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GDP OF THE SUGAR AND ALCOHOL SECTOR IN THE NORTHEAST AND THE WHOLE OF BRAZIL: AN INPUT-OUTPUT APPROACH

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ABSTRACT

Under the traditional classification into primary, secondary and tertiary sectors, the value of Agriculture Gross Domestic Product (GDP) is underestimated since the products generated upstream (inputs, implements and machines) and downstream (processing, transformation and distribution) are not computed in this statistic. In order to solve this problem, several recent studies, using the concept of Agribusiness, a term coined by Davis and Goldberg in 1957, and representing the sum of all activities related to agriculture, have sought to estimate the value of agricultural GDP considering this activity as the core of a much larger economic system called Agribusiness and Agro-industrial Complex (CAI). In this work, we attempted to quantify the GDP of the sugar and alcohol sector both for the Northeast and for Brazil, and the participation of the region in GDP composition of this sector in Brazil. The results show that the GDP of this sector accounts for 9.21% of regional GDP. In Brazil, this share is 6.91%. Given that the industry in the Northeast accounts for 15.57% of the national GDP of this activity.

Keywords: Agribusiness; Brazil; Input-output; Northeast; Sugar; Alcohol.

RESUMO

Sob a classificação tradicional em setores primário, secundário e terciário a agropecuária tem o valor do Produto Interno Bruto - PIB - subestimado uma vez que os produtos gerados a montante (insumos, implementos e máquinas) e a jusante (processamento, transformação e distribuição) não são computados nessa estatística. Objetivando equacionar essa distorção, diversos trabalhos recentes, utilizando-se do conceito de Agribusiness - termo cunhado por Davis e Goldberg em 1957 e que representa a soma de todas as atividades ligadas à agropecuária, têm buscado dimensionar o valor do PIB agropecuária considerando essa atividade como o núcleo de um sistema econômico muito mais amplo e denominado de Agronegócio ou Complexo Agroindustrial (CAI). Os resultados mostram que o PIB desse setor representa 9,21% do PIB regional e, no Brasil, essa participação é de 6,91%. Sendo que a indústria no Nordeste reponde por 15,57% do PIB nacional dessa atividade.

Palavras-chave: Agronegócio; Brasil; Insumo-produto; Nordeste; Açúcar; Álcool.

JEL Code: C67; E23; Q11.

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INTRODUCTION

The importance of the agricultural sector in the Brazilian economy plays a major role when considering the national GDP. In addition to having a decisive role under the Brazilian balance of achieving long time successive surpluses and thus contributing to macroeconomic stability, we emphasize that this sector has forward and backward linkages in its production. So by considering the relevance of those links it gives a better way of classifying the Agribusiness. Representing the relevance of the sector considering such linkages, Araújo Neto e Costa (2005) show that the Gross Domestic Product - GDP in Agribusiness (21.2%) of Pernambuco represented three times the value of this statistic when only the agricultural sector (7.7%). is considered. Some recent papers, Guilhoto et al. (2007) and Cruz et al. (2009), enlarge the argument in the agricultural sector stating that its importance should be measured including how it depends on other economic activities, such as the food industry.

Within the Agribusiness, the sugar and alcohol sector, that includes planting and processing sugarcane activities, is historically one of the most important activities for the Northeast. Data on formal employment available in the Annual Social information – RAIS – Ministry of labor and employment – MTE, for the year of 2013, show that the number of formal workers in sugarcane cultivation totals 1,595,230 jobs in the Northeast. This number is equivalent to approximately 25.5% of all formal agricultural activity jobs in the region (6,245,613 jobs).

It is worth mentioning that in Brazil, the formal employment participation in sugar cane planting is 22.3%. In other words, in the Northeast, the formal jobs generation in sugarcane cultivation was higher when compared to the national statistics. Still according to RAIS, the number of places involved in the sugar-ethanol activities in Brazil and the Northeast was 10,192 and 1,657, respectively.

Therefore, the region used to concentrate 16.2% of all establishments in the Brazilian agro-industrial sugar-ethanol complex. Still in this item, data from the Matriz de Insumo Produto do Nordeste do BNB (2010) revealed that the farming activity of sugarcane alone had the second best multiplier of jobs in the Northeast. This was of the order of 660 jobs for each variation of one million Reais in the final demand of the activity in which 94 % of the jobs were generated within the region.

The results presented above show the dimensions and importance of this sector to the economy of the Northeast. Furthermore, from the data, it is possible to infer that the sector contributes to the maintenance of employment levels and income, even in the absence of the prospect of large-scale structural changes in in the local economy that result in new work opportunities for those employed in this activity. In order to investigate other economic dimensions of this sector, this work aims at computing the measure of the contribution of the sugarcane agribusiness to the GDP of the Northeast and the whole of Brazil.

