná is also relevant to the state's economy, accounting for about 20% of the state GDP. However, according to Rolim (2004), this region is far from the major Brazilian urban centers and large cities in South America. Even considering the Metropolitan Region of Curitiba, which is the capital and the industrial center of Paraná, there is a distance of at least 636 km from Foz do Iguaçu, the most border city, to the state capital.

In addition to the distance from the major production centers of the state and the country, there is the "border effect" which also restricts the relationship of the municipalities of the Western border of Paraná with the cities in the neighboring countries (Paraguay and Argentina). As a result, the region is in itself quite complex whit specific economic and administrative conditions.

Regarding the Brazilian side, which is the object of this study, it is possible to emphasize the presence of three highly relevant factors for the region: (1) the Itaipu hydroelectric plant, which, besides generating a large number of jobs, pays royalties for some municipalities in the region that had their space flooded by the dam construction; (2) the trade with Paraguay, especially the wholesales; and (3) the great tourism potential of Foz do Iguaçu municipality.

In this context, given its economic specificity, the Western border of Paraná requires particular strategies to promote its development, driven by regional actors and, mainly, by efficient public policies, which could promote equitable development and income distribution in the region.

To better understand these concepts, the next section of this study will address some theories that analyze the conditions under which the development takes place in a region, how it happens and spreads regionally.

3. The Region and the Regional Development

As already mentioned, the Western Border was determined by the State as a strategic space for national security purposes, however, the concept of region goes beyond the space determined by the State.

According to Souza & Gemelli (2011) region is a reality that is materialized through the social actors, appearing when the similarities and common internal relations are defined. It also evidences the economic, social and cultural intra and inter dependencies, which can be established by contiguity or by network formation.

For Hirschman (1977) economic progress does not occur at the same time and everywhere in a region, there are forces that cause the spatial concentration of growth around the points where it starts, but the economic progress can be transmitted inter-regionally and internationally, i.e., since the growth becomes strong in a region, it triggers certain forces that act on the remaining parts.

The region's economic growth causes a series of repercussions in other regions, because of the interdependencies established by contiguity or by network formation, some repercussions are favorable, others adverse. The favorable effects are called "fluency effect", which are mainly composed by the effect of the increase in purchases and investments in a region because of the growth that happens in another region. However, this will only occur if there is a complementary relationship between economic regions.

On the other hand, to Hirschman (1977), the growth of a region can bring harm to other regions, such as the migration of skilled labor and capital to the region where the

growth takes place, leaving the original regions. It happens when sectors in different regions compete for the same resources.

According to Williamson (1977) this effect can be potentialized because the labor migration is extremely selective, due to the prohibitive cost of migration for people with low income levels, thus, during the migration process, regions lose workers with higher qualification. Regarding the capital, a developed banking system can accelerate the process of capital concentration, i.e., banks can raise funds from savers in a region and redirect them to the region where the growth process is more advanced.

For Hirschman (1977) regional allocation of public investment is the most obvious way in which economic policies influence the growth rates of the various regions of a country. But this is not a trivial task, according to Williamson (1977), the declared or covert intention of the federal government, to maximize national development, can further increase the degree of regional inequality.

For Souza (2005) the strategy of polarizing the development was the main rule of the Regional Planning in several countries, because the pulverized investment weakens the linkage effects between sectors. The idea is to concentrate investments in specific points in an attempt to serve the economic interests.

This way, Hirschman (1977) defines "great institutional measures" as arrangements that enhance the fluency effect, i.e., the investments at the poles should flow to the periphery, and mitigate the polarization effect, therefore, avoiding income concentration in the richest regions.

To Sonis et al (1997) most studies that deal with trade between regions focus on explaining trade flows, while little attention has been given to the geographical structure of these flows, which is the goal of this study.

In summary, this study emphasizes the importance of analyzing the economic structure of each region and identifying the relationships of complementary and inter-regional competition, in order to show how the investment in a particular industry, in a particular region, can "spill over" to the other regions and promote the "fluency effect ".

In addition, if the interest of policy makers is to develop the peripheral regions, it is very important to identify which are the sectors where the investments are kept in the peripheral regions and if there is no "spill over" to the poles, to avoid the income concentration in richer regions (polarization effect). This information can guide the policy makers in promoting efficient national strategies, without increasing regional inequalities.

To Sonis et al (1997) the availability of information as contained in the input-output matrices can help to understand the process of spatial and structural changes in a particular region.

Baumol and Wolff (1994) point out the key role of input-output analysis in policy formulation, highlighting the efficiency of this analysis of the rational use of scarce resources.

4. Methodology

The input-output model developed by Leontief (1951) shows the flows of goods and services among the sectors and agents of the economy for a given year. The inter-industries flows are determined by economic as well as technological factors and can be expressed through a system of simultaneous equations (Miller and Blair, 2009).

In matrix terms the inter-industries flows in the economy can be represented by

$$AX + Y = X \tag{1}$$

Where:

X is a vector ($n \times 1$) and it contains the value of total production by sector;

Y is also a vector ($n \times 1$) and it contains the final demand values;

and A is a ($n \times n$) matrix which contains the production technical coefficient.

In the model above, the final demand vector is usually considered exogenous to the system; thus, the total production vector is determined only by the final demand vector, which is given by:

$$Y = BX \tag{2}$$

$$B = (I - A)^{-1} \tag{3}$$

Where:

B, the Leontief inverse, is a ($n \times n$) matrix of direct and indirect coefficients, in which the element b_{ij} shows the total amount of production that is required from sector i to produce one unit of final demand of sector j.

From equation (3) one can estimate the output multipliers of type (I), which shows the direct and indirect effects for a given sector (Miller and Blair 2009), i.e., the total amount of production generated in the economy to produce one unit of final demand of the given sector, and is given by:

$$P_j = \sum_{i=1}^{n} b_{ij} \tag{4}$$

Where:

P_j is the output multiplier of sector j.

One can also estimate, for each sector in the economy, the total amount of employment, value added, emissions, etc, that is generated directly and indirectly in the economy to produce one unit of final demand of the given sector. In order to do so, one needs to calculate the direct coefficient of the variable of interest:

$$v_i = \frac{V_i}{X_i} \tag{5}$$

Where:

v_i is the direct coefficient of the variable of interest of sector i;

V_i is the total of the variable of interest corresponding to sector i (for example, total employment of sector i);

and X_i is the value of total production of sector i.

Then, the total impact, direct and indirect, on the variable of interest will be given by:

$$GV_j = \sum_{i=1}^{n} b_{ij} v_i \qquad (6)$$

where GV_j is the generator of the variable of interest corresponding to sector j, which represents the total impact, direct and indirect, on the variable of interest given a new final demand of one monetary unit in sector j.

Based on the Leontief system other indicators can be estimated and used to better understand the economic relations and the productive structure of a given economy. In this way, this paper makes use of backward and forward linkages (Hirschman-Rasmussen and Pure), to better understand the productive structure of the Brazilian economy. These indicators are described and defined in the following sections.

4.1. The Hirschman-Rasmussen 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. Being b_{ij} a typical element of the Leontief inverse matrix, B; B^* the average value of all elements of B, and $B_{\bullet j}$ associated typical column sums, then the backward linkage index can be defined as follows:

$$U_j = [B_{\bullet j} / n] / B^* \qquad (7)$$

Defining F as the matrix of row coefficients derived from the matrix of intermediate consumption, G as the Ghosh matrix given by $G = (I - F)^{-1}$ (Miller and Blair, 2009),

G^* as the average of all elements of G, and G_{i*} as being the sum of a typical row of G, the forward linkages can be defined as:

$$U_i = [G_{i*}/n]/G^* \tag{8}$$

The Hirschman-Rasmussen indices of linkages measure the importance of a sector in the economy in terms of buyer (backward) or supplier (forward) of inputs. The Pure linkage approach presented below is similar to the Hirschman-Rasmussen, however it also takes into consideration the total production value of each sector in the economy, i.e., the size of the sector. The sectors indicated as the most important inside the economy, using the Pure linkage, in general are sectors with a great interaction among the other sectors and with a significant level of production.

