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THE MEAT SECTORS AND THE BRAZILIAN MACRO REGIONS ECONOMIES: AN INTERREGIONAL INPUT-OUTPUT APPROACH

Flávia Maria de Mello Bliska¹ and Joaquim José Martins Guilhoto²

ABSTRACT

The Brazilian meat production in 1999 is estimated at 12.8 million tons, and the main productive chains of this sector are: a) the beef chain (6.7 million tons); b) the poultry chain (5.0 million tons); and the pork chain (1.7 million tons). Brazil is the world second largest beef producer (13.6% of the world's total volume), the third largest poultry producer (12.5% of the world's total volume), and the eighth largest pork producer (2.0% of the world's total volume). Brazil is also the world third largest beef exporter (9.2% of the world's total volume), second largest poultry exporter (12.7% of the world's total volume), and thirteenth largest pork exporter (1.3% of the world's total volume). Due to the importance of the meat sector for the Brazilian economy it is important to know how the product transference of the animal-raising and slaughter sectors and the meat processing industries take place among the Brazilian regions and how this can impact the national economy. This paper evaluates both the regional and the national economic significance of meat industry, using a five regions interregional input-output table.

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1. BACKGROUND

The Brazilian meat sector is very important to the Brazilian economy and to the world meat market. The Brazilian meat production in 1999 is estimated at 12.8 million tons. The main productive chains of this sector are: the beef chain (6.7 million tons or 49.9% of the total volume produced); the poultry chain (5.0 million or 37.5% of the total volume produced); and the pork chain (1.7 million tons or 12.6% of the total volume produced). Brazil is the world's second largest beef producer (13.6% of the world's total volume); third largest poultry producer (12.5% of the world's total volume); and it is still the eighth largest pork producer (2.0% of the world's total volume). Brazil is also the world's third largest beef exporter (9.2% of the world's total volume); second largest poultry exporter (12.7% of the world's total volume); and thirteenth largest pork exporter (1.3% of the world total volume) (USDA, in ANUALPEC, 1999).

Brazil's share in the world beef and pork market might increase since some Brazilian producer areas are becoming free of some animal's diseases, an important meat export barrier.

According to the Brazilian Geography and Statistical Institute (IBGE, 1997), the Brazilian herd is distributed as following: 34% in the Middle West region, 23% Southeast, 16,5%South, 14,5% Northeast and 12% in the North region (Figure 1). The beef processing industries are concentrated in the Southeast (Figure 2).

Around 36.0% of the Brazilian pigs are raised in the South region (close to the largest part of the slaughter and pork process industry), 20.0% are concentrated in the Southeast, where the slaughter houses and process industries have improved the technology used; 13% in the Middle West, where there are good perspectives of expansion, following the increase of corn and soil been productions; 7.0% in the North and 24% in the Northeast regions, and are used to the subsistence, but the installation of meat process industry in the Northeast are changed that situation (Figure 1). The pork processing industry is concentrated in the South and Southeast (Figure 2).

Following IBGE (1997), the Brazilian poultry sector is concentrated in the South region, 45.0%, and 55.0% are distributed as following: 29.0% in the Southeast region, 15.0% in the Northeast, 6.0% in the Middle West and 5.0% in the North region

(Figure 1). The poultry slaughter and processing industries are also concentrated in the South and Southeast (Figure 2).

The Brazilian poultry sector uses international technology and the pork sector has satisfactory quality and productivity indices, but the country can still improve the production and process technology. Moreover Brazil has the world's largest herd of commercial cattle (147 million of head), and it has continually improved its production technology.

Actually, the pig and poultry raising and the slaughter sectors are changing to the Middle West, following the corn and soil bean crop. The transport conditions among Middle West, North and Northeast regions are been improved, and the meat processing industries are moving from South and Southeast to the other regions.

Due to the importance of the meat sector for the Brazilian economy it was important to know how the product transference of the animal-breeding and slaughter sectors and the meat processing industries take place among the Brazilian regions and how this can impact the national economy.

2. OBJECTIVES

In this paper we analyze the significance of the animal slaughter and meat processing industry to the national and regional economies. We also verify how changes in the production process of the meat sector affect its share in the regional and national economies. The construction and the use of five regions interregional input-output table of 1995 has been accomplished. The meat sector is estimated by extracting it from the other sectors.