In other words, the study attempts to dimension GDP of the sugar and alcohol sector in Brazil and the Northeast region, making use of an input-output matrix of the region according to the data provided by the Bank of Northeast Brazil (BNB), considering, therefore, the linkages that the activity have with the other sectors of the national and regional economy.

This work is divided into five sections plus the introduction. The following section concerns the national literature review on the quantification of agribusiness. In section 3, a brief summary is presented relating to the definition of the agribusiness term as well as a review of theories of analysis of the input-output matrix. The fourth section presents the definition for each one of the aggregates and methodology of quantification. The fifth section presents and discusses the results achieved. The last section concerns the final remarks.

LITERATURE REVIEW

The literature on dimensioning GDP in agribusiness attempts to quantify the importance of the agro industrial complex of Brazil's economy. There are many works on this issue such as: Parré and Guilhoto (2001), Montoya and Finamore (2001), Furtuoso and Guilhoto (2003), Araújo Neto e Costa (2005), Finamore and Montoya (2005), Guilhoto et al. (2005c), Guilhto et al. (2007) e Cruz et al. (2009). The focus of these works differs in accordance to the region that is taken into account. Some works concentrate themselves on the GDP dimension of one singular state, while others on the GDP dimension of Brazil's agribusiness complex. Still, there are some works that quantify agribusiness GDP both in Brazil and one specific state, as well in one specific sector of the Brazilian agro-livestock.

It is noted in Table 1 that the participation of the south region of Brazil in agribusiness in 1985 and 1995 stayed unaltered for two years. Parré e Guilhoto (2001) analyzed the development of agribusiness in Southern Brazil during the years of 1985, 1990 and 1995, and measured the interdependences existing between regions. It can also be verified that approximately half the income produced in the south was originated from activities attached to the agro-industrial complex and agribusiness.

Montoya and Finamore (2001) have the main goal of dimensioning and characterizing the Brazilian agro-industrial complex from 1959 to 1995. The results, in Table 1, demonstrate expansion in the agribusiness real value, however, its contribution to the full GDP showed a tendency of falling due to the expansion of other industrial complexes and service sectors. In addition, the authors also noted a greater concentration of income in sectors upstream and downstream in the agribusiness.

An estimation and mensuration of agribusiness GDP in Brazil in the period 1994 to 2000 were carried out by Furtuoso and Guilhoto (2003). In this work, the authors quantify the agribusiness GDP separated into two big agro-industrial complexes: agriculture and livestock. For the authors, the results demonstrate a high level of interdependency between Brazilian productive sectors. According to those authors, the difference (Table 1) between the

participation of the agricultural and livestock agro-industrial complex can be mostly explained by the variety of items originated from agriculture; so there is a large number of processing units from the rural production to the agricultural agro-industrial complex.

The mensuration of agribusiness GDP of Pernambuco was taken by Araújo Neto e Costa (2005). The objectives of this work concerned the conceptualization and characterization of agribusiness as well as the discussion related to the methodology used to dimension agribusiness GDP. According to the results, shown in Table 1, the authors demonstrate that the participation of agribusiness in GDP of the Pernambuco state was superior to that indicated by official statistical data for the primary sector of the economy of Pernambuco.

Finamore and Montoya (2005) attempted to conceptualize and quantify the agro industrial complex of dairy farming in the state of Rio Grande do Sul. The methodology adopted indicators of sectorial performance as well as indexes of buy-and-sell autonomy in order to delimitate the dimensioning of the dairy complex. The results showed that the dairy cattlemen from Rio Grande do Sul are great national producers and their level of competitiveness makes them among one of the most efficient producers in Brazil. Furthermore, the results demonstrated that the participation of the southern dairy complex in the agribusiness GDP was significant and this complex offered 118,603 jobs, representing an important source of employments to agribusiness and the state, as is shown in Table 1.

The participation of family agribusiness in GDP in Brazil's agro-industrial complex was one goal of the work developed by Guilhoto et al. (2005c). According to Table 1, besides the results showing the participation around 1/3 of family agro-livestock in GDP in the Brazilian agribusiness, it is highlighted that the growth rate of agro-livestock and all the agro-industrial complex associated with it, in recent years, had overcome the growth rate of the employer segment.

