Rivista di Economia Agraria, Anno LXX, n. 1, 2015: 33-54

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Keywords: Agricultural and livestock sector, Input-output matrix, Brazilian economy.
JEL Codes: E16, Q10

Input-Output Analysis for agricultural and livestock sector in the Brazilian economy

This paper aims at assessing the behaviour's evolution in the agricultural and livestock sectors in the Brazilian economy by domestic input-output matrix for 1995, 2000, 2005 and 2009. These matrices were used to calculate the forward and backward linkages indices as well as the production, employment and income generators, enabling the analysis of the relationship among the agricultural and livestock sector and other sectors. The results showed that the agricultural and livestock sector is gaining importance in the Brazilian economy, especially as input for other sectors. Furthermore, the production, employment and income generators corroborated the importance of this sector, especially the employment generator, which depicts that this sector is the major employment generator among the sectors.

1. Introduction

In the early 90s profound changes affected the Brazilian economy, standing out the fiscal crisis of the Federal Government, leading to measures to reduce public spending; trade opening, which allowed greater competitiveness of domestic goods against international goods; and the withdrawal of the subsidy of some agricultural and livestock activities – the subsidy policy was replaced by policies regulating production and subsequently by deregulation. Macroeconomic policies became more specific to the productive sectors, which were more exposed to competitive markets and product reality, due to greater integration of trade with other countries (Jank *et al*., 2005).

The economic measures adopted for these transformations have also established the reduction in credit granting by official sources and hence the scarcity of resources for agricultural and livestock research and extension. These measures resulted in the increase of interest rates, reduction of existing rural credit subsidies and policies to guarantee minimum prices. In addition, the State began a process of deregulation of the economy, no longer regulating some productive activities and extinguishing companies and federal authorities (Bacha, 2004).

DOI: 10.13128/REA-16976
ISSN (print): 0035-6190
ISSN (online): 2281-1559

However, even with all the changes occurring in the Brazilian economy, the agricultural and livestock sector showed a real growth rate of the gross value of production (GVP) of 88.4% between 1995 and 2012. Within the periods analyzed in this article, the growth of this sector's GVP was 15.2% between 1995 and 2000; 28% (2000-2005); 17.3% (2005-2009); and 9% (2009-2012) (FAO, 2014).

Given the promising and challenging scenario that the Brazilian agricultural and livestock sector has shown, this study aims at assessing the evolution of the behaviour of the agricultural and livestock sector in the Brazilian economy through input-output analysis for the years 1995, 2000, 2005 and 2009.

Therefore, this article is divided into five sections, including this brief introduction. Section 2 discusses the importance of the agricultural and livestock sector for the Brazilian economy, highlighting its production and participation as input for other industries. Section 3 presents the input-output matrix, which is the method of analysis used in this research. The fourth section presents the results and their discussion. The fifth section presents the main conclusions and suggestions for further research.

2. The importance of the agricultural and livestock sector in the brazilian economy

In economic theory, the role of agriculture for the economic growth of a country has been highlighted by various authors since the 1960s such as William Petty (1623-1687), François Quesnay (1694-1774) (Petty, 1983), Hwa (1988) and Bacha (2004). Hwa (1988) carried out a statistical analysis on the contribution of agriculture to the economic growth and concluded that agricultural and livestock growth, although strongly linked to industrial growth throughout the development process also contributes to global economic growth, due to favorable impacts that it produces in total productivity of the factors.

According to Pimbert (1999) and Bacha (2004), the agricultural and livestock sector has five important basic functions for the development of a country: (i) to provide capital for the expansion of non-agricultural and livestock sector; (ii) to provide workforce for the growth and diversification of activities in the economy; (iii) to provide foreign exchange for the purchase of inputs and capital goods required for the development of economic activities; (iv) to constitute a consumer market for the products of the non-agricultural sector; and (v) to provide input needed for industrial development.

Brazilian agricultural and livestock sector stands out not only for its economic role, but also for social aspects (employment) and for national territory occupation by exploring livestock, crops such as sugarcane and coffee and timber harvesting.

Data from FAO (2014) show that gross domestic production (GDP – at constant 2006 prices) of the Brazilian agricultural and livestock sector increased from R$ 47.3 billion in 1990 to R$ 62 billion in 1995, reaching R$ 73.8 billion in 2000, R$ 95 billion in 2005 and R$ 115.1 billion in 2010. Between 1990 and 1995 there was a growth of 30.9%, while from 1995 to 2000 this percentage accounted for 19.0%, between 2000 and 2005 the growth was 28.7%, and from 2005 to 2010, 21.1%.

Small farmers, those who have properties of until 100 ha, represent 91% of all agricultural and livestock properties and occupy 21% of all the agricultural land. They produce about 70% of all food produced in Brazil, participate in the economy with 35% of the Brazilian GDP, and employ 40% of the economically active workforce. With respect to food production, small farmers produce about 87% of cassava, 70% of beans, 60% of milk, 59% of pig meat, 50% of poultry, 46% of maize, 38% of coffee, 34% of rise, 30% of cattle meat, and 21% of wheat (IBGE, 2006).