In general the Hirschman-Rasmussen are concerned mainly with the technical coefficients, while the pure linkage also take into consideration the importance of the values supplied and demanded by each economic sector.

4.2. The Pure Linkage Approach

As presented by Guilhoto, Sonis and Hewings (2005) the pure linkage approach can be used to measure the importance of the sectors in terms of production generation in the economy.

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

$$A = \begin{bmatrix} A_{jj} & A_{jr} \\ A_{rj} & A_{rr} \end{bmatrix} = \begin{bmatrix} A_{jj} & A_{jr} \\ A_{rj} & 0 \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & A_{rr} \end{bmatrix} = A_j + A_r \tag{9}$$

Where:

A_{jj} and A_{rr} are the quadrate matrices of direct inputs within the first and second region and A_{jr};

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and A_{rj} are the rectangular matrices showing the direct inputs purchased by the second region and vice versa.

From (7), one can generate the following expression:

$$B = (I - A)^{-1} = \begin{pmatrix} B_{jj} & B_{jr} \\ B_{rj} & B_{rr} \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{pmatrix} \begin{pmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{pmatrix}$$ (10)

Where:

$$\Delta_j = (I - A_{jj})^{-1}$$
$$\Delta_r = (I - A_{rr})^{-1}$$
$$\Delta_{jj} = (I - \Delta_j A_{jr} \Delta_r A_{rj})^{-1}$$
$$\Delta_{rr} = (I - \Delta_j A_{rj} \Delta_j A_{jr})^{-1}$$

From equation (8) it is possible to reveal the process of production in an economy as well as derive the Pure Backward Linkage (*PBL*) and the Pure Forward Linkage (*PFL*), i.e.,

$$PBL = \Delta_r A_{rj} \Delta_j Y_j$$ (11)

$$PFL = \Delta_j A_{jr} \Delta_r Y_r$$ (12)

Where the *PBL* will give the pure impact on the rest of the economy of the value of the total production in region, i.e., the impact that is free from a) the demand inputs that region *j* makes from region *j* , and b) the feedbacks from the rest of the economy to region *j* and vice-versa. The *PFL* will give the pure impact on region *j* of the total production in the rest of the economy

Other advantage of the Pure linkages in relation to the Hirschman-Rasmussen linkages is that it is possible to get the Pure Total linkage in the economy (*PTL*) by adding the *PBL* and the *PFL*, given that this index are measured in current values, i.e.,

$$PTL = PBL + PFL \tag{13}$$

To facilitate a comparative analysis of the pure linkages with the Hirschman-Rasmussen linkages one can do a normalization of the pure linkages. This normalization is done by dividing the pure linkage in each sector by the average value of the pure linkage for the whole economy, in such a way that the pure linkages normalized are given by the following equations for the backward (PBLN), forward (PFLN) and total (PTLN) linkages:

$$PBLN_i = PBL_i \bigg/ \left(\sum_{i=1}^{n} PBL_i \bigg/ n \right) \tag{14}$$

$$PFLN_i = PFL_i \bigg/ \left(\sum_{i=1}^{n} PFL_i \bigg/ n \right) \tag{15}$$

$$PTLN_i = PTL_i \bigg/ \left(\sum_{i=1}^{n} PTL_i \bigg/ n \right) \tag{16}$$

5. Database

As already mentioned, the Western border of Paraná is formed by 139 municipalities positioned in an inner strip of 150 km, parallel to the landline part of the national territory. Aiming to better analyze the Western border regions of Paraná state, and understand how this region relates to itself, with the rest of Paraná, Brazil and the World, the state of Paraná was divided into five regions (three border regions: municipalities with distance from 0-50Km (R1), 50-100Km (R2), and 100-150Km (R3) from the border, a central region (R4), and a seaside region (R5), besides a region called remaining of Brazil (R6), shown in Figure 2.

Figure 2. Map of the State of Paraná divided into 5 regions according to the input-output system
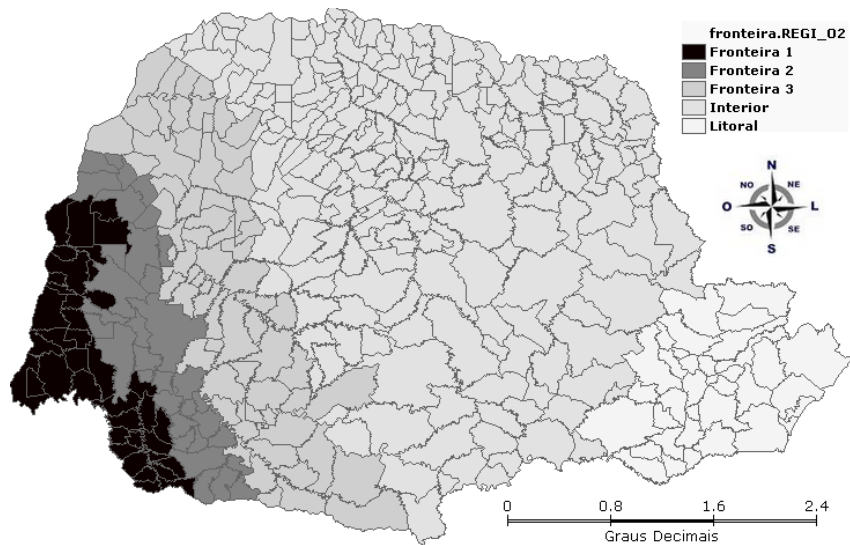
Source: IBGE (2013).

The Western border region, was divided into 3 equal sub-regions aiming to identify if, inside of the border region, there are differences between economic structures or trade relations of the sub-regions when the municipality is closer to the border or if these sub-regions are homogeneous. In addition to that, identify how much of the production of each sub-region border strip is linked to domestic demand, the demand from the other border strips, the rest of Paraná, Brazil and the World.

The interregional input-output system used in the paper was derived from the NEREUS (University of São Paulo Regional and Urban Economics Laboratory) database which consist of the Brazilian Interregional Input-Output System estimate for all the 5564 Municipalities of the Brazilian economy, at the level of 56 industries and 110 commodities, for the year of 2008.

In order to discriminate exports to Paraguay and Argentina were used data from Analysis System of Foreign Trade Information, called AliceWeb, provided by the Secretariat of Foreign Trade of the Ministry of Development, Industry and Foreign Trade.

6. Results

The aim of this paper is to analyze the productive structure and the national and international trade relations of the Western border region of the Paraná State in Brazil.

Therefore, the results were divided into three sections. The first section approaches the similarities and differences in the productive structure of the border region with itself, with the rest of Paraná and the rest of the country. The second section approaches the interdependence relations of the regions mentioned, including the rest of the world. In the third section an analysis of the production multipliers and spillover effects will be carried out.

6.1. The Productive Structure

The analysis below takes into consideration the indices of Rasmussen-Hirschman backward linkages (HRBL) and forward linkages (HRFL), and the pure indices (GHS) backward linkages (PBLN), forward linkages (PFLN) and total linkages (PTLN).