Guilhoto et al. (2007) analyzed the evolution of Brazil's GDP in Bahia during 1990-2005 trying to measure the segments and sub-complexes. It is shown by Table 1 that the participation of GDP in agribusiness in Brazil's GDP and Bahia's was approximately the same in the given period of analysis. On the other hand, participation in agribusiness by sub-complexes in Bahia have agricultural activities with greater participation while others results by segments show that the most remarkable participation was the core activity (agro-livestock).

Cruz et al. (2009) analyzed the definition of Aggregate I (suppliers of inputs and capital goods), Aggregate II (livestock itself), Aggregate III (processing and industrialization of livestock production) and Aggregate IV (agro-livestock distribution). It is possible to verify by Table 1 that the results of the study demonstrated that agribusiness in Minas Gerais state had a significant participation in the composition of the Minas Gerais GDP, as well in the GDP in Brazilian agribusiness, showing that the sector with major participation in dimensioning GDP in Minas Gerais agribusiness was: processing, industrialization and distribution.

Table 1. Brazilian literature summary

Authors	Results
Parré and Guilhoto (2001)	A rise in the participation of the Southern Brazil's agribusiness from 28.7% in 1985 to 29.6% in 1995 is indicated. The participation in GDP agribusiness of this state was approximately 50%.
Montoya and Finamore (2001)	The authors demonstrate an evolution in the real value of agribusiness in the period of 1959-1995, however, they evidenced a tendency of falling in the participation of the GDP due to an expansion of industrial complexes and service sectors.
Furtuoso and Guilhoto (2003)	The authors showed that for the period of 1994 to 2000, the agribusiness GDP of two complexes, agricultural and agro-livestock, had equal participations of 8% and 20%, respectively, and the full participation of agribusiness was a total of 27%.
Araújo Neto e Costa (2005)	On the contrary to official statistics that demonstrated a livestock GDP of 7.5%, the authors showed that the agro-livestock in Pernambuco had an effective participation of 21.2% in the GDP of this state in 1999.
Finamore and Montoya (2005)	The results showed that the dairy farming GDP in Rio Grande do Sul in 1998 had a participation of 6.77%, employing 5.07% of people occupied in agribusiness and 2.42% of the state's workers.
Guilhoto et al. (2005c)	The authors highlighted that 33.3% of Brazil's agribusiness, 1995 to 2003, originated from family agro-livestock, showing that the growth of this agro-industrial complex overcame the rate of employer segment in recent years.
Guilhoto et al. (2007)	The authors proved that agribusiness participation in the period of 1990-2005 in Brazil and Bahia's GDP was, respectively, 27.85% and 28.82%. On the other hand, the participation of sub-complexes in Bahia was: a) agriculture – 73.48% e b) livestock – 26.52%. The results by segment were: a) inputs – 6.35%; b) agro-livestock – 44.17%; c) industry – 22.39% and d) services e distribution – 27.04%.
Cruz et al. (2009)	The authors demonstrated that the agribusiness of Minas Gerais represented 29.76% of the GDP of the state, and 9.6% of Brazilian agribusiness GDP. The participation of sectors in agribusiness in Minas Gerais had the following distribution: a) input suppliers – 20.73%; b) agro-livestock – 27.53% and c) processing, industrialization and distribution obtained participation of 51.75%.

Source: The authors.

AGRIBUSINESS AND THEORIES OF INPUT-OUTPUT ANALYSIS

Making use of input-output matrix techniques developed in 1930 by Leontief, Davis and Goldberg (1956) analyzed upstream and downstream activities in the North-American agro-livestock and perceived that these activities grew more than the agro-livestock itself in the period of 1910, 1947 and 1965. In this sense, they created the term Agribusiness – which represents the sum of all activities connected to agro-livestock.

Right after this systemic perspective, agro-livestock started to represent the core of a broader economic system that was denominated Agribusiness or Agro-industrial Complex (AIC). Under this new perspective, the analysis started to decompose agribusiness into aggregates according to the distribution of the value added by each one of these segments.

In this sense, the sugar and alcohol agribusiness in the Northeast of Brazil brings together four intertwined sectors: Aggregate I (industry that supplies capital goods and inputs to agro-livestock); Aggregate II (agro-livestock); Aggregate III (processing and industrialization of agro-livestock goods); and Aggregate IV (distribution of agro-livestock goods).

It is important to highlight that this systemic perspective is part of a natural process suffered by rural proprerties all over the world. It must be considered that these properties were responsible not only for all activities involving agro-livestock, but also for the production of seeds and animals for traction (those that characterize inputs as capital goods), for the tools used for agro-livestock and for methods of transporting the production.