In the 2010/2011 and 2011/2012 harvests, Brazilian grain production increased from 122.5 million tons to 163 million tons. The farming area of these crops increased 4.3%, while the average yield increased from 2.6 tons/ha to 3.3 tons/ha, i.e. 26.9%, also increasing productivity gains. Exports of the agriculture and livestock sector, according to Central Bank of Brazil (Bacen, 2014), accounted for about 80% of Brazil's total exports in 2012, generating approximately 41.1% of the total revenue from exports, i.e. US$ 83.4 billion. In terms of revenue, the main products exported were cereals and soybean, whose revenue was US$ 26.1 billion, followed by meat sector (US$ 14.9 billion) and sugarcane sector (US$ 15.0 billion).

In general, Brazilian agricultural and livestock sector has played an important role in the world economy. According to FAO (2014), in 2012, Brazil was the world leader in the production of sugar, coffee and orange juice; the second largest world producer of soybeans, cattle meat, tobacco and ethanol; the third largest world producer of poultry and corn; the fourth largest world producer of pig meat, soybean oil and soybean meal; and the fifth largest world producer of cotton. In terms of trade, Brazilian agricultural and livestock sector also has been important in the international context. In 2012, Brazil was the world leader in the exportation of orange juice, representing 85% of the world trade, sugar (50%), soybeans (40%), poultry (38%), coffee (27%) and tobacco (11%); the second largest world exporter of cattle meat, representing 39% of the world trade, ethanol (27%), maize (25%), soybean oil (19%) and soybean meal (8%); the fourth largest world exporter of pig meat, representing 22% of the world trade, and cotton (11%).

According to Adler and Sosa (2011), international commodity prices showed an upward trend since 2001, and the explanation for this is the influ-

ence of the acceleration of the economic activity in major world economies and the growth of income in emerging economies, especially in Asia, where increased demand for primary products intensified the growth of basic commodities. Even with the shock in agricultural prices that occurred from May 2007 to July 2008 and from June 2010 to February 2011, international prices remained high. Fact perceived by the increase of 44.5% and 72.4%, respectively, of the Commodities Index-Brazil (CI-Br) Agriculture and Livestock, measured in American dollars in these periods. It is worth mentioning that the shock in agricultural prices was due to weather problems, which reduced the global supply of grains and oilseeds.

In July 2012, the CI-Br Agriculture and Livestock recorded a monthly increase of 11.4% and a decrease of 0.94% in August. The evolution of this index reflected the rise in agricultural prices, particularly in wheat prices (33.7%), maize (33.2%), and soybeans (19.2%), reflecting the drought in the USA and some countries in Eastern Europe, especially Russia (Gruss, 2014).

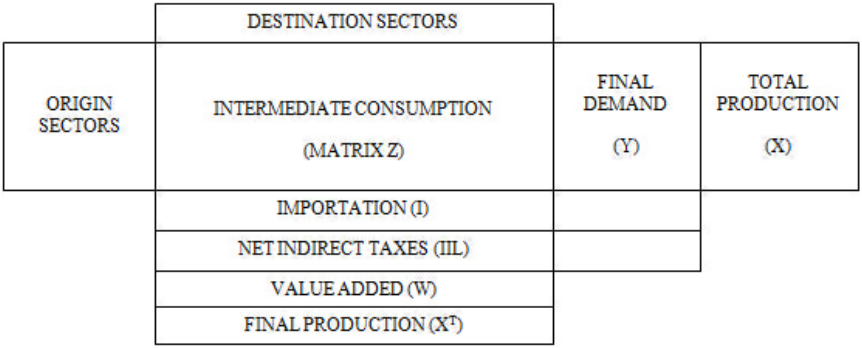
The favorable scenario for the Brazilian agricultural and livestock sector is due, in part, to the fact that there was an increase in agricultural borders, i.e. areas that were not occupied with agriculture, such as the areas in the Northeast and Central West regions. Insofar as the agricultural border was extended to Piauí, Bahia, Maranhão and Tocantins, there was a pressure on the agricultural and livestock sector, which required a new infrastructure for those regions, enabling their growth. Since then, there have been stimuli to improve the living standard of urban centers, significantly altering the landscape of these regions and promoting development. In fact, the Brazilian agriculture and livestock has transformed large areas of the country, from the productive land use to the qualification of the labor employed in agricultural and livestock activities (Barros, 2014).

However, the importance of the agricultural and livestock sector in the Brazilian economy should not be measured solely by GDP, production or exports, because its growth also induces other sectors of the economy such as food industries, footwear, textiles, financial activities, equipment supply, insurance, and other inputs. Thus, the relationship of the agricultural and livestock sector with other sectors of the economy is equally important to measure the prestige of the agricultural and livestock sector in the domestic context (Jank *et al.*, 2005).

Bacha (2004) complements stating that agriculture has always provided the input for the process of industrialization and there is a strong intensification of the process of linking agriculture with other sectors of the economy that influence and are influenced by the production of the agricultural and livestock sector.

Costa *et al.* (2013) complements affirming that the stimuli in final demand (via exports) in some specific sectors of agribusiness (forward linkage of the

Fig. 1. Basic input-output relationship among sectors of the economy



Source: Adapted from Guilhoto (2000).

agricultural and livestock sector) cause an increase in the value of production, the share of GDP, and employment generation, demonstrating the degree of importance of the agricultural and livestock sector for the economic growth.