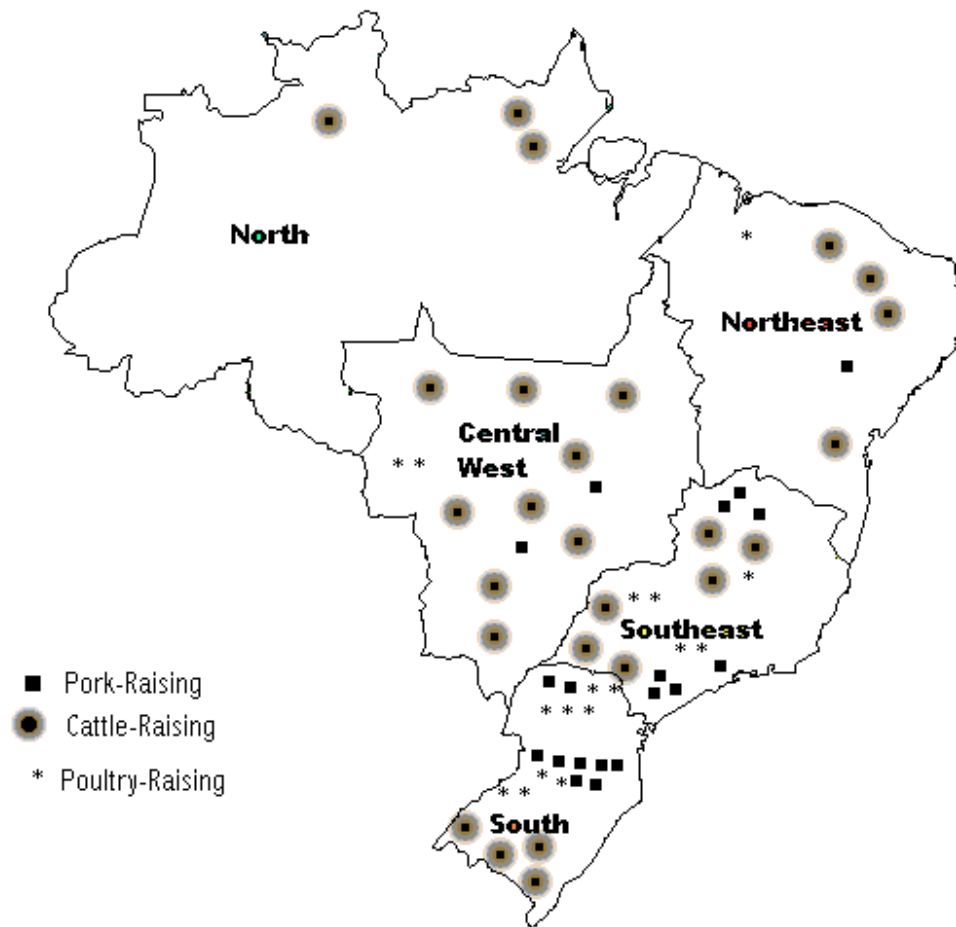


Figure 1. The animal production sectors and the Brazilian macro regions.

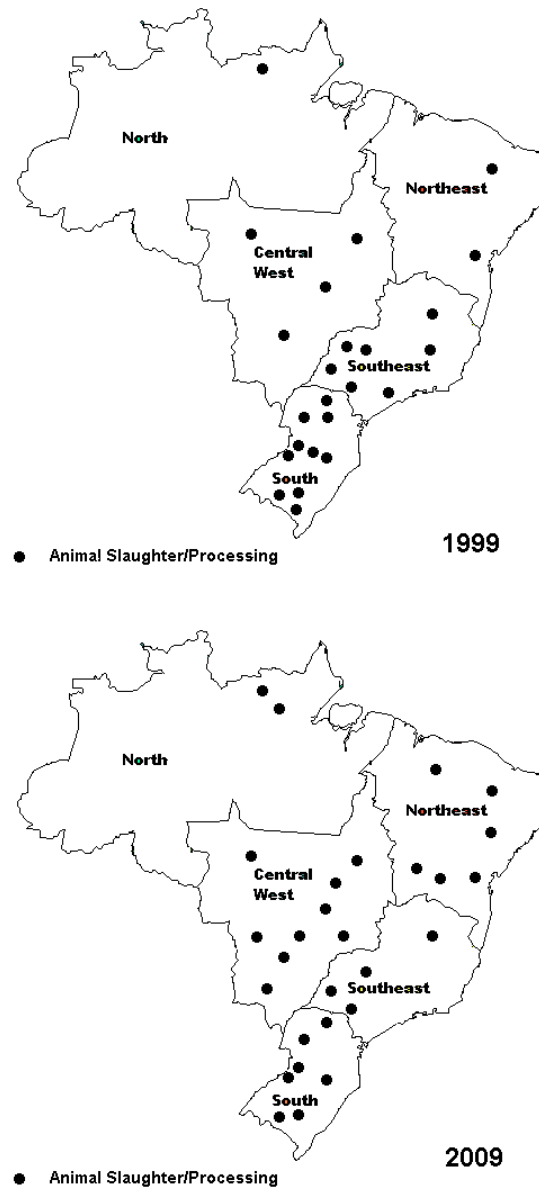


Figure 2. Trends in the Brazilian meat sector.

3. METHODS

This study was conducted mainly in three stages. Initially, we used the Brazilian input-output matrix for the year of 1995 (IBGE, 1997), in which some sectors of the Production and Input Tables were aggregated into 23 different sectors (Table 2). These tables permitted us to study the meat industry sector. We calculated how much a specific sector demands from the other sectors (backward linkage indices) and how much those other sectors demand of it (forward linkage indices). Then we separated the impacts of the certain sector from the rest of the economy (the pure inter-industrial linkage indices), and we verified how changes in the production processes of the animal industries affect their share in the Brazilian economy.

Second, we constructed and used a five region interregional input-output table, also with 23 sectors in each region (total: 115 sectors), for the year of 1995, for the Brazilian economy, which was based in GUILHOTO (1999). We used these tables to calculate the Hirschman/Rasmussen backward and the forward linkage indices as well as the pure linkage indices, and to analyze the consequences in the production processes of the meat industry to the regional and national economies. The meat sectors were estimated through their extraction from the other sectors.

Finally, we compared the present significance of the meat industry, among regional and the national economies. In the future, those results will be used to analyze the competitiveness of the meat sectors among the Brazilian regions.

3.1 Input-Output Model

Inter-industries flows in a specific economy are determined by technological and economic factors, and these flows can be described by a system of simultaneous equations represented by:

$$X = A X + Y \quad (1)$$

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 (LEONTIEF, 1951, in GUILHOTO et al., 1994; GUILHOTO, 1995; GUILHOTO & PICERNO, (1995); e MILLER & BLAIR, 1985).

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, that is:

$$X = B Y \quad (2) \quad \text{and} \quad B = (I - A)^{-1} \quad (3)$$

where B is a ($n \times n$) matrix which contains the Leontief inverse matrix.

Starting from equation (13), we can evaluate the impact of different changes in the final demand on the total production, import volumes and total salaries. Thus,

$$\Delta X = B \Delta Y \quad (4), \quad \Delta M = m \Delta X \quad (5) \quad \text{and} \quad \Delta S = s \Delta X \quad (6)$$

where ΔY , ΔX , ΔM and ΔS are ($n \times 1$) vectors which show respectively the final demand increase, and the impacts on the total production volume, on the import values and on the salary totals; m and s are diagonal ($n \times n$) matrices in which the diagonal elements are the import and salary coefficients.

