Structure and Concentration of The Brazilian Sugarcane Market

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The aim of this study was to analyze the structure and concentration indexes of the sugarcane market in the South-Central region of Brazil. Based on the concept of relevant or antitrust market, used by leading competition defense agencies worldwide, we were able to reach the conclusion that the sugarcane buyers' market is much more restricted in comparison with the market defined in the empirical literature, thus underestimating the actual market concentration indexes. Our results indicate that the sugarcane markets are restricted to local markets and, in general, these markets are structured in two ways: monopsonies or oligopsonies. All the concentration indexes found were not only high, but also much higher than the results of other empirical studies. The results however do not indicate that such indexes are decreasing over time as unarguably as exposed in the literature.

JEL Codes: L12, Q16

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Key-words: Market structure, Market concentration, Antitrust market, Market Power, Sugarcane.

JEL: L11, L12, L13

1. Introduction

With the increase of the demand for ethanol fuel over the last decade and the continuing importance of sugar production in the Brazilian agribusiness, various business opportunities have arisen in the sugar-energy sector. In recent years, a wave of mergers and acquisitions (M&A) has been observed, consolidating the presence of large corporate conglomerates such asCosan, Carlos Lyra andJosé Pessoa, in addition to global companiessuch as Shell, Bunge and Louis Dreyfus Commodities(GARCIA *et al.*, 2015).

Put into context, between 2006 and 2009, 45 M&A operations took place in the sugar-energy sector (SIQUEIRA andCASTRO JUNIOR, 2010). In 2010, theEssodistribution operations in Brazil were purchased by Cosan which entered into a*joint venture* with Shell (Raizen) in the same year. In 2011, the São MartinhoGroup announced a partnership withPetrobrasBiocombustível(Beiral, 2011) and, in 2013, purchased the agricultural assets of São Carlosmill, that belonged toBiosev.

These operations have gained importancebecause they involve some of the largest companiesof sector and tend to modify the market structure.In a general manner, lead to higher market concentration indexes, generating conditions for the development of anti-

competitive behavior in supply chains,by allowing large players to exertmarket poweragainst suppliers, distributors and retailers (SEXTON, 2000).

In this context, concerns are raised regarding the restructuring and concentrationof the sugarcane market. This issue has been addressed by Vian *etal.*(2007) who found evidence that as a result of competition and production strategies there was an increase in the number of sugarcane mills, which consequently led to a reduction in the rates of concentration. Similarly, Siqueira and Castro Júnior (2010),also found evidence of lower concentration in sugarcane markets and the production of sugar and ethanol. However, there has actually been an increase in concentration in the hydrated ethanol distribution market.

The main problem of these studies however is that they botherroneously measure the true market concentration rates. Nor do they address the relevant market delimitation problem, and this consequently tends to produce results that normally underestimate the true concentration rates. Vian *etal.* (2007), for example, found that for the2001/02 and2003/04 harvest period, the averageCR4, CR8 and*HHI* rates were respectively11%, 19% and 0.01[1]. Siqueira and Castro Júnior (2010) calculated the same indexes for 2009, and the results found were 8%, 14% and 0.008, respectively.

In both cases, the authors did not consider the fact that several processing plants belong to the same business conglomerate and, when aggregating the market shares of each plant, the authors may have disregarded large business conglomerates when calculating their concentration rates[2]. In addition, the authors also disregarded the geographic limits of the relevant marketfor input purchase. In both cases, the rates were calculated considering the state ofSão Paulo as being a single market. As shall be seen,*a posteriori*animportant factor is the transportation distance limit that exists between the harvest site and processing plant, which considerably limits the extension of the relevant market.

In this context, the aim of the present study is to analyze the structure of the sugarcane processing market and calculate market concentration rates that reflect the actual sugar-energy sector. More specifically, we consider the determining factorsof relevant market (also known as the antitrust market), in accordance with the international antitrust agencies, and attempt to depictcorrectly the market structure in this important link ofsugarcanesupply chain.

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[1] The Hirschmann-Herfindahl Index (*HHI*) is an index ranging between 0 (equal market shares among participants) and 1 (maximum concentration). However, a more common range for this index is 0 to 10,000, respectively. This difference is due to how the market shares are handled in calculating the index: decimal terms in the former, percentage in the latter.

[2] In their study, Vian *et* al. (2007) considered the forming of business groups, and calculated concentration indexes for groups. The results were 27.9%; 40.4% and 0.0331 for CR(4), CR(8) and *HHI*, respectively. However, the authors consider the geographic dimension of the relevant market as being the state of São Paulo.

In overall terms, our analysis reaches the conclusion that the sugarcane processing market isnarrower than indicated by the studies cited above and therefore much more concentrated. In addition, our results also indicate that the sugarcane market expansion trends, even on the boundary expansion, apparently continue to be highly concentrated.

The paper is comprised of six sections, including this introduction. In the following section, we present a brief overview of the sugarcane market structure and organization. In the third section, we outline the techniques and procedures used, as well as the data source. The relevant market delineation problem is addressed in the fourth section, and in the fifth we present the results of the concentration index calculations. In the sixth and last section we present our concluding remarks.

2. Structure and organization of the sugarcane market

The sugarcane agrindustrial system, of all Brazilian agribusiness systems, is one of the country's oldest, and is of a great importance for the national economy. Brazil is one of the world's largest sugarcane producers. In 2013, according to UN Food and Agricultural Organization (FAO) data, Brazil produced approximately 768 million tons (approximately 40% of global production), with a planted area of over 10 million hectares and, according to the Sugarcane Industry Union (UNICA), nearly 76% of this production went toproduce sugar and ethanol.