Graph 1 shows the backward linkage indices (HRBL) for the six regions being considered, it is noteworthy the importance of the sectors of tobacco products, electronic components and communication equipment and printing for the three border regions (R1, R2, R3).

Table 3 shows the Spearman correlation coefficient for the (HRBL) among the six regions of the analyzed system. As closer to 1 the value of the coefficient is, the more similar are the productive structures in the regions regarding backward linkages.

It is noticed that the correlation coefficients are higher among regions R1, R2 and R3, confirming the greater similarity between them, i.e., the productive structure of the border region looks more like themselves than the other regions. On the other hand, the correlation coefficient of the border regions with the rest of Brazil is the lowest, indicating little similarity between these production structures, regarding the backward linkages.

Graph1. Hirschman-Rasmussen Backward Linkage Indices for the Regions in the System
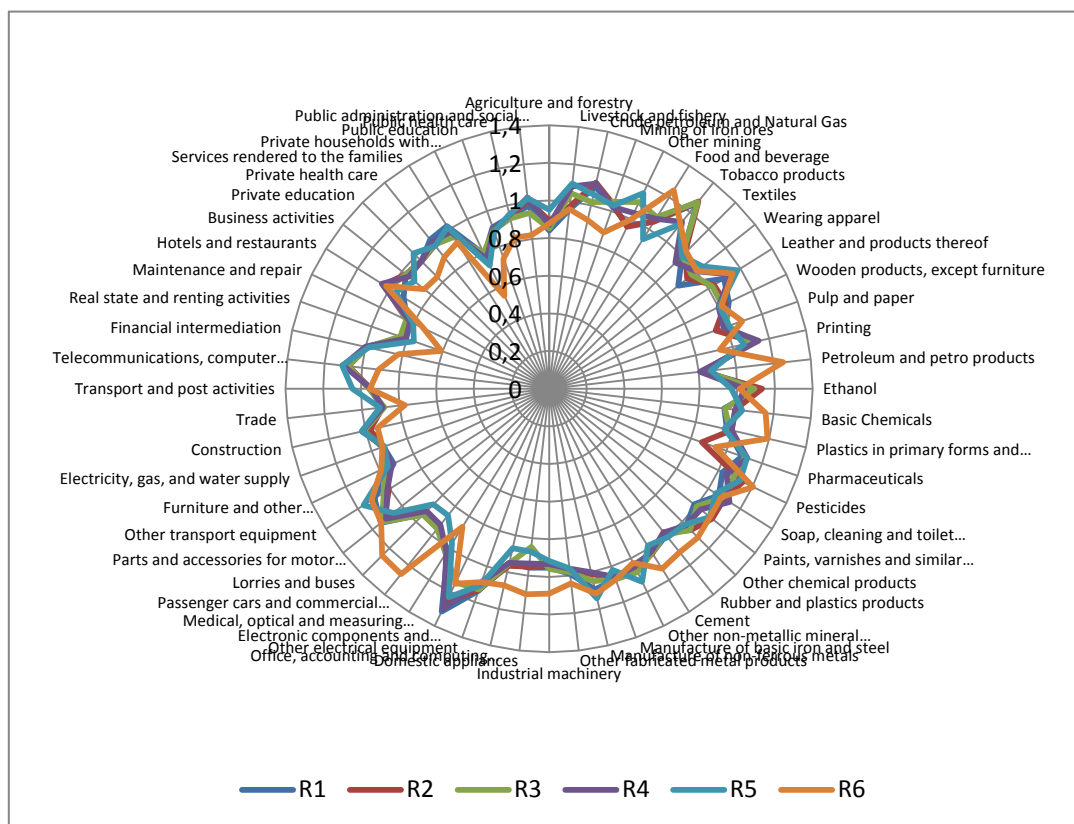
Source: Research data

Table 3. Spearman's correlation coefficient for the (HRBL) among the six regions of the analyzed system

		R1	R2	R3	R4	R5	R6
R1	Correlation Coefficient	1.000	0.820[**]	0.863[**]	0.829[**]	0.712[**]	0.321[*]
	Sig. (2-tailed)	.	0.000	0.000	0.000	0.000	0.016
R2	Correlation Coefficient	0.820[**]	1.000	0.780[**]	0.820[**]	0.630[**]	0.367[**]
	Sig. (2-tailed)	0.000	.	0.000	0.000	0.000	0.005
R3	Correlation Coefficient	0.863[**]	0.780[**]	1.000	0.889[**]	0.764[**]	0.352[**]
	Sig. (2-tailed)	0.000	0.000	.	0.000	0.000	0.008
R4	Correlation Coefficient	0.829[**]	0.820[**]	0.889[**]	1.000	0.801[**]	0.269[*]
	Sig. (2-tailed)	0.000	0.000	0.000	.	0.000	0.045
R5	Correlation Coefficient	0.712[**]	0.630[**]	0.764[**]	0.801[**]	1.000	0.243
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	.	0.071
R6	Correlation Coefficient	0.321[*]	0.367[**]	0.352[**]	0.269[*]	0.243	1.000
	Sig. (2-tailed)	0.016	0.005	0.008	0.045	0.071	.

Source: Research data

Graph 2 shows the forward linkages (HRFL) to the six regions of the analyzed system. It can be highlighted the importance of sectors such as tobacco products, and textiles regarding the supply of inputs to the border region. Again, a significant difference between the indices calculated for the rest of the country and the border regions is observed.

Graph 2. Rasmussen-Hirschman Forward Linkage Indices for the Regions in the System
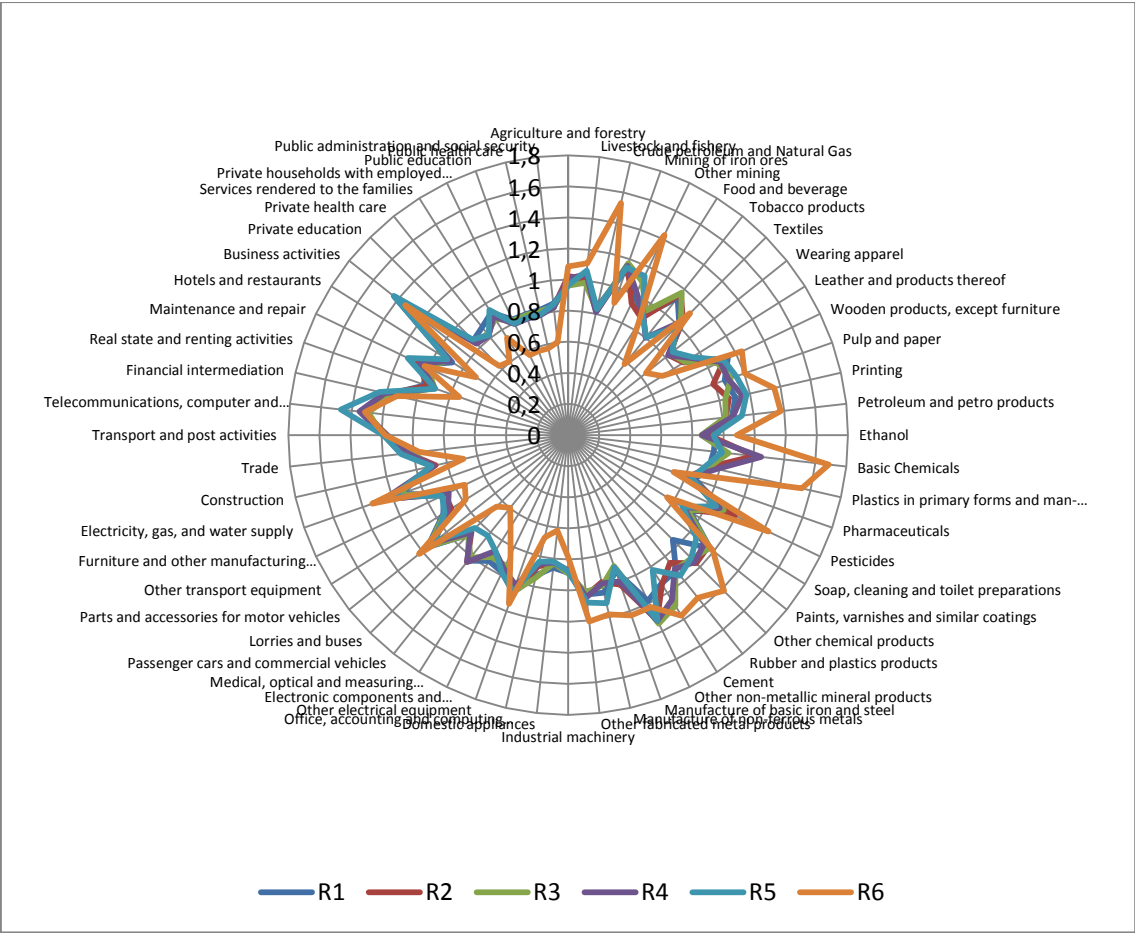
Table 4 shows the Spearman correlation coefficients for the (HRFL) among the regions of the analyzed system. In the same way as the (HRBL), the border regions show greater similarity to each other than other regions, especially if compared with the rest of Brazil, where the correlation coefficients were lower.