Thus, it may be stated that rural properties were practically self-sufficient and, therefore, they were denominated as a primary sector of the economy. Nevertheless, due to changes such as: i) increasing urbanization of the regions (countries/states); ii) economic growth and development and iii) the post-war technological revolution in agriculture (worldwide), the properties contributed for the rural producer to dedicate only and exclusively to agricultural and agro-livestock activities, that is, to the specialization of the cattleman.

In this sense, the other activities started to be developed out of the rural properties, but, they are connected to these properties. Under a new scenario, bonds appear linking the upstream operations, core (agro-livestock) and downstream operations. Thus, the food system starts to be denominated agribusiness.

Building on the previous ideas, this article has a theoretical framework according to the studies of Leontief in 1930 such as the input-output matrix. Since the agribusiness has strong bonds of interdependency between sectors (upstream, core and downstream), it is possible to use the economic theory of general balance as a base in order to carry out an analysis on the interrelations of the activities of sugar and alcohol AIC, concentrating on the circular flow theory.

Considering that one of the main elements in the information on the input-output analysis is the data on the production of inter-sector flows, Leontief

developed the input-output matrix to study the relations that occur inside one country's economy as a function of the observable basic sectoral interdependencies. This is based on the general interdependency classic theory that considers the full economy of one region, a country and the whole world, as a simple system.

The analysis of the input-output matrix also uses a set of coefficients that determine the level of interdependency in sectors of a specific economy and also denominated technical coefficients of production (a_{ij}). However, this matrix has been adapted to study inter-sector relations of regions/states. Both at country level and region/state, the basic model makes use of the articulation by groups of sectors in order to measure the impact on the economy,[1] as a whole, occasioned by changes suffered on the final demand or any other component[2] of it.

The operation of one economy can be summarized as being a problem of equating offer and demand, that is, a question of general balance. Therefore, at the same time that the sectors offer goods and services to other sectors of the economy, those (sectors offered) also demand goods and services from others sectors, demonstrating in this way that the sectors relate to each other (directly or indirectly).

One of the most important assumptions in the analysis of the input-output matrix is that the flow of input from sector i to sector j, that is, the inter-sector flow, depends exclusively on the level of total production of this last sector. In this sense, the level of interdependency between sectors i and j is given by the condition $w_{ij} = X_j$. This is,

$$a_{ij} = \frac{w_{ij}}{X_j} \tag{1}$$

where a_{ij} is the coefficient that determines the interdependency between the sectors i and j; w_{ij} characterizes the input flow from i to j and X_j the level of production in the sector j.

However, when considering the intermediate consumption of input by units of the final product as being fixed, there is the open system[3] of Leontief given by:

$$\sum_{j=1}^{n} a_{ij}X_i + \Gamma_i = X_i \; i = 1, \dots, n; \tag{2}$$

where a_{ij} represents the technical coefficient of production that supplies the quantity of input of the sector i that is used to produce one unit of final product in the sector j $\left(a_{ij} < 1 ou \left(1 - a_{ij}\right) > 0\right)$; X_j is the total domestic

[1] On the full production, importation, taxes, income, added value and so on.

[2] Consumption of families, government spending, investments, exportations.

[3] Open input-output model implies that the final demand is the exogenous part on dimensioning the level of the product, while the closed model is at least one of the components of the final demand and also the endogenous part that consequently impacts on the final production level (See Guilhoto, 2011).

production of the sector j and Γ_i is the final demand of products in the sector i.

Equation (2) can be represented in matrix form as follows:

$$AX + \Gamma = X \tag{3}$$

where A represents the matrix of direct[4] input coefficients of order (nxn); X a vector of order $(nx1)$ that characterizes the gross value of production and Γ, as well as X, is a column vector of order $(nx1)$ that characterizes the full final demand.[5]

Equation (3) above can be represented as it follows

$$(I - A)X = D \tag{4}$$

where each entry a_{ij} of the Leontief matrix, $(I - A)$, represents the direct effects of demands in sector i for inputs offered by sector j, that is, on currency, the impact on the final demand of the sector j. In addition, as characterized in Equation (1), a_{ij} is the coefficient that determines the interdependency between the sectors i and j.

Working with the open system of Leontief, the final demand is considered to be exogenous to the system, which is the opposite of the closed one, making it possible to obtain the full needed production in order to satisfy the full demand by resolving the expression (4) above. In this case,

$$X = (I - A)^{-1}\Gamma \tag{5}$$

where $(I - A)^{-1}$ is denominated as the matrix[6] of direct and indirect technical coefficients.