Starting from equation (3), and following Rasmussen (1956) and Hirschman (1958), we can determine which sectors present high linkage power in a specific economy. That is, we can calculate how much a specific sector demand from the other sectors (backward linkage indices) and how much those other sectors demand of it (forward linkage indices).

3.2 Pure Inter-Industrial Linkages Index (GHS Approach)

The pure inter-industrial linkage index is an alternative proceeding to separate the impacts of a certain sector from the other economic sectors. This proceeding can also be used to separate the impacts of the certain region from the rest of the economy, or still to separate the impacts of certain country from the economic block in which it is inserted (GUILHOTO, SONIS, HEWINGS, 1996; GUILHOTO, HEWINGS, SONIS, 1997). This index is an improvement of the Cella-Clements approach.

The basic idea is to isolate certain sector j from the rest of the economy and to define the effect of the total linkages of the sector j in the economy. That is, the difference between the total production of the economy and the production in the economy if the sector j does not buy inputs from the rest of the economy and it does not sell its production to the rest of the economy. This situation is equivalent to an elimination of a given industrial sector.

We can isolate determined sector j from the rest of the economy considering an input-output system with two regions, which can be represented by the following direct Leontief coefficients (GUILHOTO, HEWINGS, SONIS, 1997):

$$A = \begin{pmatrix} A_{jj} & A_{jr} \\ A_{rj} & A_{rr} \end{pmatrix} \quad (7)$$

where A_{jj} and A_{rr} are the quadrate matrices of direct inputs within the first and second regions and A_{jr} and A_{rj} are the rectangular matrices showing the direct inputs purchased by the second region and vice versa.

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

$$B = \left(I - A \right)^{-1} = \begin{pmatrix} B_{jj} & B_{jr} \\ B_{rj} & B_{rr} \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{pmatrix} \begin{pmatrix} I & A_{jr} \Delta_r \\ A_{rj} \Delta_j & I \end{pmatrix} \quad (8)$$

where: $\Delta_j = (I - A_{jj})^{-1}$ (9)

$$\Delta_r = \left(I - A_{rr} \right)^{-1} \quad (10)$$

$$\Delta_{jj} = \left(I - \Delta_j A_{jr} \Delta_r A_{rj} \right)^{-1} \quad (11)$$

$$\Delta_{rr} = \left(I - \Delta_r A_{rj} \Delta_j A_{jr} \right)^{-1} \quad (12)$$

Through the equation (8) we can reveal the process of production in an economy as well as derive a set of multipliers/linkages.

The matrix

$$\begin{pmatrix} \Delta_{jj} & \mathbf{0} \\ \mathbf{0} & \Delta_{rr} \end{pmatrix} \quad (13)$$

can be interpreted as the Miyazawa (1976) internal multipliers for region j and the rest of the economy, r .

And, the matrix

$$\begin{pmatrix} \Delta_j & \mathbf{0} \\ \mathbf{0} & \Delta_r \end{pmatrix} \quad (14)$$

can be interpreted as the Miyazawa (1976) internal multipliers for region j and the rest of the economy, r .

In the matrix

$$\begin{pmatrix} I & A_{jr} \Delta_r \\ A_{rj} \Delta_j & I \end{pmatrix} \quad (15)$$

the first row separates the final demand by its origin; that is, it distinguishes between the final demand that comes from inside the region (I) from the one that comes from outside the region ($A_{jr} \Delta_r$).

$$X = \left(I - A \right)^{-1} Y \quad (16)$$

and using the equations (8) to (16), we can derive a set of indices which can be used to

rank the regions in terms of their importance in the economy and to see how the production process occurs in the economy.

From equations (8) to (17) we obtain:

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{pmatrix} \begin{pmatrix} I & A_{jr} \Delta_r \\ A_{rj} \Delta_j & I \end{pmatrix} \begin{pmatrix} Y_j \\ Y_r \end{pmatrix} \quad (17)$$

which leads to:

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{pmatrix} \begin{pmatrix} Y_j + A_{jr} \Delta_r Y_r \\ A_{rj} \Delta_j Y_j + Y_r \end{pmatrix} \quad (18)$$

where

$$A_{jr} \Delta_r Y_r \quad (19)$$

is the direct impact of the rest of the final demand of the economy on region j ; that is, it provides the level of exports in region j that are needed to satisfy the production necessities of the rest of the economy for a level of final demand by Y_r ; and

$$A_{rj} \Delta_j Y_j \quad (20)$$

is the direct impact of region j final demand on the rest of the economy, that is, it generates the level of exports in rest of the economy that are needed to satisfy the production necessities of region j for a level of final demand given by Y_j .

Continuing from equation (18):

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j Y_j + \Delta_j A_{jr} \Delta_r Y_r \\ \Delta_r A_{rj} \Delta_j Y_j + \Delta_r Y_r \end{pmatrix} \quad (21)$$

we have the definitions for the Pure Backward Linkage (PBL) and for the Pure Forward Linkage (PFL),

$$PBL = \Delta_r A_{rj} \Delta_j Y_j \quad \text{and} \quad PFL = \Delta_j A_{jr} \Delta_r Y_r \quad (22)$$

where the PBL will give us the pure impact on the rest of the economy of the value of the total production in region j , ($\Delta_r Y_r$). This impact is free from: a) the demand inputs that region j makes from region j , and b) the feedback from the rest of the economy to

region j and vice-versa. The PFL will give us the pure impact on region j of the total production in the rest of the economy ($\Delta_r Y_r$).