Also, it can be inferred that among the three border strips dismembered in this study (R1, R2, R3), there is greater similarity, which indicates a high level of homogeneity in the economic structure within the Western border of Paraná.

Thus, we can conclude that both the purchase of inputs and the sale of products between sectors of the economy, the border region has a peculiarity, compared to the rest of Brazil, which justifies specific policies for this region.

Table 4. Spearman's correlation coefficient for the (HRFL) among the six regions of the analyzed system

		R1	R2	R3	R4	R5	R6
R1	Correlation Coefficient	1.000	0.913**	0.937**	0.849**	0.817**	0.586**
	Sig. (2-tailed)	.	0.000	0.000	0.000	0.000	0.000
R2	Correlation Coefficient	0.913**	1.000	0.930**	0.901**	0.798**	0.653**
	Sig. (2-tailed)	0.000	.	0.000	0.000	0.000	0.000
R3	Correlation Coefficient	0.937**	0.930**	1.000	0.878**	0.799**	0.625**
	Sig. (2-tailed)	0.000	0.000	.	0.000	0.000	0.000
R4	Correlation Coefficient	0.849**	0.901**	0.878**	1.000	0.901**	0.745**
	Sig. (2-tailed)	0.000	0.000	0.000	.	0.000	0.000
R5	Correlation Coefficient	0.817**	0.798**	0.799**	0.901**	1.000	0.732**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	.	0.000
R6	Correlation Coefficient	0.586**	0.653**	0.625**	0.745**	0.732**	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	.

Source: Research data

Graph 3 shows the (PBLN) of the six regions being considered. As described in the methodology, the GHS indices differ from Hirschman Rasmussen due to the fact that it considers in its calculation the size of the sector, besides the linkages among the sectors. Graph 3 shows that the Food and Beverage sector is the most relevant for all regions analyzed. It is also relatively more important for the border strips (R1, R2, R3) than the rest of the country (R6), with respect to the size and the backward linkages. This may be related to the presence of important cooperatives and agribusinesses in the Western border of Paraná, which makes the region relatively more dependent on these sectors.
Table 5 presents the Spearman correlation coefficients for PBLN among the six regions of the analyzed system. As in the previous Tables it can be noticed greater similarity between the PBLN indices in the border strips (R1, R2, R3) than with the rest of the country (R6).

Graph 3: PBLN to the six regions of the analyzed system
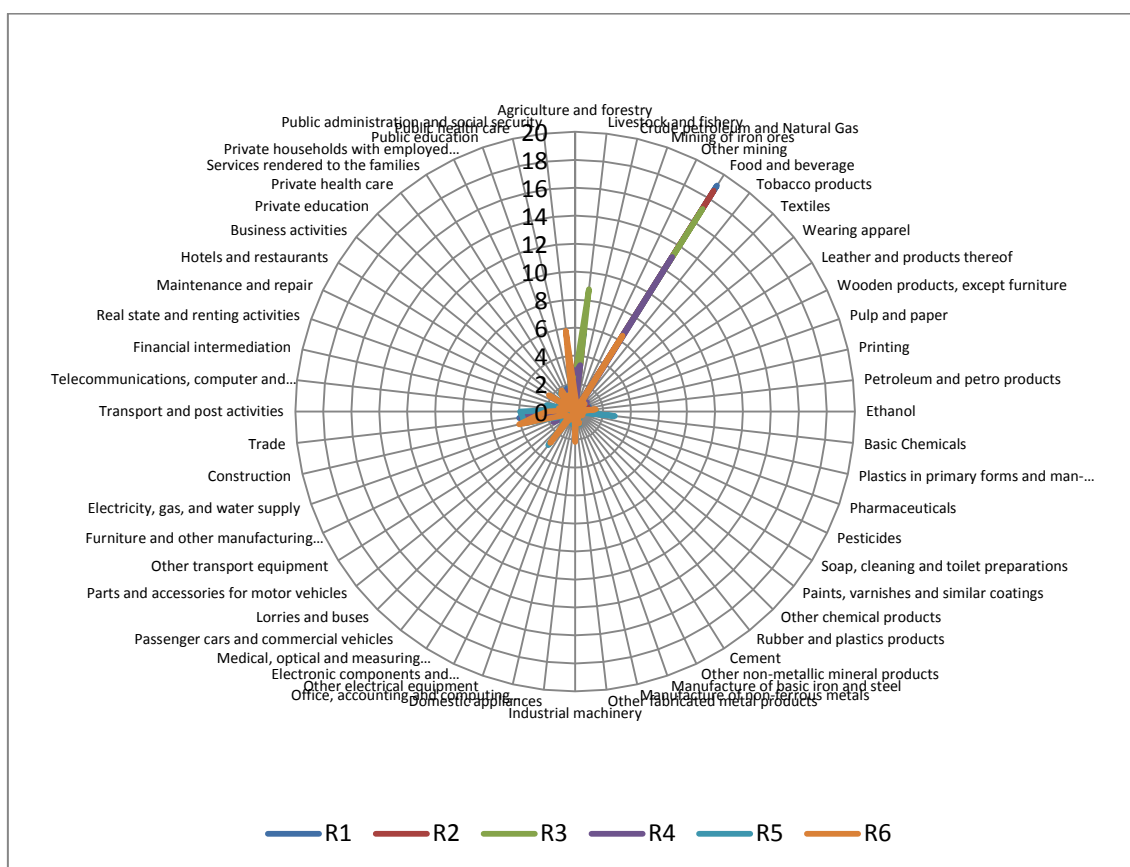
Source: Research data

Table 5. Spearman's correlation coefficient for the PBLN among the six regions of the analyzed system

		R1	R2	R3	R4	R5	R6
R1	Correlation Coefficient	1.000	0.915[**]	0.878[**]	0.822[**]	0.585[**]	0.620[**]
	Sig. (2-tailed)	.	0.000	0.000	0.000	0.000	0.000
R2	Correlation Coefficient	0.915[**]	1.000	0.856[**]	0.878[**]	0.588[**]	0.583[**]
	Sig. (2-tailed)	0.000	.	0.000	0.000	0.000	0.000
R3	Correlation Coefficient	0.878[**]	0.856[**]	1.000	0.887[**]	0.443[**]	0.563[**]
	Sig. (2-tailed)	0.000	0.000	.	0.000	0.001	0.000
R4	Correlation Coefficient	0.822[**]	0.878[**]	0.887[**]	1.000	0.490[**]	0.546[**]
	Sig. (2-tailed)	0.000	0.000	0.000	.	0.000	0.000
R5	Correlation Coefficient	0.585[**]	0.588[**]	0.443[**]	0.490[**]	1.000	0.702[**]
	Sig. (2-tailed)	0.000	0.000	0.001	0.000	.	0.000
R6	Correlation Coefficient	0.620[**]	0.583[**]	0.563[**]	0.546[**]	0.702[**]	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	.