3. Theory and methodology: Input-Output Matrix

3.1 The Input-Output Matrix

Input-output analysis is the name given to an analytical framework developed by Wassily Leontief in the late 1930s, in which the primary purpose was to analyze the interdependence of industries in an economy. In other words, the means used for the analysis of inputs used by the economy for the production of the final product, therefore the product of a sector can be the input of another (Leontief, 1966).

The economic sectors are grouped into a matrix in which the rows record the outflow of production, showing how the production of an activity sector is distributed among the other sectors of the economy. The columns of the matrix record the necessary inputs for production, showing the structure of inputs used by each sector of the productive activity.

As shown in Figure 1, each row of the matrix *Z* indicates the intersectoral flow, i.e. the intermediate consumption of goods and services in each sector. The matrix *Y* records the final consumption, divided into household consumption, government consumption, exports, gross fixed capital formation and changes in inventories. The lines below the *Z* and *Y* matrices record import spending (I), net indirect taxes (IIL) and value added (W) (compen-

sation for the production factor services). The totals of the columns and the rows of the matrix (vector X and X^T) record the total output of each sector, which should be equal, indicating the balance of the economy, where the costs of each sector are equal to their respective revenues.

3.2 Rasmussen-Hirschman and Pure linkage indices

From the basic Leontief model, you can determine which sectors have greater linkage power within the economic system through the methodology proposed by Rasmussen and Hirschman. This methodology allows calculating the backward linkage indices – that would provide how much the respective sector demands from the other sectors of the economy – and the forward linkage indices – that would provide the quantity of products demanded from other sectors to the respective sector. It is noteworthy that Rasmussen and Hirschman forward and backward linkage indices have long been applied, widespread by authors such as McGilvray (1977), Hewings (1982), Guilhoto *et al.* (1996) among others. These measures originally created by Rasmussen (1956), were used as a means of identifying key sectors by Hirschman (1958).

The backward linkage index U_j, or the dispersion power of the sector, can be estimated by the equation:

$$U_j = [B_{(*j)}/n]/B^* \quad (1)$$

The forward linkage index U_i, or dispersion sensitivity, can be estimated by the equation:

$$U_i=[G_{i*}/n]G^* \quad (2)$$

Where B is the Leontief inverse matrix, B^* is the average of all elements of B, B_{*j}, is the sum of a typical column, is the sum of a typical line and n is the number of sectors. G is the Ghosh matrix, where $G = (I - F)^{-1}$, F is the matrix of row coefficients derived from the intermediate consumption matrix, G^* is the average of all elements of G, and G_{i*} is the sum of a typical line of G.

Thus, for the interpretation of the results of these equations, it can be emphasized that values greater than the unity for the forward and backward linkage indices in a respective sector means that it has linkages above the average of the economy as a whole, so they are considered key sectors for the economy.

However, Rasmussen-Hirschman linkage indices ignore the different levels of production for each sector of the economy. To improve this approach, Guil-

hoto *et al.* (1996) developed a new pure linkage index called GHS with new definitions for backward linkage (PBL) and forward linkage (PFL):

$$PBL=\Delta_r A_{rj}\ \Delta_j\ Y_j \tag{3}$$

$$PFL=\Delta_j A_{jr}\Delta_r Y_r \tag{4}$$

PBL indicates the pure impact of the value of total production in sector *j* for the rest of the economy. PFL indicates the pure impact of the value of total production from the rest of the economy *r* over the sector *j*. The impact is considered pure because it is free of demand for inputs produced by sector *j* to sector *j*, and free of returns to the sector *j* from the rest of the economy, and vice versa. As the PBL and PFL are expressed in value of production, the total for the economy can be obtained by adding both in the following way:

$$PTL = PBL + PFL \tag{5}$$

Once the pure linkage indices are expressed in value of total production, it is necessary to normalize them so that you can compare these indices in different periods. Normalization is performed by dividing the value of production in each sector by the average value of the economy.

The normalized pure backward linkage index is calculated as follows:

$$PBLN = PBL \Big/ \left(\sum_i^n PBL / n\right) \tag{6}$$

The normalized pure forward linkage index is represented by:

$$PFLN = PFL \Big/ \left(\sum_i^n PFL / n\right) \tag{7}$$

And the normalized pure total linkage index of each sector is represented by:

$$PTLN = PTL \Big/ \left(\sum_i^n PTL / n\right) \tag{8}$$

Considering the normalization of indices, it is necessary to emphasize that the pure index of total linkage is no longer called by the sum of the pure forward and backward linkage indices, once its value is not expressed in current values.

These techniques allow the decomposition of impacts among sectors, enabling an analysis of the integration in a domestic economy. In addition to identifying the key sectors, it is possible to identify the sources of changes in the economy.

3.3 Production, Employment and Income Generators

From Leontief model, one can estimate the direct and indirect impacts that a change in demand generates on production for each sector of the economy (Miller and Blair, 1985). Thus, we have:

$$\Delta X = (I - A)^{-1}\Delta Y \tag{9}$$

In which ΔX is the total production; $(I - A)^{-1}$ is Leontief inverse matrix; and ΔY is final demand.