Through the *inverse matrix of Leontief*, $B = (I - A)^{-1}$, it is possible to identify the effects on the final production level of the economy, arising from variations in one of the components of the final demand. It is important to highlight that it is possible to obtain different effects for each of the components since the interdependencies vary from sector to sector.

That is to say that sectors have *forward linkages*, which define the sector as an input supplier for the other sectors, and *backward linkages*, that classifies the sector as one which demands inputs from the other sectors and may cause different results after a "shock" in one of the final demand components. Each one of the elements b_{ij} represents the direct and indirect requirement of needed inputs of the sector i to produce one unit of final demand in sector j.

[4] Assuming returns are constant in scale and the use of inputs in fixed proportions, the matrix's columns of direct coefficients A characterize as a technological structure of the correspondent sector.

[5] It should be noted that the full final demand corresponds both to purchases made within the sector itself and to inputs from other sectors.

[6] This matrix is denominated as global effects matrix or as inverse matrix of Leontief.

The data used for this analysis were extracted from the Input-Output Matrix estimated from national accounts data according to the methodology developed by Guilhoto and Sesso Filho (2005, 2010). Finally, the sample period comprises the year 2004.

QUANTIFICATION METHODOLOGY OF THE SUGAR AND ALCOHOL SECTOR GDP

According to the methodology used by the Brazilian Institute of Geography and Statistics – IBGE – in producing the national accounts, the agribusiness GDP corresponds to the sum of the goods and services production of all productive units that are interrelated with agro-livestock activities. In other words, the sugar and alcohol GDP takes into account all the corresponding values to the upstream sectors ("before the gate"), the agro-livestock properties ("inside the gate") and the downstream sectors ("after the gate").

"GDP characterizes as a macroeconomic aggregate whose purpose is to provide a summary measure of the results from economic activities of a country, representing the full production of final goods and services in a given period of time" (Cruz et al. 2009, p. 814 [free translation]). There are two ways to calculate the GDP: at market prices or at cost factors.

The difference between them is basically the exclusion of indirect taxes on the production, the prices of goods and services, when they are used to calculate the cost factors. So, since this study attempts to quantify the GDP of the sugar and alcohol sector, considering only payments that are exclusively intended for remuneration of production, it is also used to calculate the cost factors – GDP_{cf}. It is noted that this macroeconomic aggregate can be measured from three points of view: production, cost and income.

Production view: $GDP = VP - IC - T = VA - T$

Cost view: $GDP = C + G + GFCF + CS + (X - M) - T$

Income view: $GDP = W + GOS - T$

where:

VP → is the value of the product at basic prices;

IC → is the intermediate consumption at market prices;

T → are the net indirect taxes;

VA → value added

C → is household consumption at market prices;

G → is government consumption at market prices;

GFCF → is the gross fixed capital formation at market prices;

CS→ is the change a stock market prices;

X → are exportations;

M → are importations;

W → is the reward of the employees and;

GOS → is the gross operating surplus.

The mensuration of the GDP of Brazil and the Northeast sugar and alcohol sector, in this work, it is carried out under the production view. This choice is justified because this type of approach requires much less statistical information and, therefore, requires less computational resources as well. This approach has been widely used in the agribusiness GDP sizing literature and thus making comparisons with the results of others works possible.[7] In this work, the GDP composition is divided into four aggregates.

a) Aggregate I: (suppliers of goods and inputs to agro-livestock)

b) Aggregate II: (livestock production)

c) Aggregate III: (processing and industrialization of livestock goods)

d) Aggregate IV: (agro-livestock product distribution)

In this sense, the next section of this work is about dimensioning each one of these aggregates of the sugar and alcohol agro-industrial complex in order to obtain the full gross domestic product of the sector under study as well as to identify the aggregate with large volume of production and, consequently, bigger representation. Thus, it is possible to direct the attention of the *policy makers* to which sectors deserve more attention in the function of the politics to be implemented.

Quantification of Aggregate I

In Aggregate I the sectors which are "before the gate" are found, this is to say that they are suppliers of capital goods and inputs for the main activity of agribusiness, which is the agro-livestock itself. Following this hypothesis of input-output relation being constant, since there are no statistical data on the added value by the upstream agribusiness, this work attempts to estimate the gross domestic product of Aggregate I by the intermediate consumption of the agro-livestock.