Source: Research data

Graph 4 shows the PFLN to the six regions of the interregional system, again we see the importance of the sectors: a) Agriculture and Forestry; b) Trade; and c) Food and Beverage sectors for the border. The mentioned sectors are also important for the rest of the country, but in a lower proportion than for the border strips.

Table 6 presents the Spearman correlation coefficient for the PFLN among the six regions of the analyzed system. It emphasizes the highest values for the coefficients among the border strips, indicating greater similarity between the economic structure of this region, and structural differences with the rest of Brazil, as in the previous tables.

With respect to the PTLN, it can be seen that the sectors of: a) Agriculture and forestry; b) Livestock and fishery; and c) Food and beverage, are the most important to the border strips, and in proportional terms are more relevant to the border strips than the rest of the country, reinforcing the idea of the dependence of the area of traditional sectors, such as aforementioned. It is shown in Graph 5.

Table 7 presents the Spearman correlation coefficient for the PTLN among the six regions of the analyzed system. The findings confirm what happens in the previous tables, reinforcing the homogeneity of the economic structure in the Western border of Paraná and also its difference from the rest of Brazil as a whole.

Graph 4. PFLN to the six regions of the analyzed system
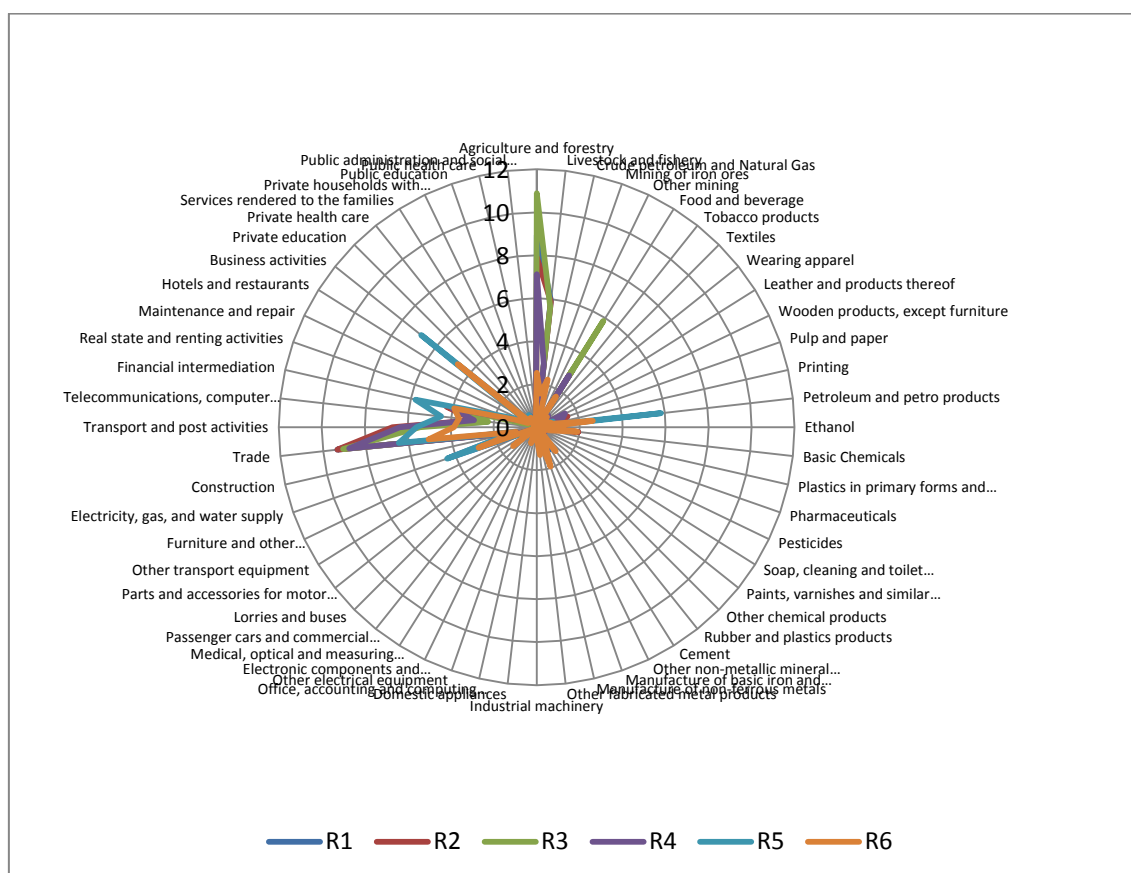
Source: Research data

Table 6. Spearman's correlation coefficient for the PFLN among the six regions of the analyzed system

		R1	R2	R3	R4	R5	R6
R1	Correlation Coefficient	1.000	0.927[**]	0.938[**]	0.875[**]	0.808[**]	0.697[**]
	Sig. (2-tailed)	.	0.000	0.000	0.000	.000	0.000
R2	Correlation Coefficient	0.927[**]	1.000	0.907[**]	0.962[**]	0.842[**]	0.743[**]
	Sig. (2-tailed)	0.000	.	0.000	0.000	0.000	0.000
R3	Correlation Coefficient	0.938[**]	0.907[**]	1.000	0.919[**]	0.745[**]	0.670[**]
	Sig. (2-tailed)	0.000	0.000	.	0.000	0.000	0.000
R4	Correlation Coefficient	0.875[**]	0.962[**]	0.919[**]	1.000	0.801[**]	0.736[**]
	Sig. (2-tailed)	0.000	0.000	0.000	.	0.000	0.000
R5	Correlation Coefficient	0.808[**]	0.842[**]	0.745[**]	0.801[**]	1.000	0.804[**]
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	.	0.000
R6	Correlation Coefficient	0.697[**]	0.743[**]	0.670[**]	0.736[**]	0.804[**]	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	.

Source: Research data.