Summing all elements of the vector X (total production), one obtains the impact on the total volume of production. Besides the production, there is also the impact on other variables such as employment, imports, taxes and wages, estimated by the equation:

$$\Delta V = \hat{v}\Delta X \tag{10}$$

In which ΔV is a vector (*nx1*) that indicates the impact on each variable, $\hat{v}$ is a diagonal matrix (*nxn*), in which the diagonal elements are the coefficients of the variables. These values are obtained by dividing the value of these variables used in total production by total production, for each sector.

The coefficient of employment can be estimated as follows:

$$CPO = PO.\hat{X} \tag{11}$$

In which *PO* is the number of employees; and *X* is the total production.

From this, it is possible to estimate the employment and income generators with the following calculus:

$$GV_j = \sum_{i=1}^{n} b_{ij} v_i \tag{12}$$

In which GV_j is the total impact, direct and indirect, on the variable analyzed; b_{ij} is *ij*-th element of the Leontief inverse matrix; and v_i is direct coefficient of the variable analyzed.

In this study, the generators of employment and income will be analyzed. The result of each generator expresses the amount of employment (or income) needed in all sectors of the economy to meet the increase of a monetary unit in the final demand of a given sector.

In this analysis, it is necessary to take into account that the input-output matrix depicts as «employment» the number of employed persons in each group of activities, which includes all those working in the activity. This includes owners, partners and family members who do any work in the company, even without payment. This value also includes the amount of informal labor. Regarding compensation (income) of employees, this involves all payments made by the productive units to their employees: wages, overtime hours, 13th salary, productivity bonuses, payments in goods and services, and social contributions that are the responsibility of the employer. It must be taken into consideration that the input-output matrix covers the total number of employed persons and their compensation, even without any employment relationship.

The input-output matrices used in this study are disaggregated into 42 economic sectors for the years 1995, 2000 and 2005, and estimated for the year 2009 by the Regional and Urban Economics Lab of the University of São Paulo – NEREUS.

3.4 Application of input-output analysis in the evaluation of agriculture's role in the economy

In order to analyze how important is the link between agriculture and industry or and other sectors of the economy, many authors have studied the importance of this sector and its role in the economy in many countries by input-output matrices.

Peterson and Heady (1955), Holland and Martin (1993) and Hale (2012) have studied the dependence of the agricultural sector on other sectors. According to their studies, we can observe an increased evolution of the importance of this sector in the American economy from 1929 to 2010. Peterson and Heady (1955) studied the interdependence coefficients between agriculture and industry for the years 1929, 1939 and 1949 in the United States. The analysis for this period showed that the coefficient for the dependence of primary agriculture on industry has increased from 0.36 to 0.56, while the coefficient for the dependence of secondary agriculture on industry remained constant at 0.56. On the other hand, the dependence of secondary agriculture on primary agriculture has decreased from 0.96 to 0.66. Holland and Martin (1993) analyzed output changes in the United States agricultural economy from 1972 to

1977. Their results showed that the real output in agriculture expended 9.43%, in which 7.56% was accounted by the export, domestic final demand accounted for 3.21%, import substitution increased 0.69%, and technical change was negative account for -2.02%. Hale (2012) has studied the impact of the agriculture in the Haywood Country (USA) in 2010. The results showed that labor income and employment proportions were 0.74% and 13.6%, respectively. The multipliers showed that the agriculture had an impact per dollar of output of US$ 0.33 on the rest of the economy, while the largest manufacturing industry had an impact per dollar of output of US$ 0.19 on the rest of the economy.

Henry and Schluter (1985) by measuring the backward and forward linkages of food and fiber sector in USA, stressed the importance of agriculture. They stated that the impact of agriculture in the whole economy is influenced not only by the magnitude of the linkages and the interdependence among the sectors of the economy, but also by the structure of the particular economy and the relative shares of the raw and processed food sectors.

Hamilton *et al.* (1991) and Baumol and Wolff (1994), both in their studies stressed the significance of indirect effects of agriculture in the economy. However, a little analysis has taken place about the impact of disaggregated farming systems on the development of rural areas.

Sonis *et al.* (1995) analyzed the Brazilian economy evolution from 1959 to 1980. Their results show that agricultural and livestock sector was a key sector for the national economy having an important role on the development of the other sectors of the economy.

Cummings *et al.* (2000) investigated the role of farming sector in the local economy of Ontario region and evaluated the direct and indirect effects of agriculture to the rest sectors.

Giannakis (2010) analyzed the impact of extensive versus intensive farming systems on rural development in Greece. His results suggest that intensive crops create stronger backward linkages from extensive ones. Almost all farming systems appear to have rather low income and employment multipliers. Amongst them extensive crops seem to have the greatest due to high direct income and employment effects they create.

Heringa *et al.* (2013) analyzed the economic impact of multifunctional agriculture in four Dutch regions – Flevoland, Noordoost-Noord Brabant, Overig Zeeland, and Zuid-Limburg – in 2007. Their results showed that, in terms of output and employment, multifunctional agriculture was not a main driver for economic growth. Moreover, it appeared that multifunctional agriculture led in particular to more expenditure in the agricultural sector itself, rather than in any other economic sector. The indirect feedback effects of multifunctional agriculture on the non-agricultural sectors in the Dutch economy appeared rather small. Although the absolute size of employment in

multifunctional agriculture was very small, the employment per unit of output was high, especially when compared with the employment/production rate in primary agriculture.

