**GDP of the Sugar and Alcohol Sector in Brazil and Northeast: an input-output approach**

**ABSTRACT**

Under the traditional classification into primary, secondary and tertiary sectors, the value of Agriculture Gross Domestic Product – GDP – is underestimated since upstream and downstream relations 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 and 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%. The industry in the Northeast account for 15.57% of the national GDP of activity.

**Keywords:** agribusiness, Brazil, input-output, Northeast, sugar and alcohol.

**JEL: C67, E23, Q11.**

**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). Neste trabalho, buscou-se quantificar o PIB do setor sucroalcooleiro tanto para o Nordeste quanto para o Brasil, bem como a participação dessa região na composição do PIB desse setor no Brasil. Os resultados demonstram que essa participação foi de 15,57%.

**Palavras-chave:** Agronegócio, Brasil, Insumo-produto, Nordeste, açúcar e álcool.

**JEL: C67, E23, Q11.**

**Introduction**

 The importance of the agricultural sector in Brazilian economy goes over its participation in the GDP. In addition to having a decisive role under the Brazilian balance of achieving a long time successive surpluses and thus contributing to macroeconomic stability, we emphasize that this sector has forward linkage and backward linkage, in its production, having its relevance better evaluated considering those links or, classifying the Agribusiness. Representing the relevance of the sector considering such linkages, Neto and Costa (2005) show that Gross Domestic Product - GDP in Agribusiness (21.2%) of Pernambuco represented three times the value of this statistic when you consider only the agricultural sector (7.7%). Some recent papers as Guilhoto et al. (2007) and Cruz et al. (2009) enlarge the argument on the agricultural sector that should have its importance measured pending on how to relate to others economic activities of economy, such as industry foods.

 Within the Agribusiness, the sugar and alcohol sector, that includes planting and processing activities sugarcane, 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 the sugarcane cultivation totals 1,595,230 jobs in the Northeast. This number is equivalent to approximately 25.5% of all formal agricultural activities jobs in the region (6,245,613 jobs).

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

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 only the farming activity of sugarcane had the second best multiplier of jobs in Northeast, of 660 jobs order for each variation of one million *reais* in the final demand of the activity in which 94 % of the jobs are 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 prospects of structural changes in large-scale in the local economic that result in new work opportunities for those employed in this activity. In order to investigate other economic dimensions of this sector, this works aims at computing the measure of contribution to the GDP of Northeast and Brazil from sugarcane agribusiness.

In other words, the study attempts to dimension GDP of the sugar and alcohol sector in brazil and the Northeast region, making use of 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 section besides the introduction. The following section concerns the national literature review on the quantification of agribusiness. In the section 3, it is presented a brief summary related to the definition of the agribusiness term as well as a review on theories of analysis of input-output matrix. The next section presents the definition for each one of the aggregates and methodology in the sense of quantification. The fifth section presents and discusses the results achieved. The last section concerns the final remarks.

**2 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 that issue such as: Parré and Guilhoto (2001), Montoya and Finamore (2001), Furtuoso and Guilhoto (2003), Neto and Costa (2005), Montoya and Finamore (2005), Guilhoto et al. (2006), 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 the Brazil’s agribusiness complex. Still, there are some works that quantify agribusiness GDP both in Brazil and one specific estate, as well in one specific sector of the Brazilian agro-livestock.

It is noted on the Table 1 that the participation of the south region of Brazil in agribusiness in 1985 and 1995 maintained 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 of the income produced in the south was originated from activities attached to agroindustrial complex and agribusiness.

Montoya and Finamore (2001) have the main goal dimensioning and cauterizing the Brazilian agroindustrial complex from 1959 to 1995. The results, on the Table 1, demonstrate expansion in the agribusiness real value, however, its participation in the full GDP showed a tendency of falling provoked by 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 of 1994 and 2000 were carried out by Furtuoso and Guilhoto (2003). In this work, the authors quantify the agribusiness GDP separated into two big agroindustrial 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 agroindustrial 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 agroindustrial complex.

 The mensuration of agribusiness GDP of Pernambuco was taken by Neto and 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 of agribusiness GDP. According to the results, showed on Table 1, the authors demonstrate that the participation of agribusiness in GDP of the Pernambuco state was superior to that one pointed by official statistic data for the primary sector of the economy of Pernambuco.

 Finamore and Montoya (2005) attempted to conceptualize and quantify the agroindustrial complex of dairy farming in the state of Rio Grande do Sul. The methodology adopted indicators of sectorial performance as well 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 is a great national producer and their level of competitiveness makes them among one of those 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, representing an important source of employments to agribusiness and the state, as it is showed on Table 1.