Graph 5. PTLN to the six regions of the analyzed system

Agriculture and forestry
Livestock and fishery
Crude Oil, Petroleum and Natural Gas
Mining of iron ores
Other mining
Food and beverage
Tobacco products
Textiles
Wearing apparel
Leather and products thereof
Wooden products, except furniture
Pulp and paper
Printing
Petroleum and petro products
Ethanol
Basic Chemicals
Plastics in primary forms and…
Pharmaceuticals
Pesticides
Soap, cleaning and toilet…
Paints, varnishes and similar…
Other chemical products
Rubber and plastics products
Cement
Other non-metallic mineral…
Manufacture of basic iron and…
Manufacture of non-ferrous metals
Other fabricated metal products
Industrial machinery
Domestic appliances
Office, accounting and computing
Other electrical equipment
Electronic components and…
Medical, optical and measuring…
Passenger cars and commercial…
Lorries and buses
Parts and accessories for motor…
Other transport equipment
Furniture and other…
Electricity, gas, and water supply
Construction
Trade
Transport and post activities
Telecommunications, computer…
Financial intermediation
Real state and renting activities
Maintenance and repair
Hotels and restaurants
Business activities
Private education
Private health care
Services rendered to the families
Private households with…
Public education
Public administration and social…

R1 — R2 — R3 — R4 — R5 — R6

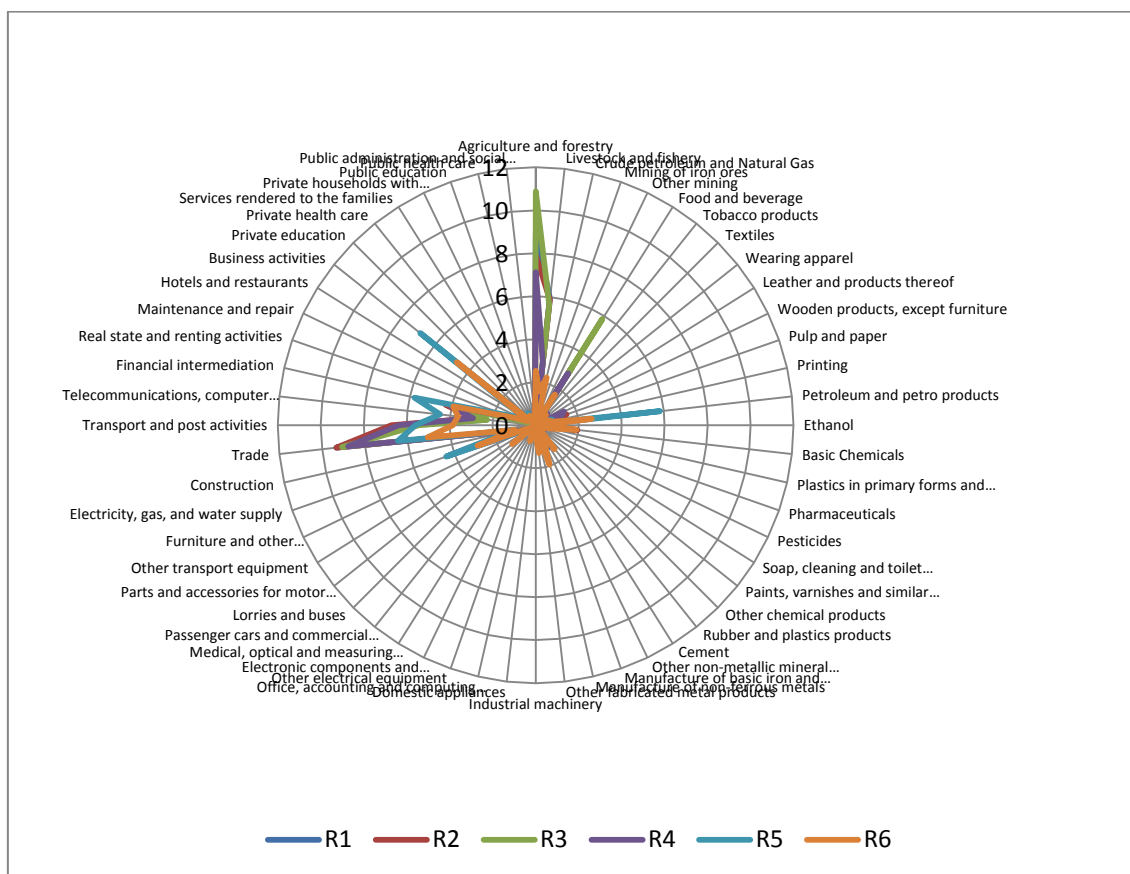Source: Research data

Table 7. Spearman's correlation coefficient for the PTLN among the six regions of the analyzed system

		R1	R2	R3	R4	R5	R6
R1	Correlation Coefficient	1.000	0.920**	0.900**	0.842**	0.648**	0.703**
	Sig. (2-tailed)	.	0.000	0.000	0.000	0.000	0.000
R2	Correlation Coefficient	0.920**	1.000	0.868**	0.910**	0.669**	0.679**
	Sig. (2-tailed)	0.000	.	0.000	0.000	0.000	0.000
R3	Correlation Coefficient	0.900**	0.868**	1.000	0.911**	0.513**	0.607**
	Sig. (2-tailed)	0.000	0.000	.	0.000	0.000	0.000
R4	Correlation Coefficient	0.842**	0.910**	0.911**	1.000	0.567**	0.599**
	Sig. (2-tailed)	0.000	0.000	0.000	.	0.000	0.000
R5	Correlation Coefficient	0.648**	0.669**	0.513**	0.567**	1.000	0.793**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	.	0.000
R6	Correlation Coefficient	0.703**	0.679**	0.607**	0.599**	0.793**	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	.

Source: Research data

As described in the database section, the Western border region of Paraná, in this study, was divided into three groups in order to identify the similarities of internal productive structure in the region. The results show that there are similarities between the productive structures in the three specific border strips, highlighting the dependence of traditional sectors like Food and beverage, Livestock and fishery, and Agriculture and forestry. Moreover, we also show that the economic structure of the Western Border Regions of Paraná presents no great similarity with the rest of Brazil as a whole, which reinforces the need for specific policies to stimulate the growth in the region.

The next section will approach how the interdependence relations of the Western Border of Paraná are established with itself, the rest of Paraná, Brazil and the rest of the world.

6.2. Interdependence Relations in Output, Employment and Value Added, Among the Analyzed Regions

Table 8 shows the trade flows between the six regions of the analyzed system and it is presented as follows: the first row shows the percentage of total production of the R1 region that is linked to the final demand of itself and all other regions (R2, R3, R4, R5 and R6), divided into inputs for export and domestic production.

The export to Paraguay (EXP PY), to Argentina (EXP ARG) and the rest of the world (EXP RW) columns present the total production of the each region that is linked to exports to each one these countries and the rest of the world. And the last column shows the total domestic exports, i.e., the total production of each region linked to final demand in other regions of the analyzed system, whether to internal demand or to exportation.

Table 8. Average percentage of the production linked to the final demand of the regions, divided into exports and the rest of final demand (RFD) for the six regions of the analyzed system production

	R1		R2		R3		R4		R5		R6		EXP ARG	EXP PY	EXP RW	Total domestic export
	EXP	RFD	EXP	RFD	EXP	RFD	EXP	RFD	EXP	RFD	EXP	RFD				
R1	8,8%	38,5%	0,1%	0,8%	0,1%	1,0%	0,5%	3,4%	0,5%	4,3%	4,5%	37,5%	0,8%	4,2%	9,6%	52,6%
R2	0,1%	1,1%	9,8%	32,3%	0,1%	1,0%	0,6%	3,6%	0,6%	5,3%	5,1%	40,3%	1,5%	2,5%	12,1%	57,9%
R3	0,0%	0,9%	0,1%	0,8%	10,1%	38,0%	0,4%	3,2%	0,5%	4,4%	4,3%	37,2%	1,6%	1,4%	12,6%	51,9%
R4	0,1%	1,0%	0,1%	0,9%	0,1%	1,0%	11,3%	35,7%	0,6%	5,1%	5,0%	39,2%	1,7%	1,4%	14,0%	53,0%
R5	0,1%	1,5%	0,2%	1,3%	0,1%	1,7%	0,7%	6,5%	9,2%	30,3%	5,1%	43,3%	2,2%	0,6%	12,6%	60,5%
R6	0,0%	0,2%	0,0%	0,2%	0,0%	0,2%	0,2%	0,9%	0,2%	1,0%	18,8%	78,3%	2,2%	0,2%	16,9%	2,9%

Source: Research data

Observing Table 8 it can be noticed that 8.8% of the total production of the R1 region is linked to the direct export, having the smallest percentage among all regions. However, R1 region has 5% of its production linked to exports to Paraguay and Argentina, which is the highest percentage among the six regions of the analyzed system.