The information required for this calculation is available from input-output tables. With this data, the first step is to calculate the Value Added Coefficient for an activity, $VAC's$. These are obtained through the ratio between the intermediate value of consumption in the sector i. Subsequent to estimating the $VAC's$ it is possible to extract the portion of the value added in each of the suppliers sectors of inputs and capital goods for agribusiness following the equation:

$$GDP_I = \sum_{i=1}^{n} \left(\frac{x_i}{X_i}\right) VA_i \qquad (6)$$

[7] Another factor relates to the convenience of working under this perspective.

where x_{i1} represents one fraction of the value of the full production in sector i. This was also used as intermediate consumption by the sugar and alcohol sector. X_i is the full production of the sector i and VA_i corresponds to the full added value of sector i – this value is a price factor since the net indirect taxes extracted reflect on the production.

Quantification of Aggregate II

The agribusiness Aggregate II comprises the core activities of this sector, that is, the agricultural activity itself. However, in order to avoid the occurrence of double counting[8] in the measurement of Aggregate II and its added value, a procedure usually adopted in the literature from the input-output analysis is applied. Thus, it is subtracted from the added value in the cost factors of the core sector, a portion of the added value at cost factors already accounted in the capital goods and inputs purchased in upstream sectors related to their own acquisition that the sector conducts itself.

That is to say that, in this study, it is valid to subtract the added value as cost factors of the resulting upstream purchases that the sugar and alcohol sector carried out itself. It must be noted that, if this procedure were not adopted, the GDP of Aggregate II would be overestimated and, thus, possibly, it would wrongly indicate this aggregate of the sugar and alcohol sector as it had a large production volume and, consequently, this sector would have the biggest representation. This could induce *policy makers* to formulate and direct politics to this sector. The equation for Aggregate II is given by:

$$GDP_{II} = (VA_1 - T_1)\left[(VA_1 - T_1)\left(\frac{x_{i1}}{X_i}\right)\right] \quad (7)$$

where VA_1 corresponds to the value added at market price to the sugar and alcohol sector; T_1 is the net indirect taxes that focus on the production of the sugar and $(VA_1 - T_1)\left(\frac{x_{i1}}{x_i}\right)$ alcohol sector and represents the deduction of acquired portions by the sugar and alcohol sector in this sector, and accounted in Aggregate I

Quantification of Aggregate III

The agricultural sectors of processing and industrialization, that is, the aggregation sectors of value to primary goods, are those that constitute Aggregate III of the sugar and alcohol agro-industrial complex. However, it is worth highlighting the fact that there are some agro industries where transformation occurs only on products originated from agro-livestock activities, while there are others that can aggregate values to inputs that are not originated only from the agro livestock.

[8] Since the value added of some inputs and capital goods used in the agricultural sector have been recorded in the aggregate I dimensioning.

For example, the textile industry that uses products originated from agriculture (cotton) also employs synthetic thread in its production. As reported by Finamore and Montoya (2005), when dimensioning the dairy sector of Rio Grande do Sul, only agro industries directly related to that sector were considered, this work also exclusively considers the agro industry of the sugar and alcohol sector, this is to say that it considers sugar, drinking and alcohol making.

It is important to mention that, once the drinking sector is formed by a variety of industries (wine making; malt making; beer and draft beer; soft drinking and soda making, and bottling; and mineral water gasification), the effective participation of the sugar and alcohol sector in this industry was calculated through Annual Industrial Research carried out by IBGE – PIA. The result found was approximately equal to 2.92% of the income of this industry. Finally, as in the estimation of Aggregate II, the calculation of Aggregate III excludes the components already counted in the upstream. In that way, again, this avoids double counting. Therefore,

$$GDP_{III} = \left(VA_j - T_j\right)\left[\left(VA_j - T_j\right)\left(\frac{x_{j1}}{X_j}\right)\right]; \quad (8)$$

where VA_j represents the value added at market price in the agro industrial sector j; T_j corresponds to net indirect taxes on the agro industrial production (and paid by it) and $\left(VA_j - T_j\right)\left(\frac{x_{j1}}{X_j}\right)$ corresponds to the deduction of the component already assigned to the upstream.

Quantification of Aggregate IV

Aggregate IV is characterized as being the agribusiness sector responsible for the distribution of the agro-livestock production as well as of the agro industry, which means that the measurement comprises the relative sectors of transport and trade, and service sectors. In this quantification the methodology used in Cruz et al. 2009, p. 820 was adopted.