 The participation of family agribusiness in GDP in the Brazil’s agroindustrial complex was one the goal of the work developed by Guilhoto et a. (2006). 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 agroindustrial complex associated to it, in recent years, had overcome the growth rate of the employer segment.

 Guilhoto et al. (2007) analyzed the evolution of Brazil’s GDP and Bahia during 1990-2005 trying to measure the segments and sub-complexes. It is perceived by the Table 1 that the participation of GDP in agribusiness on Brazil’s GDP and Bahia’s was approximately the same in the same period of analysis. On the other hand, participations 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 the Table 1 that the results of the study demonstrated that agribusiness in Minas Gerais state had a significant participation in the composition of Minas Gerais GDP, as well in the GDP in Brazilian agribusiness, showing that the sector with major participation im dimensioning GDP in Minas Gerais agribusiness was: processing, industrialization and distribution.

**Table 1:** *Brazilian literature summary*

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| Authors | Result |
| Parré and Guilhoto (2001) | It is indicated a raise in the participation of the Southern Brazil’s agribusiness from 29.7% in 1985 to 29.6% in 1995. 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, 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%  |
| Neto and Costa (2005) | On the contrary of official statistics that demonstrated a livestock GDP of 7.5%, the authors showed that the agro-livestock in Pernambuco had, effectively, participation of 21.2% in the GDP of this state in 1999. |
| Finamore and Montoya (2005) | The results pointed that the dairy farming GDP in the 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. (2006) | The authors highlighted that 33.3% in Brazil’s agribusiness, 1995 to 2003, was originated from family agro-livestock, pointing that the growth of this agroindustrial 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 Minas Gerais’s agribusiness 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%.  |

**3 Agribusiness and theories of input-output analysis**

Making use of input-output matrices techniques developed in 1930 by Leontief, Davis and Goldberg (1956) who 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 and, 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 Agroindustrial Complex (AIC). Under this new perspective, the analysis started to decompose agribusiness in 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 and Brazil gathers two 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 processes suffered by rural proprieties all over the world, considering that these properties were responsible not only for all activities evolving 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 their on methods of transporting the production.

 Thus, it may be stated that rural properties were practically self-sufficient and, therefore, they were denominated as 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) technological revolution in agriculture the post-war (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, it appears bonds linking the upstream operations, core (agro-livestock) and downstream and, thus, the food system starts to be denominated agribusiness.

In front of what was exposed above, this article has theoretical framework according to 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 base on the economic theory of general balance in order to carry out an analysis on the interrelations of the activities of the sugar and alcohol AIC, concentrating on the circular flow theory.

Considering that one of the main information on the input-output analysis is the data on the production of inter-sectors flows, Leontief developed the input-output matrix to study the relations that occur inside one country’s economy in function of the observable basic sectoral interdependencies, basing on the general interdependency classic theory that considers the full economy of one region, a country and whole world, as a simple system.

The analysis on 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 $\left(a\_{ij}\right)$. However, this matrix has been adapted to study inter-sectors 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]](#footnote-1), as a whole, occasioned by changes suffered on the final demand or any other component[[2]](#footnote-2) of it.

The operation of one economy can be summarized as being a problem of equating between 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 economy, those (sectors offers) also demand goods and services from others sectors, demonstrating in this way as the sectors relate to each other (directly or indirectly).

One of the most important assumptions on 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 equal to the reason $w\_{ij}=X\_{j}$. This is,

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| $$a\_{ij}=\frac{w\_{ij}}{X\_{i}}$$ | (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]](#footnote-3) of Leontief given by:

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| $$\sum\_{j=1}^{n}a\_{ij}X\_{i}+Γ\_{i}=X\_{i} i=1,…, n;$$ | (2) |

where $a\_{ij}$ represents the technical coefficient of productions that supplies the quantity of input of the sector $i$ that is used to produce one unit of final product in the sector $j$ $\left(a\_{ij}<1 ou \left(1-a\_{ij}\right)>1\right)$; $X\_{j}$ is the total domestic production of the sector $j$ and $Γ\_{i}$ is the final demand of products in the sector $i$.

 The equation (2) can be represented by matrix as it follows:

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| $$AX+Γ=X;$$ | (3) |

where $A$ represents the matrix of direct[[4]](#footnote-4) input coefficients of order $\left(n x n\right)$; $X$ characterizes as a vector of order $\left(n x 1\right)$ that represents the gross value of production and $Γ$, as well as $X$, is a column vector of order $\left(n x 1\right)$ that characterizes the full final demand.

 The equation (3) above can be repraesented as it follows

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| $$\left(I-A\right)X=D;$$ | (4) |

where each entry $a\_{ij}$ of the Leontief matrix, $\left(I-A\right)$, 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 $j$.