Continuing from equation (21):

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} \Delta_j Y_j + \Delta_{jj} \Delta_j A_{jr} \Delta_r Y_r \\ \Delta_{rr} \Delta_r A_{rj} \Delta_j Y_j + \Delta_{rr} \Delta_r Y_r \end{pmatrix} = \begin{pmatrix} X_j^j + X_j^r \\ X_r^j + X_r^r \end{pmatrix} \quad (23)$$

the level of total production in region j can be broken down into two components:

$$X_j^j = \Delta_{jj} \Delta_j Y_j \quad \text{and} \quad X_j^r = \Delta_{jj} \Delta_j A_{jr} \Delta_r Y_r \quad (24)$$

where the first component, X_j^j , indicates the level of total production in region j that is due to the level of final demand in region j and the second component, X_j^r , will yield the level of total production in region j that is due to the level of final demand in the rest of the economy. In the same way, the level of total production in rest of the economy can also be broken down into two components:

$$X_r^j = \Delta_{rr} \Delta_r A_{rj} \Delta_j Y_j \quad \text{and} \quad X_r^r = \Delta_{rr} \Delta_r Y_r \quad (25)$$

where the first component, X_r^j , is the level of total production in the rest of the economy that is due to the level of final demand in region j , and the second component, X_r^r , is the level of total production in the rest of the economy that is due to the level of final demand in the rest of the economy.

3.3 Changes in the technical production coefficients

In this work we simulated changes in the technical production coefficient of the Brazilian slaughter/meat industry sector. We changed the production coefficient of the sector **16- Meat industry** (Table 1): coefficient $a_{16\ 16}$ of the *A* matrix - equation (1). We considered that the other productive sectors would not have changes in their respective technical production coefficients. We obtained the Rasmussen/Hirschman backward and forward linkage indices and the pure inter-industrial linkage indices, before and after each simulation. The coefficient was reduced in the same proportion in which the increases in the production efficiency of the 16- Meat industry are expected.

To estimate changes in the production technical coefficient we considered in the first and second simulations the preliminary results of the studies on technological demands, such as BLISKA *et al.* (1998), BLISKA & GONÇALVES (1998) and results that are still not published. Moreover we used some statistics to the meat sector, from ANUALPEC 1996/99 (annual rates of animal-raising, meat production and slaughter in the last 10 years – Brazilian average), and other data from the literature (ALVES, OLIVEIRA & DEVIES OSORIO, 1997; COUTINHO & FERRAZ, 1993; MARTINS, 1996). We also simulated two very improbable changes in the production technical coefficient, to identify their potential effects. We used those same changes in the production technical coefficients to the Brazilian regions, and we compared their effects on the national and regional economies.

Table 1. Changes in the production process of the meat industry sector.

Sector	Coefficient changed in the Matrix A	% of changes in the coefficients of Matrix A			
16-Meat industry (animal slaughter/processing)	A_{1616}	Simulations			
		1 st -	2 nd -	3 rd -	4 th -
		10	15	20	50

4. RESULTS

In this section we first show the significance of the meat industry sector (slaughter/processing) to the national economy and the effects of changes on the production process of this sector. Then, we show the importance of the regional meat industry to own region and to the national economy. Finally, we show the results of the regional simulations, where we can observe the effects of changes on the meat industry production process on the regional and the national economies.

4.1 Meat industry sector: significance to the Brazilian economy and impacts of changes on the production process of this sector on the national economy.

The input-output analyze shows that:

*The meat industry displays strong Rasmussen/Hirschman backward linkage - the first highest - but this sector shows small forward linkage index. These indices indicate that the meat industry demands products from the several other sectors, but it is not demanded by other sectors. That is, the meat industry is more connected to final demand. Tables 2 and 3 contain, respectively, the Rasmussen/Hirschman forward and backward linkage indices. These indices are also represented in the Figure 3, where we can see that the backward linkage is bigger than the average value, while the forward linkage is smaller than the average value.

*The meat industry sector can be considered a key-sector to the Brazilian economy - we are considering that key-sectors are those which display Rasmussen/Hirschman backward or forward linkage indices above 1.

*The total pure inter-industrial linkage index (Table 4, Figure 4) – proceeding used to separate the impacts of the certain sector from the rest of the economy – shows that effects of the disappearance of the meat industry sector will result in a significant impact on the Brazilian economy (12th impact). However, this effect is smaller than the average value.

* We are primarily interested in the potential impact of meat industry on the national

economy. Then, we analyzed the changes in the production processes of the meat industry, and we verified that those changes do not affect their share in the Brazilian economy. First, we analyzed Rasmussen/Hirschman backward and forward linkage indices and pure backward, forward and total linkage indices. Second, we simulated changes in the technical coefficients and calculate those indices again. Then, we compare the order of those indices before and after the changes in the production process. We can see, in Tables 2, 3 and 4, that there are small changes in the indices analyzed, but there are not changes in the hierarchy of those indices.