In this way, every sector of the economy that also uses these sectors to distribute their products has to determine the representative fraction of the sugar and alcohol agribusiness, as well as to calculate the marketing margin (MM) of agro-livestock business and the agro-industrial part of the sugar and alcohol sector. In other words, the marketing margins are proxies to the portion of the value of the sector of transport and trade and service sectors that should be associated to agribusiness in the study. The expression for this calculation is given by:

$$MM = VA_t - T_t\left[\left(VA_t - T_t\right)\left(\frac{x_{t1}}{X_t}\right)\right] + VA_s - T_s\left[\left(VA_s - T_s\right)\left(\frac{x_{s1}}{X_s}\right)\right]; \quad (9)$$

where VA_t represents the value added to the transport and trade sector; VA_s represents the value added to service sectors (both at market prices); T_t and T_s are the net indirect taxes on the production in the sector of transport and

trade and also service one, respectively; $(VA_t - T_t)\left(\frac{x_{ti}}{X_t}\right)$ corresponds to the deduction of the parcel to the added value at cost factors in the transport and trade sector already counted in the upstream; $(VA_s - T_s)\left(\frac{x_{si}}{X_s}\right)$ represents the deduction of the component of the added value to the cost factors of services already counted in the upstream.

However, before calculating the value of Aggregate IV, the domestic product (DP) to regions also has to be obtained in the analysis for which expression for which is given by $DP = GFDP - NIT - IRW$. Where DP is the domestic product; GFDP[9] represents the global and final demand for national and imported products; NIT corresponds to the net indirect taxes related to the final demand, and IRW represents the importations of the rest of the world and the country.[10] According to this, the expression for dimensioning Aggregate IV is given by:

$$GDP_{IV} = \left(\frac{\Phi_i + \sum_{n=1}^{3} \Xi_n}{DP}\right) MM; \quad (10)$$

where Φ_1 represents sugarcane final demand; $\sum_{n=1}^{3} \Xi_n$ corresponds to the sum of the final demand by sugarcane, alcohol and drinking; DP is the domestic production and MM is the marketing margin.

In this sense, the gross domestic product of the sugar and alcohol agribusiness, under the perspective of production, is given by the sum of the four aggregates above:

$GDP_{sugar \wedge alcohol} = GDP_I + GDP_{II} + GDP_{III} + GDP_{IV}$.

RESULTS

It is noted in Table 2 below that the GDP of the Brazilian sugar and alcohol sector, in 2004, represented 6.82% of the Brazilian GDP, while in the Northeast this value was 8.15% of the GDP in this region. In monetary terms, the amounts totalized R$ 113,6 billion and R$ 17,7 billion, respectively for Brazil and the Northeast. In this way, it is perceived that the participation of the sugar and alcohol agribusiness of the Northeast in the Brazilian GDP in this same sector was 15.57%. It is worth mentioning that for the year of 2004, the participation in the agribusiness GDP was 6.92%, using the traditional classification in primary, secondary and tertiary sectors. However, this work verified that only the sugar and alcohol sector was responsible for 6.82% of the national GDP, contributing to the perception that the traditional approach underestimates the participation in

[9] GFDP include net taxes consumed by investors, by exportations to the rest of the world and Brazil, by the inventory variation, and by the government and families (Cruz et al. 2009, p. 820).

[10] Note that when considering Brazil the term IRW corresponds to imports from the rest of the world, that is, purchases from other sectors are not accounted for in this variable. On the other hand, when the analysis refers to the Northeast region, the term IRW counts both imports originating in other countries as well as those originating in other Brazilian regions, Southeast, Midwest, North and South.

agribusiness. That is, considering the upstream and downstream segments in the composition of agricultural GDP, it can be seen that their share in the full GDP is higher than that obtained through the traditional classification.

In relation to the segments (upstream and downstream) being more representative in the quantification of the gross domestic product by aggregates resulted in the following results for Brazil and the Northeast, respectively: a) Aggregate I – 10.81% and 10.27%; b) Aggregate II – 29.98% and 32.28%; c) Aggregate III – 34.93% and 26.91%, and d) Aggregate IV – 24.27% and 30.54%. Starting the analysis of the aggregates according to the core criteria? of the sugar and alcohol agribusiness, it is observed that this had less representative magnitude to Brazil (29.89%), when compared to the value obtained in the Northeast region (32.28%)

Nevertheless, the importance of the sector "out of the gate" is evidenced in the composition of the gross domestic product of activities from the sugar and alcohol activity (as in Brazil as in the Northeast) as well as the traditional approach of classification that underestimates the GDP in these activates since it does not consider forward and backward linages. It is also observed that the amount from these activities ("out of the gate") in the sugar and alcohol GDP is expressive not only for Brazil, 70.02%, but also for the Northeast (67.72%), values considering both the upstream and downstream segments. For Brazil, the aggregate with major participation in GDP was the agro-industrial sector and, for the Northeast, the core activity represented the major participation. Aggregate I was the aggregate in which the level of participation in Brazil and the Northeast had minor representation, respectively, 10.82% and 10.27%

In the aggregated analysis of the downstream sector of agro-livestock activities (sum of Aggregate III and IV), the values found were 59.20% (Brazil) and 57.45% (Northeast). With these results, it is possible to state that the downstream sectors of the sugar and alcohol agro-industrial complex represent more than a half the GDP of both Brazil and the Northeast.