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

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| $$X=\left(I-A\right)^{-1}Γ;$$ | (5) |

where $\left(I-A\right)^{-1}$ is denominated as the matrix[[5]](#footnote-5) of direct and indirect technical coefficients.

 Through the *inverse matrix of Leontief*, $B=\left(I-A\right)^{-1}$, 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.

 This is to say that sectors have *forward linkages*, what defines the sector as an input supplier for the other sectors, and *backward linkages*, what classifies the sectors 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 Quantification methodology of the sugar and alcohol sector GDP**

 According to the methodology used by the Brazilian Institute of Geography and Statistics – IBGE – in accounting 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 counts all the correspondent values to the upstream sectors (“before the gate”), the agro-livestock properties (“inside the gate”) and to downstream sectors (“after the gate”).

 “GDP characterizes as a macroeconomic aggregate which 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 to 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: $GDP=C+G+GFCF+CS+\left(X-M\right)-T$

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;

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 Northeast sugar and alcohol sector, in this work, it is carried out under the production view. This approach requires less statistic information and has been used on the most on the literature of dimensioning agribusiness GDP[[6]](#footnote-6). In this work, the GDP composition is divided into four aggregates.

1. Aggregate I: (suppliers of goods and inputs to agro-livestock)
2. Aggregate II: (livestock production)
3. Aggregate III: (processing and industrialization of livestock goods)
4. Aggregate IV: (agro-livestock product distribution)

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

**4.1 Quantification of the Aggregate I**

 In the aggregate I it is found the sectors which are “before the gate”, 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 as 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 the Aggregate I by the intermediate consumption of the agro-livestock.

 The information required for this calculation are available from input-output tables. With this data, the first step is to calculate the Value Added Coefficient for activity, $VAC's$. These are obtained through the reason between the intermediate value of consumption in the sector $i$. Right after $VAC's$ estimation 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:

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| $$GDP\_{i}=\sum\_{i=1}^{n}\left(\frac{x\_{i}}{X\_{i}}\right)VA\_{i};$$ | (6) |

where $x\_{i1}$ represents one fraction of the value of the full production in sector $i$, and also it was 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 the sector $i$ – this value is on factor prices since the net indirect taxes were extracted that reflects on the production.

**4.2 Quantification of the Aggregate II**

The agribusiness Aggregate II is composed by the core activities of this sector, that is, the agricultural activity itself. However, in order to avoid the occurrence of double counting[[7]](#footnote-7) in the measurement of the Aggregate II and its added value, a procedure usually adopted on the literature from the analysis input-output is applied. Thus, it is subtracted from the added value at 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 at cost factors to the resulting upstream purchases that the sugar and alcohol sector carried out itself. It is highlighted that, if this procedure was not adopted, the GDP of Aggregate II would be underestimated and, thus, possibly, it would wrongly indicate this aggregate of sugar and alcohol sector as it had large production volume and, consequently, this sector would have the biggest representativity. This could induce *policy makers* to formulation and direction of politics to this sector. The equation for the Aggregate II is giver by:

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| $$GDP\_{II}=\left(VA\_{1}-T\_{1}\right)\left[\left(VA\_{1}-T\_{1}\right)\left(\frac{x\_{i1}}{X\_{i}}\right)\right];$$ | (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 alcohol sector and $\left(VA\_{1}-T\_{1}\right)\left(\frac{x\_{i1}}{x\_{i}}\right)$ represents the deduction of acquired portions by the sugar and alcohol sector in this sector, and accounted in the Aggregate I

**4.3 Quantification of the Aggregate III**

The agricultural sectors of processing and industrialization, that is, the aggregation sectors of value to primary goods, are those that compound the 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 occur 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.

For example, the textile industry that uses products originated from agriculture (cotton) also employs synthetic thread in its production. As Finamore and Montoya (2005) that, when dimensioning the dairy sector of Rio Grande do Sul, considered only agro industries directly related to those sector, this work also exclusively considers the agro-industry of the sugar and alcohol sector, this is to say that it considers the 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% in the income of this industry. At last, as in the estimation of the Aggregate II, for the calculation of the Aggregate III excludes the parcels already counted in the upstream. In that way, again, to avoid double counting. Therefore,

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| $$GDP\_{III}=\left(VA\_{j}-T\_{j}\right)\left[\left(VA\_{j}-T\_{j}\right)\left(\frac{x\_{j1}}{X\_{j}}\right)\right];$$ | (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 parcel already counted to the upstream.

**4.4 Quantification of the Aggregate IV**

The Aggregate IV characterizes 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 is composed by relative sectors of transport and trade, and service sectors. In this quantification was adopted the methodology used in Cruz et al. 2009, p. 820.