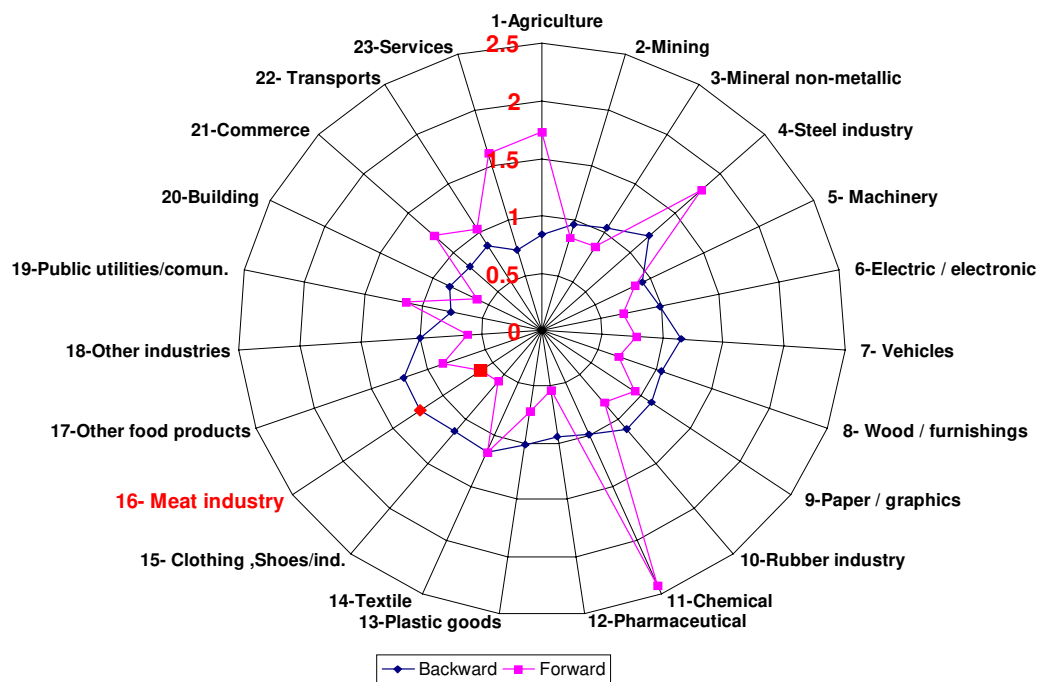


Figure 3. Rasmussen/Hirschman backward and forward linkage indices to the Brazilian economy (normalized).

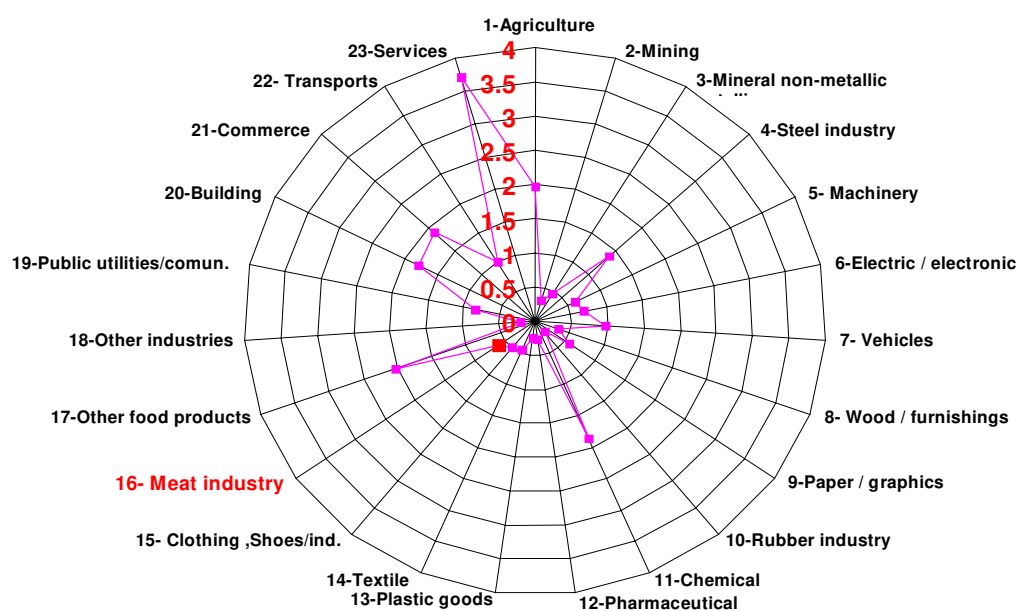


Figure 4. Pure total linkage index to the Brazilian economy (normalized).

4.2 Regional meat industry: significance to national economy and impacts of changes in their production process.

The results about the value and the hierarchy of the meat industry forward and backward linkages in the national economy show that (Tables 5):

- The regions South (S), Southeast (SE) and Middle West (MW) display strong Rasmussen-Hirschman backward indices, respectively the 2nd-, 6th- and 8th-, while the other regions display indices smaller than the first ones. This result is not surprisingly, because regions S, SE and MW concentrate the national meat industry.
- All regional meat industries show small Rasmussen-Hirschman forward indices, but the MW displays the smallest one. That is, the MW meat production is more connected to final demand than the other regions. We would like to emphasize that: a) in fact, in the MW there is a slaughter housing concentration while in the S and

SE there is a meat processing concentration; b) the South and Southeast's productions (sausages, hamburgers, ham, etc) are exported from those regions to the rest of the country; c) the S and SE regions use to buy cattle or animal carcass from the other regions to slaughter and/or processing; d) moreover, in the regions S and SE are located the largest Brazilian sectors in terms of value added.

- The Pure backward, forward and total linkage indices behavior indicate that the disappearance of the South meat industry can affect strongly the national economy. The disappearance of the Southeast and Northeast meat industry can also affect the Brazilian economy, but with less intensity. The separated impacts of Northeast and North meat sectors do not show significant changes in the simulations analyzed.
- The increases in the efficiency of the regional meat industries do not affect their share in the national economy. In fact, Table 5 shows that the value of the indices and the hierarchy of forward and backward linkages of regional meat industry do not show significant changes in the simulations analyzed.

In Table 6 we can observe the coefficient of variation and the hierarchy of regional meat industry backward and forward linkages in the national economy. The results show that the backward linkage's South meat industry displays a small coefficient of variation, and a relatively high coefficient of variation with respect to forward linkages. The backward linkage's of the Southeast meat industry displays the smallest coefficient of variation, and the coefficient of variation of its forward linkage's is high. Those sectors probably demand inputs from several other sectors, and they are demanded by few sectors.

Table 2. Rasmussen/Hirschman backward linkage indices: before and after simulations of the changes on the production process of the meat industry sector.