Zuhdi *et al.* (2014a) analyzed the dynamics of total output of Japanese livestock sector caused by final demand changes in 2005. They employed a tool of analysis and two conditions in order to describe those changes. Those conditions are «whole sector change» and «pure change». Their results show that those conditions have different patterns and suggest to both conditions regarding import activity, the restriction of what is needed in order to increase the total output of Japanese livestock sector in the future period.

Zuhdi *et al.* (2014b) analyzed the dynamics of total output of livestock sectors of Indonesia caused by final demand changes in 2005. Their results suggest that livestock sectors of Indonesia have similar pattern and the biggest impact to their total output on future period comes from change of household consumption.

Many other studies have been made in order to show the importance of the agricultural and livestock sector in the world.

4. Results and Discussions

The results obtained from the application of the methodology proposed by Rasmussen and Hirschman, and also the GHS method, demonstrated which sectors have greater linkage power within the economic system, through backward and forward linkage indices, as shown in Tab. 1. It is important to highlight that the PBLN and PFLN indices show how much the agricultural

Tab. 1. Pure linkage indices and Rasmussen-Hirschman for the domestic matrices in the analyzed years, highlighting the agricultural sector

	1995		2000		2005		2009	
	Value	Rk*	Value	Rk	Value	Rk	Value	Rk
PBLN	0.91	14	0.98	15	1.17	12	1.17	11
PFLN	3.17	4	3.09	3	3.21	4	3.09	4
PTLN	0.56	26	2.03	4	2.19	5	2.13	7
HRBL	0.81	37	0.83	38	0.88	32	0.87	34
HRFL	1.07	18	1.08	18	1.1	17	1.09	18

* Rk is the domestic ranking, considering the 42 sectors analyzed, shown in Tab. 3.
Source: Research data (2014).

and livestock sector demands from other sectors, and the quantity demanded of other sectors of the economy by the agricultural and livestock sector. The main difference between these indices and the Rasmussen-Hirschman indices is that these last show the sectors with greatest linkage power within the economy considering the demand from agricultural and livestock sector to the own sector.

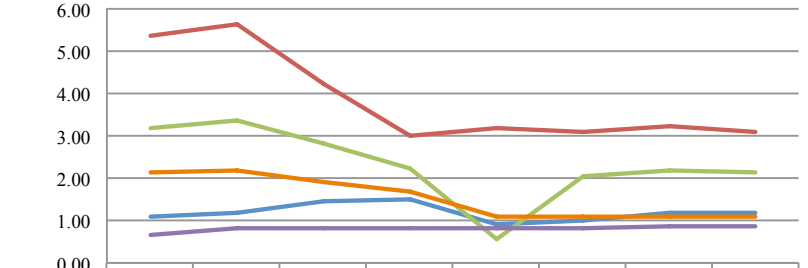
The pure backward linkage index (PBLN) signals to what extent a sector demands inputs from the economy in relation to the others, i.e. values over the unit indicate a highly dependent sector from the rest of the economy. It is observed in Table 1 that the agricultural and livestock sector had lower values than the unity for 1995 and 2000, standing in the 14th and 15th positions, respectively, in the domestic ranking. This indicates that the agriculture and livestock did not show any dependence on other sectors of the economy that serve as inputs for its production in these years. For 2005 and 2009, the agricultural and livestock sector recorded higher values than the unity, which positioned itself respectively in 12th and 11th positions in the domestic ranking values. This fact expresses the increasing dependence of the agricultural and livestock sector as a demander of inputs needed for production (fertilizers, seeds, machinery, implements, equipment, vaccines, feed etc.).

The pure forward linkage index (PFLN) indicates the extent to which a sector has its inputs demanded by the economy in relation to other sectors. Thus, values higher than the unity represent a sector whose production is widely used by other sectors of the economy. It can be seen in Tab. 1 that for all the years studied, the agricultural and livestock sector had higher values than the unity, indicating that the agricultural and livestock sector was very demanded by other sectors. This indicates that the agricultural and livestock sector is considered an important offering of inputs for other downstream sectors.

The total pure linkage index (PTLN) indicates the importance of a sector within the economy, considering the other sectors both upstream and downstream, but without distinguishing them. Thus, values above the unity means that the sector is important for the development of the others, both as a demander and as a supplier of inputs. In Table 1 it is observed that the value of this index was lower than the unity only in 1995, showing that the agricultural and livestock sector is important for the development of other sectors of the economy as a whole.

Previous studies support this result. Furtuoso and Guilhoto (2000), for example, showed the importance of the agricultural and livestock sector as a demander of goods and services and supplier of inputs for the non-agricultural and livestock sector. Costa *et al.* (2013) highlighted Brazil as one of the largest global producers in this sector, emphasizing that the entire agribusiness has

Fig. 2. Pure linkage indices and Rasmussen-Hirschman evolution for the agricultural sector



	1959	1970	1975	1980	1995	2000	2005	2009
PBLN	1.11	1.20	1.47	1.49	0.91	0.98	1.17	1.17
PFLN	5.38	5.62	4.21	2.98	3.17	3.09	3.21	3.09
PTLN	3.18	3.37	2.81	2.22	0.56	2.03	2.19	2.13
HRBL	0.66	0.82	0.82	0.81	0.81	0.83	0.88	0.87
HRFL	2.14	2.20	1.91	1.70	1.07	1.08	1.10	1.09

Source: Sonis *et al.* (1995) and research data (2014).

generated 28% of the GDP in 2005 and, in 2007, the value of the Brazilian agriculture and livestock production was third in global rankings.