Table 2. Gross domestic product of the Agribusiness in 2004 (millions of Reais)

Aggregates	Northeast		Brazil	
	GDP	%	GDP	%
Aggregate I	1,816.18	10.27	12,279.82	10.81
Aggregate II	5,709.41	32.28	34,058.56	29.98
Aggregate III	4,759.55	26.91	39,677.98	34.93
Aggregate IV	5,402.02	30.54	27,573.18	24.27
Agribusiness GDP*	17,687.16	100.00	113,589.54	100.00
GDP (Full)**	216,956.91	-	1,666,258.00	-

* Source: Research results.

** Source: Brazilian Institute of Geography and Statistcs.

In this sense, these results evidenced that, out of the sectors which do not constitute the core activity, the most important are those which are "after the gate". It is important to mention that these results also correlate with the values found in Brazilian literature on the determiners of the agribusiness GDP.

For instance, Araújo Neto e Costa (2005) verified that the activities represented by the downstream segment of the agribusiness sector of Pernambuco represented approximately one third of the agribusiness GDP of the state (32.1%). Cruz et al. (2009) observed that the downstream sectors of the agribusiness of Minas Gerais represented 51.74% (when the interstate transactions and importations of the rest of the world are considered in the composition of Aggregate I) and 59.77% (when the interstate transactions and importation of the rest of the world is not taken into account when dimensioning Aggregate I).

In this work, the downstream sector that stood out from the others at Brazil level was Aggregate III, with participation equal to 34.93%, while for the Northeast they were the sectors of transport and trade, and service sectors – 30.54%. However, at Northeast level, the aggregate with the greatest representation was the core activity – 32.28%.

FINAL REMARKS

The results reported in this work show that the participation of the sugar and alcohol sector in the Northeast, in the composition of the GDP of this sector at national level, was 15.57%. For Brazil, the agro industries was the sector with the greatest representation in the quantification of the sugar and alcohol gross domestic product, while for the Northeast region, Aggregate II had the biggest fraction. Perhaps these results are related to a greater industrial concentration in the other Brazilian regions. Therefore, it would be interesting to analyze which industrial sectors are demanding inputs from the sugar and alcohol sector and verify the concentration of these in Brazil and the Northeast confirming or refuting this hypothesis.

In this sense, public politics directed to these sectors that focus on raising the income generated by these activities should be concentrated on these aggregates. Through the results obtained, it is possible to infer that the gross domestic product of agribusiness in those specific areas is significantly larger than those calculated through the traditional methodology of classification. That is because the agro-livestock GDP for Brazil and the Northeast totalized, respectively, 6.91% and 9.21%[11]. However, only the GPD of the sugar and alcohol sector totalized 6.82% (Brazil) and 8.15% (Northeast). In other words, the non-consideration of upstream and downstream segments in agro-livestock GDP underestimates the importance of this sector in the Brazilian economy which has contributed for successive surpluses in Brazil's trade balance in recent years.

[11] According to the Brazilian Institute of Geography and Statistics, the agro-livestock GDP of Brazil and the Northeast totaled, in 2004, R $ 115,194.00 million and R $ 19,993.45 million, respectively. That is, 6.91% = 115,194/1,666,258 and 9.21% = 19,993.45/216,956.91.

As mentioned in section 3, the functioning of an economy is characterized as a matter of general equilibrium. Thus, although the present methodology presents an advance in relation to the traditional approach that divides the composition of GDP into primary, secondary and tertiary sectors, an underestimation of the value of GDP still occurs. As a result, it is not considered that changes in the other sectors would impact on the sugar and alcohol industry itself. Therefore, it would be extremely important to determine which sectors are in demand in the sugar and alcohol industry. In addition, it is noteworthy that for the Northeast the sugar-alcohol sector has shown an important source of work and income generation in the countryside and, thus, contributing to a decrease in the rural exodus. On the other hand, for Brazil, the sector has stood out as a source of work and income generation for the population that is in the urban area, since the greater participation was for the agro-industries sector.

It is important to highlight that since the data used in this article refer to the year 2004 and therefore the reality of Brazil and its regions, as well as the sugar and alcohol sector, was another, it is suggested to update the data with more recent information in future work.

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