Sector	Backward linkage indices Simulations									
	Original		1 st -		2 nd -		3 rd -		4 th -	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1-Agriculture	0.8377	20	0.8382	20	0.8385	20	0.8387	20	0.8402	20
2-Mining	0.9568	15	0.9574	15	0.9577	15	0.9579	15	0.9596	15
3-Mineral non-metallic	1.0345	10	1.0351	10	1.0354	10	1.0357	10	1.0375	10
4-Steel industry	1.2004	3	1.2011	3	1.2015	3	1.2019	2	1.204	2
5- Machinery	0.9179	17	0.9185	17	0.9188	17	0.919	17	0.9206	17
6-Electric / electronic	0.993	13	0.9936	13	0.9939	13	0.9942	13	0.996	13
7- Vehicles	1.1423	5	1.143	5	1.1434	5	1.1437	5	1.1458	5
8- Wood / furnishings	1.0363	9	1.037	9	1.0373	9	1.0376	9	1.0394	9
9-Paper / graphics	1.101	8	1.1017	8	1.1021	8	1.1024	8	1.1043	8
10-Rubber industry	1.112	7	1.1127	7	1.113	7	1.1133	7	1.1153	7
11-Chemical	0.9864	14	0.987	14	0.9873	14	0.9876	14	0.9893	14
12-Pharmaceutical	0.9417	16	0.9422	16	0.9425	16	0.9428	16	0.9443	16
13-Plastic goods	1.0087	11	1.0093	11	1.0097	11	1.01	11	1.0117	11
14-Textile	1.1579	4	1.1586	4	1.159	4	1.1593	4	1.1614	4
15- Clothing ,Shoes/ind.	1.1373	6	1.1375	6	1.1377	6	1.1378	6	1.1385	6
16- Meat industry	1.2238	1	1.2109	1	1.2046	2	1.1983	3	1.162	3
17-Other food products	1.2101	2	1.2108	2	1.2111	1	1.2115	1	1.2134	1
18-Other industries	0.9939	12	0.9945	12	0.9948	12	0.9951	12	0.9968	12
19-Public utilities/com.	0.7615	22	0.762	22	0.7622	22	0.7624	22	0.7638	22
20-Building	0.841	19	0.8415	19	0.8418	19	0.842	19	0.8435	19
21-Commerce	0.8139	21	0.8144	21	0.8146	21	0.8149	21	0.8163	21
22- Transports	0.8648	18	0.8654	18	0.8657	18	0.8659	18	0.8674	18
23-Services	0.7271	23	0.7275	23	0.7277	23	0.7279	23	0.729	23

Table 3. Rasmussen/Hirschman forward linkage indices: before and after simulations of the changes on the production process of the meat industry sector.

Sector	Forward linkage indices Simulations									
	Original		1 st -		2 nd -		3 rd -		4 th -	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1-Agriculture	1.7275	3	1.7242	3	1.7225	3	1.7209	3	1.7115	3
2-Mining	0.8343	13	0.8347	13	0.8349	13	0.8351	13	0.8364	13
3-Mineral non-metallic	0.8389	12	0.8394	12	0.8396	12	0.8399	12	0.8413	12
4-Steel industry	1.7895	2	1.7905	2	1.791	2	1.7914	2	1.7942	2
5- Machinery	0.8667	10	0.8671	10	0.8674	10	0.8676	10	0.8689	10
6-Electric / electronic	0.685	17	0.6854	17	0.6856	17	0.6858	17	0.687	17
7- Vehicles	0.7796	15	0.7801	15	0.7803	15	0.7805	15	0.7818	15
8- Wood / furnishings	0.6694	18	0.6698	18	0.67	18	0.6702	18	0.6713	18
9-Paper / graphics	0.9308	9	0.9313	9	0.9315	9	0.9318	9	0.9332	9
10-Rubber industry	0.8169	14	0.8173	14	0.8176	14	0.8178	14	0.8192	14
11-Chemical	2.4218	1	2.4226	1	2.423	1	2.4234	1	2.4256	1
12-Pharmaceutical	0.5363	23	0.5366	23	0.5368	23	0.5369	23	0.5378	23
13-Plastic goods	0.7158	16	0.7162	16	0.7164	16	0.7165	16	0.7175	16
14-Textile	1.1559	6	1.1566	6	1.157	6	1.1573	6	1.1592	6
15- Clothing ,Shoes/ind.	0.5736	22	0.574	22	0.5742	22	0.5743	22	0.5753	22
16- Meat industry	0.6134	20	0.607	20	0.6038	21	0.6007	21	0.5824	21
17-Other food products	0.8626	11	0.8628	11	0.8629	11	0.863	11	0.8637	11
18-Other industries	0.6144	19	0.6148	19	0.615	19	0.6152	19	0.6162	19
19-Public utilities/com.	1.1414	7	1.1419	7	1.1422	7	1.1424	7	1.1439	7
20-Building	0.6045	21	0.6048	21	0.605	20	0.6052	20	0.6062	20
21-Commerce	1.2014	5	1.2018	5	1.2019	5	1.2021	5	1.203	5
22- Transports	1.0255	8	1.0258	8	1.0259	8	1.0261	8	1.0269	8
23-Services	1.5947	4	1.5953	4	1.5955	4	1.5958	4	1.5974	4

Table 4. Pure total linkage indices: before and after simulations of the changes on the production process of the meat industry sector.