The Rasmussen and Hirschman backward (HRBL) and forward (HRFL) linkage indices indicate that for values higher than the unity, the interpretation is that the sector presents higher linkage than the average of the economy as a whole and that the sector is considered a key sector for the economy.

In the case of HRBL index, for all years analyzed, this index was smaller than unity, ie, the agricultural and livestock sector recorded backward linkage below the average of the economy and considering it the agriculture cannot be considered a key sector for the development of the upstream sectors. On the other hand, the HRFL index had its values above unity for all years analyzed, indicating that the agricultural and livestock sector has forward linkages above average of the economy and thus it is considered a key sector for the development of the downstream sectors.

Comparing these results with Sonis *et al.* (1995) ones, we can observe that the agricultural and livestock sector has reduced its dependence from the other sectors that serve as inputs for its production, and as supplier for downstream sectors. In addition, the role of this sector as key sector for the economy also has reduced from 1959 to 2009 (Fig. 2).

In addition to the analysis of the importance of agriculture as a key sector for the development of the national economy, there are the production, employment and income generators, which measure the impact on final de-

mand of each sector on production, employment and income of all economy. To analyze comparatively the period, the value of the shock on final demand has been revised for the year 2009 using the implicit GDP deflator, provided by Fundação Getúlio Vargas. This is, it was considered a shock of 1.00 million Reais in 1995, R$ 1.4958 million for 2000, R$ 2.3738 million for 2005 and R$ 3.0995 million for 2009. The analysis of these generators for the agricultural and livestock sector is exposed in Table 2.

It is observed in the Table 2 that the production generator evolved positively over the years. While in 1995 each million Reais of increased final demand generated 1.56 million Reais in the value of agricultural and livestock production, in 2009 the amount equivalent to one million Reais in 1995 generated 5.27 million Reais in the value of production. It is noticed that from 1995 to 2000, the value of the production generator increased from 1.56 to 2.44, however, the agricultural and livestock sector reduced a position in the domestic ranking. This fact implies that the other sectors of the economy also showed increase in the production generator proportionally higher than the agricultural and livestock sector. The same fact can be observed from 2005 to 2009.

Regarding the employment generator, we note that there was a decrease every year, i.e. while in 1995 each million Reais of increase in the final demand generated 405.78 jobs, in 2009 the amount equivalent to one million Reais in 1995 produced an average of 327.30 jobs. Even with the decrease in the value of the employment generator from one year to another, from 1995 to 2000, the agricultural and livestock sector remained the main employment generator,

Tab. 2. Production, employment and income generators for the domestic matrices for the analyzed years

	1995		2000		2005		2009	
	Value	Rk	Value	Rk	Value	Rk	Value	Rk
Production generator	1.56	37	2.44	38	4.18	32	5.27	34
Employment generator	405.78	1	327.3	1	283.89	2	230.89	2
Income generator	372,360.11	24	538,039.63	22	853,896.96	15	967,612.34	36
Income generated by employment in minimal wage of the period.	91,764,037		108,865,198		100,260,019		901,249,818	

Source: Research data (2014).

and from 2000 to 2005 its position slipped to second place, and remained so in 2009. Likewise, it is highlighted the importance of the agricultural and livestock sector as a major employment generator in the country. These results are confirmed by the studies of Ichihara *et al.* (2007) and Costa *et al.* (2013).

The fall of the employment generator over the years can be partly explained by the mechanization of agriculture, which somehow reduced the number of jobs in the field, whether in agriculture or livestock. Moreover, all sectors have also suffered falls of the employment generator, which can be partly explained by trade opening in the 1990s, since the competition between companies made small and inefficient firms go bankrupt and/or were bought by larger and more efficient firms, reducing the number of jobs in the sectors and enabling technological development and increased imports.

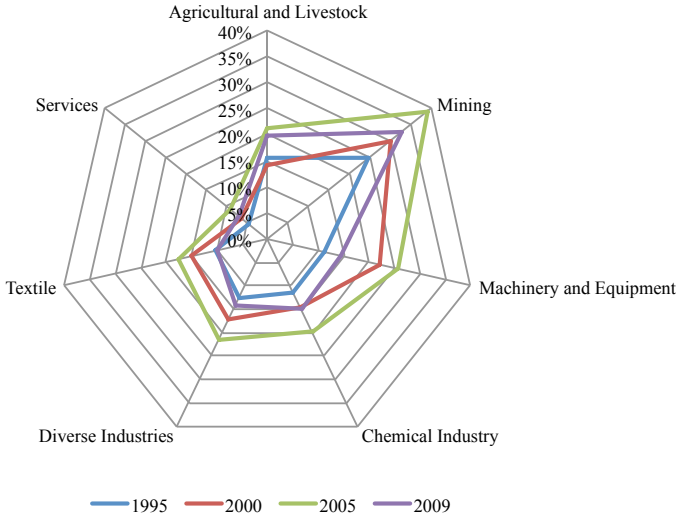
With regard to the income generator, its evolution has been positive over the years. While in 1995 each million Reais of increase in the final demand generated R$ 372,360 of income for the agricultural and livestock sector, in 2009 the equivalent of a million Reais in 1995 value generated R$ 967.6. This real increase in the income generator from 1995 to 2009, improved the position of the agricultural and livestock sector in the domestic ranking, which implies that in the period analyzed the gains of the agricultural and livestock sector were proportionally higher than some other sectors.