It is also noticed that the links between the three border strips are smaller than the links of the border strips with the other parts of the system, for example, 40.3% of the total production of the R2 region is linked to the final demand of the rest of Brazil, it is more than the production linked to the final demand in the region itself (32.3%) and more than the sum of the percentages linked to the final demand of the other two border strips.

With regard to the total, direct and indirect export, R1 is the region that has the lowest percentage of export value, even being the nearest of the West limit of the country. The R5 region is the coast of Paraná, it has the second lowest value for total direct and indirect exports, i.e., the proximity of the limits of the country is not conducive to international trade, with respect to exports.

In all regions examined, the internal interdependence is greater than the total exports, which, according to Ypersele Turrini (2010) and Leasing Jr and Azevedo (2009), it can be attributed to the "border effect" that restricts international economic relations, where the economic space is limited by administrative boundaries. Even the closest regions of

the country limit, both the West and the East, have internal trade flows at least three times larger than the international transactions.

Table 9 is organized in the same manner as the previous one, however, the variable that is used in the analysis is not the production, but employment. In this context, we noticed that the R1 region has over 40% of its jobs linked to final demand from the rest of the country, and few jobs linked to final demand from other border strips R2 and R3.
The most jobs of three border strips are linked to domestic final demand. The areas closer to the national limits R1 and R5 have the lowest percentage of their jobs linked to exports, direct or indirect.

The R1 region has about 15% of their jobs linked to exports, of which only 1% are linked to export to Paraguay and Argentina. The behavior is similar in R2 and R3 regions, i.e., the jobs linked to exports to Paraguay and Argentina do not represent more than 1%.

Regarding the rest of Brazil dependence of the jobs of the final demand from Paraná regions, it may be noticed that 2.1% of jobs in the region R6 are linked to final demand of the sub-regions of the state.

Table 9. Average percentage of the jobs linked to final demand of the regions, divided into exports and the rest of final demand (RFD) for the six regions of the analyzed system production

	EXP R1	RDF R1	EXP R2	RDF R2	EXP R3	RDF R3	EXP R4	RDF R4	EXP R5	RDF R5	EXP R6	RDF R6	EXP ARG	EXP PY	EXP RW	Total domestic export
R1	9,0%	34,7%	0,2%	0,5%	0,1%	0,6%	1,1%	2,9%	0,8%	4,9%	4,4%	40,8%	0,4%	0,7%	14,4%	56,3%
R2	0,1%	0,8%	12,9%	35,5%	0,1%	0,6%	0,9%	2,7%	0,8%	6,5%	4,3%	34,9%	0,5%	0,5%	17,9%	51,6%
R3	0,1%	0,6%	0,3%	0,5%	13,6%	35,3%	1,1%	2,5%	0,8%	5,8%	5,2%	34,3%	0,4%	0,7%	19,9%	51,1%
R4	0,1%	0,7%	0,2%	0,6%	0,1%	0,7%	11,4%	43,9%	0,7%	6,0%	3,8%	31,8%	0,6%	0,3%	15,4%	44,7%
R5	0,1%	1,7%	0,2%	1,3%	0,1%	2,1%	0,7%	7,3%	6,2%	51,3%	2,7%	26,3%	0,8%	0,2%	9,0%	42,5%
R6	0,0%	0,1%	0,1%	0,1%	0,0%	0,1%	0,2%	0,7%	0,1%	0,7%	11,9%	86,0%	0,6%	0,1%	11,6%	2,1%

Source: Research data

Another interesting analysis of regional interdependence is related to the value added (VA). The value added is the additional value that the goods and services receive when they are transformed in the production process and can be a better measure than the gross value to understand the impact of trade on employment and growth in the regions. (GUILHOTO, SIROEN, YUCER 2013).

Table 10 shows very similar values in the previous tables, showing the low interdependence between border strips, i.e., lower percentage of value added generated in the border strips, linked to final demand of the border strips themselves. In addition, about 50% of the value added generated in the three border strips are linked to domestic exports.

Among the regions of the analyzed system, R2 is the one with the highest percentage of value added linked to exports (15.9%), however, just over 1% corresponds to export to Paraguay and Argentina. In the other regions the export to Paraguay and Argentina represents less than 2% of value added.

These results confirm the high percentage of domestic exports in the composition of domestic production, evidenced by Guilhoto, Siroën and Yücer (2013). It is also evident that, despite the proximity of the West Border of the country, R1 is the region that has the lowest percentage of value added linked to the final demand for exports, when compared to R2 and R3.

Table 10. Average percentage of the Value Added linked to final demand of the regions, divided into exports and the rest of final demand (RFD) for the six regions of the analyzed system production

	EXP R1	RDF R1	EXP R2	RDF R2	EXP R3	RDF R3	EXP R4	RDF R4	EXP R5	RDF R5	EXP R6	RDF R6	EXP ARG	EXP PY	EXP RW	Total domestic export
R1	7,7%	39,4%	0,2%	0,7%	0,1%	0,9%	1,0%	4,1%	0,8%	5,2%	3,8%	36,1%	0,5%	0,9%	12,2%	52,8%
R2	0,1%	0,9%	11,9%	36,9%	0,1%	0,8%	0,8%	3,2%	0,8%	6,2%	4,0%	34,3%	0,7%	0,9%	15,9%	51,3%
R3	0,1%	0,6%	0,2%	0,6%	12,1%	39,9%	0,9%	3,0%	0,8%	5,5%	4,3%	31,9%	0,5%	0,5%	17,4%	48,0%
R4	0,1%	0,9%	0,2%	0,8%	0,1%	0,9%	10,5%	45,6%	0,7%	5,7%	3,6%	31,0%	0,7%	0,4%	14,0%	43,9%
R5	0,1%	1,9%	0,2%	1,8%	0,2%	2,3%	0,9%	9,3%	6,3%	42,3%	3,4%	31,2%	1,2%	0,3%	9,6%	51,4%
R6	0,0%	0,1%	0,0%	0,1%	0,0%	0,1%	0,1%	0,7%	0,1%	0,7%	12,3%	85,7%	0,8%	0,1%	11,7%	2,0%

Source: Research data

6.3. Output Multipliers and Spillover Effects

The sector with the largest output multiplier in R1 is the Food and beverage. For each R$1 of impact on final demand of this sector increases the production in R$ 2.5 throughout the interregional system, however, much of this impact is outside of the R1, only 53%, i.e., R$ 1.3 remains in the region. There is a spillover effect, mainly to R6 (the rest of Brazil).

Other sectors with high values for the production multiplier in R1 are: Lorries and buses, Passenger cars and Commercial vehicles and Pesticides, however, all of them with a low percentage multiplier that really remains in the Region.
Considering the impact within the region of analysis, the sectors with the largest intra-regional percentage impact are: electronic components and communication equipments, tobacco products and parts and accessories for motor vehicles, respectively, as shown in Graph 6.

In R2, the sectors with the highest production multipliers do not generate the highest percentage of intra-regional impact as in R1. The Food and beverage sector has the highest production multiplier, considering the whole inter-regional system, but it is the fifteenth in terms of impact within the region. The sector in which a stimulus in final demand causes the greatest impact on intra-regional production in R2 is the Tobacco product.
The sectors with higher percentage on intra-regional production multiplier in R3 are respectively Tobacco products, Electronic components and Communication equipment, Parts and accessories for motor vehicles, Other electrical equipment and Pharmaceuticals.