Sector	Pure total linkage indices (R\$)									
	Simulations									
	Original		1 st -		2 nd -		3 rd -		4 th -	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1-Agriculture	57797115	3	5779721 ₂	3	5779725 ₉	3	5779730 ₆	3	5779757 ₈	3
2-Mining	9317118	19	9317072	19	9317049	19	9317027	19	9316897	19
3-Mineral non-metallic	13927471	16	1392745 ₃	16	1392744 ₄	16	1392743 ₆	16	1392738 ₅	16
4-Steel industry	40645474	7	4064535 ₃	7	4064529 ₃	7	4064523 ₄	7	4064489 ₄	7
5- Machinery	17954969	13	1795487 ₄	13	1795482 ₈	13	1795478 ₂	13	1795451 ₅	13
6-Electric / electronic	20299736	11	2029952 ₀	11	2029941 ₄	11	2029930 ₉	11	2029870 ₂	11
7- Vehicles	28537370	9	2853707 ₅	9	2853693 ₀	9	2853678 ₆	9	2853595 ₇	9
8- Wood / furnishings	9673617	18	9673391	18	9673279	18	9673169	18	9672533	18
9-Paper / graphics	16748085	14	1674798 ₂	14	1674793 ₁	14	1674788 ₀	14	1674758 ₉	14
10-Rubber industry	6044843	22	6044829	22	6044823	22	6044816	22	6044779	22
11-Chemical	55156422	5	5515630 ₉	5	5515625 ₄	5	5515620 ₀	5	5515588 ₅	5
12-Pharmaceutical	8079925	20	8079066	20	8078644	20	8078227	20	8075816	20
13-Plastic goods	7555618	21	7555605	21	7555599	21	7555592	21	7555555	21
14-Textile	13255330	17	1325525 ₆	17	1325522 ₀	17	1325518 ₄	17	1325497 ₇	17
15- Clothing ,Shoes/ind.	14789212	15	1477807 ₁	15	1477259 ₃	15	1476717 ₆	15	1473588 ₈	15
16-Meat industry	18039167	12	1804245 ₀	12	1804406 ₅	12	1804566 ₂	12	1805488 ₄	12
17-Other food products	59864592	2	5985772 ₂	2	5985434 ₄	2	5985100 ₃	2	5983170 ₆	2
18-Other industries	6025089	23	6024960	23	6024896	23	6024833	23	6024470	23
19-Public utilities/com.	24700177	10	2470005 ₇	10	2469999 ₈	10	2469993 ₉	10	2469960 ₂	10
20-Building	52959478	6	5295888 ₆	6	5295859 ₅	6	5295830 ₈	6	5295664 ₆	6
21-Commerce	56103216	4	5610236 ₇	4	5610194 ₉	4	5610153 ₆	4	5609915 ₀	4
22- Transports	30066543	8	3006629 ₀	8	3006616 ₆	8	3006604 ₃	8	3006533 ₄	8
23-Services	110000000	1	110000000	1	110000000	1	110000000	1	110000000	1

Table 5. Forward and Backward linkages of meat the industry in the National economy¹: value and hierarchy.

INDICES											
Simulations ²											
Regions	Original		1 st		2 nd		3 rd		4 th		
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	
N	1.1162	34	1.1013	38	1.0941	39	1.0869	42	1.0457	52	
NE	1.1505	24	1.1502	24	1.1501	24	1.1499	24	1.1490	25	
BL	MW	1.2321	8	1.2282	9	1.2262	10	1.2243	10	1.2127	12
	SE	1.2555	6	1.2515	6	1.2495	6	1.2475	7	1.2357	6
	S	1.2990	2	1.2766	3	1.2657	3	1.2549	5	1.1941	13
N	0.6696	72	0.6607	72	0.6563	74	0.652	77	0.6273	80	
NE	0.5799	97	0.5797	97	0.5796	97	0.5796	97	0.5791	97	
FL	MW	0.5714	102	0.5694	102	0.5685	102	0.5675	102	0.5619	102
	SE	0.5782	98	0.5767	99	0.5760	99	0.5752	99	0.5708	101
	S	0.7297	59	0.7170	61	0.7108	61	0.7048	65	0.6705	71
N	713463	57	713957	57	714198	57	714437	57	715802	57	
NE	3651136	25	3651228	25	3651274	25	3651320	25	3651607	25	
PBL	MW	636318	60	637844	60	638603	60	639360	60	643847	60
	SE	3991637	23	3989467	23	3988422	23	3987401	23	3981767	23
	S	6874805	13	6901145	13	6913968	13	6926568	13	6997788	12
N	42676	105	42089	105	41802	105	41518	105	39895	105	
NE	183758	95	183629	95	183565	95	183501	95	183116	95	
PFL	MW	143797	98	142535	98	141908	98	141282	98	137578	98
	SE	649241	64	647288	64	646316	64	645347	64	639594	64
	S	1382864	45	1358374	45	1346451	47	1334736	47	1268512	49
N	756139	76	756046	76	756000	76	755955	76	755697	76	
NE	3834894	47	3834857	47	3834839	47	3834821	47	3834724	47	
PTL	MW	780114	75	780379	75	780511	75	780642	75	781425	75
	SE	4640878	40	4636756	40	4634738	40	4632748	40	4621361	40
	S	8257669	25	8259519	25	8260419	25	8261303	25	8266300	25

¹ Rasmussen/Hirschman backward linkage indices (BL), Rasmussen/Hirschman forward linkage indices (FL), Pure backward linkage indices (PBL), Pure forward linkage indices (PFL), Pure total linkage indices (PTL); Pure linkages: R\$.

² Simulations of the changes on the production process of the meat industry sector (Table 1).

4.3 Regional meat industry: significance to regional economies and impacts of changes in their production process

The Table 7 shows the value and the hierarchy of regional meat industry backward and forward linkages in the regional economy. We can observe that, in general, the meat sector is very important to the regional economies. The Southeast meat sector is the exception.

The Southeast is the most industrialized region in Brazilian and its economic sectors are the largest sectors in terms of value added. The significance of the meat industry is not large when we consider the whole Southeast economy. However the significance of this sector to the national economy is strong. As showed above, in the national economy the Southeast meat sector displays the 6th- highest Rasmussen-Hirschman backward index and the 40th- pure linkage index. Moreover, as also showed, that sector probably demands inputs from several other sectors. Therefore, we can conclude that the Southeast meat industry is strongly interrelated with several sectors from other Brazilian regions.