The increase in the values of the income generator of the agricultural and livestock sector is related to the correction of the shock value given in the final demand as aforementioned. Only by dividing the income generator by the employment generator, and dividing again by the minimum wage in the period, it is noticed that the average income generated by each job remains constant, around 10 minimum wages, according to Table 2.

Furthermore, the macroeconomic scenario of this period reflected negatively on the performance of the Brazilian economy by virtue of national and international events that occurred as the terrorist attack in the United States on September 11, 2001; the Argentina crisis; and energy rationing and high interest rates in Brazil in 2001 and 2005, respectively. On the other hand, the GDP grew by 1.31% in 2001 thanks to the good performance of the agricultural and livestock sector which presented a historical harvest and strengthened foreign trade, as in 2004 exports records were registered, influenced by high external demand, mainly of commodities (Santana and Nascimento, 2012).

In reference to the percentage of the domestic product linked to foreign demand in the period analyzed, Figure 3 shows this percentage for the seven aggregated sectors, in which contain the 42 individual sectors considered in this analysis (Tab. 3). Analyzing the percentage of the domestic production linked to external demand, which is considered as the greatest route of increase in the final demand of agricultural products in Brazil, it is observed that the

Fig. 3. Percentage of domestic production linked to external demand for the analyzed period



Source: Research data (2014).

mining is the sector that had higher participation in domestic production linked to external demand for all years.

Considering the seven aggregated sectors (Fig. 3), the agricultural and livestock sector showed a little increase in participation in domestic production linked to external demand between 1995 and 2009. Even if this sector continues in the 2nd position, in 2000 and 2005 it was in the 6th and 4th position, respectively. It is important to highlight that the participation of the agricultural and livestock sector in the domestic production decreased from 2005 (21.23%) to 2009 (19.85%) while the position in the ranking increased from 4th to 2nd position. It can be explained by the fact that others sectors reduced more their participation in domestic production linked to external demand.

If we analyze 42 individual sectors (Tab. 3), we can observe that the agricultural sector increased its participation in domestic production and its position in the ranking. From 1995 to 2009, the participation of agricultural sector rose from 12.91% (17th position) to 24.25% (8th position) while the participation of livestock sector (animal slaughtering) rose from 8.32% (25th position) to 22.37% (10th position). It is emphasized that 2005 is the only year that livestock sector showed higher participation in domestic production (28.60% - 10th position) than the agricultural sector (25.35% - 14th position). It is due to the fact that 2005 was characterized by problems that have affected the Brazil-

Tab. 3. Percentage of domestic production linked to external demand for the analyzed period

	1995	2000	2005	2009
Agricultural	12.9	16.5	25.4	24.3
Mining	38.2	53.4	69.0	67.1
Petroleum and gas	17.5	19.4	35.4	37.1
Non-metalic mineral	7.0	10.9	17.0	8.9
Steel	36.6	41.7	48.5	33.2
Non-ferrous metals	44.9	51.1	55.9	47.7
Other metals	12.9	16.0	22.9	16.0
Machinery and equipment	15.5	18.0	26.8	15.4
Electric material	9.8	15.3	19.4	12.6
Eletronics	4.8	15.5	18.0	9.6
Cars/lorries/buses	6.0	14.8	23.4	7.6
Other vehicles and parts	19.8	46.5	41.5	26.2
Wood and furniture	8.6	15.9	23.6	9.5
Pulp, paper and printing	16.2	17.7	21.0	17.5
Rubber industry	17.9	25.1	31.3	22.8
Chemical elements	14.3	17.5	27.4	22.1
Petroleum refining	16.0	18.6	26.1	20.3
Other chemicals	16.8	19.1	24.4	18.3
Pharmacy and veterinary	4.3	5.6	6.1	4.9
Plastic products	10.5	15.4	21.4	14.4
Textile	9.4	11.5	18.1	11.1
Manufacture of clothing	2.1	2.6	3.0	1.2
Manufacture of shoes	19.5	31.1	32.1	17.2
Coffee industry	18.2	10.0	14.5	10.5
Processing of vegetable production	18.6	11.9	15.2	14.3
Animal slaughtering	8.3	13.4	28.6	22.4
Dairy products	0.8	0.9	1.8	1.1
Manufacture of sugar	24.8	21.0	40.3	47.5
Manufacture of vegetable oil	36.5	33.3	38.6	34.6
Other food products	4.3	4.7	5.5	4.0
Diverse industries	7.8	9.8	10.1	6.2
S.I.U.P. (Industrial services of public utility)	5.9	7.7	12.1	8.8
Construction	0.3	1.4	1.5	1.2
Trade	8.7	12.7	18.5	13.0
Transport	11.9	12.0	18.6	13.9
Communication	4.3	6.6	9.4	7.0
Financial institutions	4.6	6.1	7.7	7.0
Services provided to families	5.7	3.8	5.6	4.0
Services provided to firms	7.1	14.3	19.3	16.6
Real estate rental	1.3	1.7	3.1	3.1
Public administration	0.3	0.4	0.5	0.3
Non-market private services	2.2	3.4	4.5	3.0

Source: Research data (2014).

ian agricultural and livestock sector. In this year has occurred strong drought and agricultural crop failures followed by falling prices of major products, currency appreciation and animal health problems. However, agricultural sector was more affected by these factors than livestock sector.