The pharmaceutical sector is noteworthy since it is the thirty-sixth in the ranking of production multipliers of R3, but considering the percentage of intra-regional impact, rises to fifth place (this due to the presence of a large pharmaceutical company in the R3).

Graph 6. Production multiplier for the three border strips
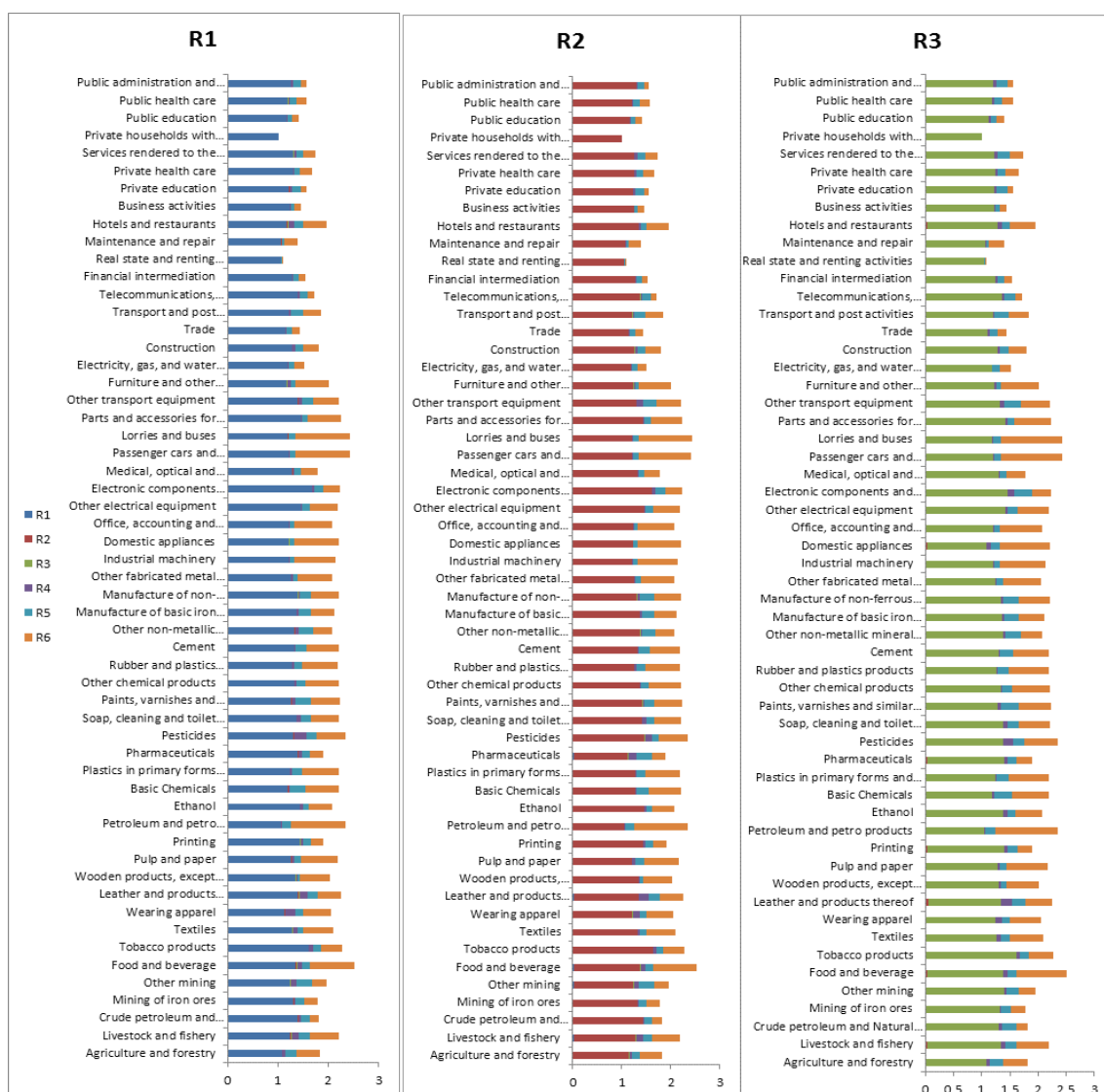
Source: Research data

Regarding the increased production in the Western Border Regions, it is also necessary to examine how the investments made out of the border regions can spillover into the region. In this context, considering the R4, we highlight the sectors of Tobacco products, Textiles, Ethanol and Pesticides where about 3% to 5% of the production multiplier spill over to the border regions.

Regarding spillovers from R5 to the border regions, the investments made in the Food and beverage and Ethanol sectors can be highlighted, with respectively 5% and 6% of the total production multiplier. Considering R6 (the rest of Brazil), the sectors which,

when stimulated, contribute most to the border regions are Food and beverages and Tobacco products.

The analysis of production multipliers in border regions makes it possible to observe that some sectors with high multiplier, as the food and beverage, has its spillover effect to other regions, other than the border region, and the same sector, when stimulated in other regions also spills into the border region, but to a lesser extent.

This can be attributed to the fact that the Border Region is a major producer of food (maize, chicken and pork), however, much of the production is transported to other regions with little value added. Moreover, most of the inputs used for food production in the Border Region are imported from other regions.

7. Concluding Remarks

The aim of this study was to analyze the productive structure, national and international trade relations, besides the spillover of production in the Western Border of Paraná.

It could be noticed that the Western border strips of Paraná (R1, R2, R3) are similar to each other and different from the rest of Brazil, regarding the productive structure, as shown in the Spearman correlation coefficient. Moreover, they are more dependent on traditional sectors of the economy as Food and beverage and Agriculture and Livestock than the rest of Brazil as a whole.

The results show the low interdependence in respect to production, employment and value added between the border regions, and a greater relationship with the rest of Brazil, this can be explained by the homogeneity of the productive structure between the border regions, which make the complementary relationship between economic sectors difficult and does not promote the trade between regions.

The R1 region has 8.8% of its production linked to direct export, more than a half of this value, about 5%, is linked to exports to Paraguay and Argentina. It is the highest percentage among all regions analyzed, but not sufficient to put R1 among the main exporters. The proximity of both West and East borders of the country does not increase

exports of R1 and R5 regions enough to excel them as exporters. It can be a result of the "border effect", as described in literature.

It may suggest that the proximity of the limits is not considered strategic for export companies to choose locations in the border region. There are other factors determining the location of these companies, apart from the distance to markets.

Analyzing the output multipliers and the spillover effects to outside of the region, it was noticed that the Food and beverage sector has the major output multiplier for the three border strips, but only a portion of this multiplier remains in the original regions, approximately half of the production multiplier spills over out of the border regions. Moreover, the strong dependence of the border region from traditional sectors of the economy exacerbates the spillover effect, for example in agriculture and forestry and livestock sectors, only about 60% and 56% of the effect remains in the region, respectively.

In conclusion, it is suggested that regional policy makers invest in public policies that promote the complementarity of the production chain, increasing the processing of the products within the border region, and thus increasing the multiplier effect of the production within the region. Besides, increasing the interdependence between the border regions and stimulating "fluency effect" and consequently, increasing the number of jobs and value added generated within that region.

It should be emphasized that the results presented in this study are specific to the Western Border Regions of Paraná State, given its peculiarities and idiosyncrasies, it is not possible to generalize to other regions. Therefore, we emphasize the importance of interregional input-output studies, which allow the structural analysis of regions and their interdependencies, in order to enable the definition of development strategies that are better suited for each region.

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