However, meat industries of the other regions are more connected with other sectors in their own regions.

Table 6. Coefficient of Variation: Rasmussen-Hirschman backward and forward linkages - the meat industry in the national economy ¹.

Regions		Coefficients									
		Simulations ²									
		Original		1 st		2 nd		3 rd		4 th	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	
N	6.2658	67	6.2658	67	6.2658	67	6.2658	67	6.2659	67	
NE	6.0462	76	6.0462	76	6.0463	76	6.0463	76	6.0464	76	
RVBL¹	MW	5.9763	80	5.9765	80	5.7880	80	5.9766	80	5.9772	80
	SE	5.1538	115	5.157	115	5.1585	115	5.1600	115	5.1688	114
	S	5.7677	91	5.7677	91	5.7677	91	5.7677	91	5.7677	91
N	9.7273	35	9.7273	35	9.7274	35	9.7274	35	9.7274	35	
NE	9.8997	30	9.8999	30	9.8999	30	9.9000	30	9.9005	30	
RVFL¹	MW	10.3329	17	10.3351	17	10.3362	17	10.3372	17	10.3437	17
	SE	10.1498	20	10.1499	20	10.1499	20	10.1500	20	10.1502	20
	S	9.2245	46	9.2252	46	9.2255	46	9.2259	46	9.2279	46

¹ RVBL: Coefficient of Variation: Rasmussen-Hirschman backward index.

RVFL: Coefficient of Variation: Rasmussen-Hirschman forward index.

² Simulations of the changes on the production process of the meat industry sector (Table 1).

Table 7. Forward and Backward linkages of regional meat industry in the Regional economy ¹: value and hierarchy.

INDICES											
Simulations ²											
Regions	Original		1 st -		2 nd -		3 rd		4 th -		
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	
N	1.3544	1	1.3370	1	1.3284	1	1.3200	1	1.2715	2	
NE	1.2096	2	1.2088	2	1.2084	2	1.2080	2	1.2056	3	
BL	MW	1.4263	1	1.4215	1	1.4191	1	1.4167	1	1.4026	1
	SE	0.9257	17	0.9230	17	0.9217	17	0.9204	17	0.9125	17
S		1.3994	1	1.3762	1	1.3648	1	1.3537	1	1.2904	2
N		0.8741	10	0.8629	10	0.8573	10	0.8519	10	0.8206	14
NE		0.6906	18	0.6901	18	0.6899	18	0.6896	18	0.6883	18
FL	MW	0.7276	16	0.7251	16	0.7239	16	0.7227	16	0.7154	16
	SE	0.5909	22	0.5892	22	0.5884	22	0.5875	22	0.5825	22
S		0.8067	15	0.7933	16	0.7868	16	0.7804	16	0.7439	17
N		603999	4	604392	4	604584	4	604773	4	605859	4
NE		2845654	3	2845757	3	2845809	3	2845860	3	2846168	3
PBL	MW	572734	6	573087	6	573262	6	573436	6	574470	6
	SE	1898002	17	1899076	17	1899611	17	1900144	17	1903310	17
S		6015748	3	6025187	3	6029783	3	6034298	3	6059822	3
N		39789	19	39242	19	38974	19	38710	19	37196	19
NE		164878	18	164763	18	164705	18	164648	18	164303	18
PFL	MW	95674	15	95330	15	95159	15	94988	15	93977	15
	SE	590499	21	588722	21	587838	21	586956	21	581721	21
S		628532	15	617401	15	611982	15	606657	16	576557	16
N		643789	7	643634	7	643558	7	643483	7	643055	7
NE		3010533	7	3010520	7	3010514	7	3010508	7	3010471	7
PTL	MW	668410	9	668417	9	668421	9	668425	9	668447	9
	SE	2488501	23	2487799	23	2487449	23	2487100	23	2485031	23
S		6644280	5	6642588	5	6641764	5	6640955	5	6636379	5

¹ Rasmussen/Hirschman backward linkage indices (BL), Rasmussen/Hirschman forward linkage indices (FL), Pure backward linkage indices (PBL), Pure forward linkage indices (PFL), Pure total linkage indices (PTL).

² Simulations of the changes on the production process of the meat industry sector (Table 1).

5. CONCLUSIONS

This work analyzed the significance of the meat industry to the regional and the national economies of Brazil, and verified how changes in the production process of the meat industry affect their share in the Brazilian economy.

We could conclude that, among the regional meat sectors, the South meat industry is the most important, followed by the Southeast meat industry. We could also conclude that, in general, the meat sector is very important to the regional economies. The Southeast meat industry is the exception. The analysis showed that the Southeast meat industry is strongly interrelated with the other Brazilian sectors, while meat industries of the other regions are more connected with other sectors in their own regions.

These results let us raise some questions. As showed above, part of the Southeast industry tends to be transferred to the Middle West. Then, probably this transference will not affect the Southeast economy as a whole. As also showed above, part of the South meat industry tends also to be transfer to the Middle West. However, the South meat sector is more connected with it own sectors. Then, the disappearance of part of this sector probably will cause strong impacts in the South economy.

However, questions are still left with no answer, and need a further study, i.e.: could those transferences affect national economy or the competitiveness of the regional meat sectors? Could those transferences also increase the significance of the Middle West meat industry to the Brazilian economy?

Moreover, although all the Brazilian meat sectors can still increase its production and improve its technological process, changes in the production processes of the meat sector do not affect its share in the regional and national economies.

We believe that the next stage of this study would be to analyze the regional animal-raising. Then, we will open the animal-raising and the meat sector, to analyze the separated effects of cattle, poultry and pork transferences and changes in their technical coefficients. In the future, these results can be used to analyze the competitiveness of the meat sectors among the Brazilian regions.

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