In that way, every sector of the economy that also uses those 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 $\left(MM\right)$ of agro-livestock business and agroindustrial 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 study. The expression for this calculation is given by:

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| $$MM=VA\_{t}-T\_{t}\left[\left(VA\_{t}-T\_{t}\right)\left(\frac{x\_{t1}}{X\_{t}}\right)\right]+VA\_{s}-T\_{s}\left[\left(VA\_{s}-T\_{s}\right)\left(\frac{x\_{s1}}{X\_{s}}\right)\right];$$ | (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; $\left(VA\_{t}-T\_{t}\right)\left(\frac{x\_{ti}}{X\_{t}}\right)$ 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, and $\left(VA\_{s}-T\_{s}\right)\left(\frac{x\_{si}}{X\_{s}}\right)$ represents the deduction of the parcel to the added value to the cost factors of services already counted in the upstream.

 However, before calculating the value of the Aggregate IV, it also has to obtain the domestic product $\left(DP\right)$ to regions in analysis which expression is given by $DP=GFDP-NIT-IRW$. Where PI is the domestic product; GFDP[[8]](#footnote-8) 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. According to this, the expression for dimensioning the Aggregate IV is given above:

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| $$GDP\_{IV}=\left(\frac{Φ\_{i}+\sum\_{n=1}^{3}Ξ\_{n}}{DP}\right)MM;$$ | (10) |

where $Φ\_{1}$ represents sugarcane final demand; $\sum\_{n=1}^{3}Ξ\_{n}$ 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:

$$GDP\_{sugar and alcohol}=GDP\_{I}+GDP\_{II}+GDP\_{III}+GDP\_{IV}$$

**5 Discussing the results**

 It is noted by the 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 Northeast. In this way, it is perceived that the participation of the sugar and alcohol agribusiness of 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 works verified that only the sugar and alcohol sector responded 6.82% of the national GDP, contributing to the perception that the traditional approach underestimate the participation in agribusiness.

 In relation to the segments (upstream and downstream) more representative in the quantification of the gross domestic product by aggregates resulted in the following results for Brazil and 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 acritical of the sugar and alcohol agribusiness, it is observed that this one had less representative magnitude to Brazil (29.89%), when compared to the value obtained in the Northeast region (32.28%)

 Nevertheless, it is evidenced the importance of the sector “out of the gate” in the composition of the gross domestic product of activities from the sugar and alcohol activity (as in Brazil as in 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 upstream from these activities (“out of the gate”) in the sugar and alcohol GDP is expressive not only for Brazil, 70.02%, but also for Northeast (67.72%). For Brazil, the aggregate with major participation in GDP was the agro industrial sector and, for Northeast, the core activity presented the major participation. The aggregate I was that one in which the participation in Brazil and Northeast level had minor representativity, respectively, 10.82% and 10.27%

In the aggregated analysis of the downstream sector of agro-livestock activities (sum of the 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 respond for more than a half of both Brazil and Northeast’s GDP.

|  |
| --- |
| **Table 2:** Gross domestic product of the Agribusiness in 2004 (millions of real) |
| **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\*\*** | 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 does not compound the core activity, the most important are those which are “after the gate”. It is important to mention that these results are also coherent to values found in the Brazilian literature on the determiners of the agribusiness GDP.

 For instance, Neto and 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 responded 51.74% (when considered the interstate transactions and importations of the rest of the world in the composition of the Aggregate I) and 59.77% (when it is not taken into account the interstate transactions and importation of the rest of the world on dimensioning the Aggregate I).

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

**6 Final remarks**

 The results reported in this work showed 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 were the sector with great representativity in the quantification of the sugar and alcohol gross domestic product, while for the Northeast region, the Aggregate II had the biggest fraction. In this sense, public politics directed to this sectors that focus on raising up the income generated by this activity should be concentrated on this 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 Northeast totalized, respectively, 6.91% and 9.21%. However, only the GPD of the sugar and alcohol sector totalized 6.82% (Brazil) and 9.15% (Northeast). In other words, the non-consideration of upstream and downstream segments in agro-livestock GDP underestimate the importance of this sector in the Brazilian economy which has contributed for successive surpluses in Brazil’s trade balance in recent years.

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1. On the full production, importation, taxes, income, added value and so on. [↑](#footnote-ref-1)
2. Consumption of families, government spending, investments, exportations. [↑](#footnote-ref-2)
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 what consequently impacts on the final production level. [↑](#footnote-ref-3)
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. [↑](#footnote-ref-4)
5. This matrix is denominated as global effects matrix or as inverse matrix of Leontief. [↑](#footnote-ref-5)
6. Another factor relates to the convenience of working under this perspective. [↑](#footnote-ref-6)
7. Since the value added of some inputs and capital goods used in the agricultural sector have been recorded in the aggregate I dimensioning. [↑](#footnote-ref-7)
8. 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). [↑](#footnote-ref-8)