It is noticed that the trade opening that occurred in the 90s made the participation of the agriculture and livestock production linked to external demand, increase over this period, with a slight stabilization in 2009, where we can relate the international crisis of 2008. Nevertheless, even in this period, it is emphasized that the agricultural and livestock sector was less affected than other sectors of the economy, considering its evolution in the domestic ranking.

Notwithstanding this scenario, the Brazilian agriculture and livestock sector showed to have an important role in the national economy. In general, this sector has showed its importance for the economic development in many countries, especially those developing.

5. Conclusion

The aim of this paper was to assess the behaviour's evolution in the agricultural and livestock sector in the Brazilian economy by input-output matrix for the years 1995, 2000, 2005 and 2009.

The empirical results confirm the importance of agriculture for the Brazilian economy, in terms of its trade relations with the other activities, as an important buyer of inputs as an important supplier of inputs to other sectors. This highlights two main roles of the agriculture in the economic development process: to constitute a consumer market for the products of the non-agricultural sector, and to provide input needed for industrial development.

The pure linkage indices calculated showed the importance of the agricultural and livestock sector to the economy. The pure backward linkage index (PBLN) showed that the sector has no great dependence on upstream sectors, but the pure forward linkages (PFLN) showed that the agricultural and livestock sector is large offering of input for downstream sectors. Overall, the total pure linkage index (PTLN) showed that the agricultural and livestock sector is important for the development of other sectors of the economy as a whole.

The Rasmussen-Hirschman linkage indices showed the degree of linkage of the agricultural and livestock sector with other sectors. The Rasmussen and Hirschman backward linkage (HRBL) showed the agricultural and livestock sector with a linkage level below the average of the economy, and therefore the agricultural and livestock sector does not represent a key sector upstream. On the other hand, the Rasmussen and Hirschman forward linkage index (HRFL) showed the agricultural and livestock sector with a linkage level above the av-

erage of the economy, which implies that the agricultural and livestock sector is regarded as a key downstream sector. Overall, agriculture proved to be a key sector for the development of the economy as a whole.

Therefore, the evolution of these indices show that the agricultural and livestock sector is increasing its dependence on sectors that serve as inputs, strengthening backward linkage, although it does not represent a key sector for the development of upstream sectors. On the other hand, this evolution also shows that the sector is losing relative importance as a supplier of inputs, but this loss is still insignificant, since this sector is considered a key sector for the development of other downstream sectors and has been strengthening forward linkage.

In addition, it means that the supply chains, which belong to agricultural and livestock sector, are more organized than before, i.e. there are more coordination among the stakeholders in this sector. It can be explained by the agricultural polices existing in Brazil, which subsidizes small farmers and production and commercialization of some crops, as well as guarantees their minimum price.

Despite the agricultural and livestock sector is a key sector for the development of the other sectors in the Brazilian economy, it did not show much dynamism on the capability to generate employees in opposite to generate production and income. The employment generator showed decrease in all of periods analyzed, while the production and income generators presented increases in all of the periods. It can be inferred that the fall in the number of jobs created in the economy by the agricultural and livestock sector was mainly due to the process of mechanization of the industry, which intensified with the economic opening in the 90s. However, real income in terms of minimum wages generated by employment in the agricultural and livestock sector remains constant, around 10 minimum wages.

It suggests that, insofar as the agricultural and livestock sector is specializing and increases the use of capital, it requires fewer people to work directly. Similarly, it will need more inputs and more people to work in other activities, so that the surplus of work, which initially worked directly in the agricultural and livestock sector, moves to other activities. Thus, another important function of agriculture and livestock of economic development was observed: to provide workforce for the growth and diversification of activities in the economy.

In this context, it can be concluded that the economic opening that happened in the country, especially after 1995, intensified the process of agricultural mechanization by facilitating imports, which reduced the number of jobs generated in each shock in the final demand, nevertheless the average income generated by employment remained constant. On the other hand, also from

1995, the percentage of agricultural and livestock sector production linked to external demand increased, which shows the gain of competitiveness of the sector in international trade.

Moreover, it is clear the resistance of the sector to international setbacks, vis a vis other sectors of the national economy, considering the maintenance of the percentage of its production linked to external demand, even after the crisis of 2008, which did not happen with the other sectors of the economy, which consequently improved the position of agriculture in the domestic ranking.

Thus, since the agricultural and livestock sector is important for the development of the country, Brazilian specific policies could be enhanced in order to improve this sector. Some aspects related to this sector still need to be improved such as production, infrastructure, logistic, market and investment.

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