Sugarcane is a permanent crop; i.e. the same plant is cut over a series of harvests, making long-term planning necessary. Also, since its processing involves several activities– from planting to harvest – a variety of contracts are establishedbetween the processing plants and its suppliers. Basically two overall models are observed: (i)own crops (vertical integration) grown on own or leased land, and(ii) by independent farmers, who may or may not be regulated by a formal supply contract[3].

Sugarcane is the base for the production various types of sugars,neutral alcohol, anhydrous ethanol, hydrous ethanol, in addition to other by-products, such as bagasse, vinasse and yeast. The sugarcane production chain is comprised of a series of actors: ranging from traditional 'before the gate' inputsuppliers,sugarcane farmers (suppliers), processing plants, and a large group of businesses involved in the distribution, consumption and processing of

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[3]Autor (2014) calculated the share of independetsuppliers to be 40% of total sugarcane processed from a sample of 110 plants in the state of São Paulo, for the 2011/12 harvest.

the production, as well as theby-products (fuel distributors, cosmetics and beverage industries, power utilities, animal feed industry, wholesalers, retailers, among others).

The production process of the two main products, sugar and ethanol, takes place separately within the same plant, and most have the capacity to produce both sugar and ethanol, generating the need to decide their respective final production shares[4]. In making this decision, the technical conditions of each mill are taken into consideration, as well as the price situation of each final product on the market (FARINA; ZYLBERSZTAJN, 1998).

In Brazil, the production of sugarcane is basically concentrated in two regions: the South-Central region, mostly comprised of the states of Paraná, São Paulo, Minas Gerais, Mato Grosso do Sul, Mato Grosso and Goiás; and the North-Northeastern region, comprised of the states of Sergipe, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte and Ceará. In the 2012/2013 harvest, 94% of the country's total production was concentrated in the South-Central regionand only 6% in the North-Northeastern region.

In the 2012/13 harvest, there were 387 industrial plants in operation in Brazil[5], 313 were located in the South-Central region.The plants in this region have an average processing capacity of 10 thousand tons of sugarcane per day, and the average volume harvested was around1.95 million tons. A high degree of heterogeneity was detected among the installed plants. In comparative terms, the 10 largest plants processed, on average, 28 thousand tons/day, with an approximate average volume of 5.5 million tons per harvest.

The67 largest business groups, located exclusively in the South-Central region, own183 plants and concentrate nearly 75% of the sugarcane processing market. From a domestic market perspective, this proportion drops slightly to 67.3%. The four and eight largest groups were also responsible for the processing of 22.8% and 31.7%, respectively, of the total sugarcane milled in the region(PROCANA, 2013).

As highlighted, the South-Central region is the main producing region in the country and, in recent years, has gained importance due to the presence of large business conglomerates, such asCosan, Carlos Lyra and José Pessoa. These large groups are mainly the result of a merger and acquisition process that took over the first decade of the millennium, along with the entry of large international groups such as Shell, Louys Dreyfus, Bunge, Cargill, among others (GARCIA *et al.*, 2015).

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[4] Data of the 2009 harvest indicate that nearly 70% of plants had a hybrid production capacity, i.e. with equipment to produce both sugar and ethanol. Approximately 25% produced only ethanol (generally called exclusive distilleries) and only 5% of plants produced only sugar (CONAB, 2010).
[5] According to the *Anuário da Cana*, during the 2012/13 harvest, 70 plants with full production capacity were nevertheless idle.

Between 2006 and 2009 only, 45 merger and acquisition operations took place in the sugar energy sector (SIQUEIRA; CASTRO JUNIOR, 2010) and the 67 largest business groups in the South-Central region increased the number of plants from 154 to 183 (18% increase) over just a six-year period (2006/07 to2012/13 harvests). The concentration rates for these 67 groups have changed little, rising from 73.2% for the 2006/07 harvest to 74.6% for the 2012/13 harvest. The period between 2010 and 2013, in comparison to the previous period, was characterized by the decrease in the number of mergers and acquisitions, associated with a stagnation in the volume of sugarcane processed, and a worsening in the financial situation of most large national groups. Simultaneously, an intense decrease was registered in the rate of opening of new plants(EPE, 2014), further evidence of the worsening of the financial situation of processing groups.

Although the numbers used here do not apparently indicate an increase in the market power of these groups, our assessment must also consider the specificities of each market and particularly the characteristics of each operation. In addition, as will be clearly seen, as the paper develops, the sugarcane market also possesses local specificities that significantly limit the geographic coverage of the relevant market, and thus may produce results that are completely different than those on the local level.

The entry of conglomerates such as Shell (Raízen), Louys Dreyfus (Biosev), Odebrecht, Bunge, British Petroleum and Cargill into the group of the 50 largest processors is unequivocal evidence of how the control of the processing and distribution assets is becoming globalized, with a specific focus on the control of the supply of ethanol. In 2010, the Esso distribution operations were bought by Cosan, one of the largest in the segment. In the same year, Cosan entered into a joint venture with Shell, further increasing its market share. In2011, the São Martinho Group, holder of one of the largest plants in the industry, announced a partnership withPetrobras Biocombustível, two of the sector's largest companies in the country (BEIRAL, 2011). In 2013, the Brazil's Council for Economic Defence[6] (CADE) approved the purchase of the agricultural assets of São Carlos mill, which belonged toBiosev, by the São Martinho Group (RESENDE, 2013).

In spite of all the restructuring activity described above, the sugar-energy business presently faces a high level of indebtedness by a large part of the businesses holding industrial assets, and a high number of plants are operating under judicial trusteeship, some even shutting down their activities in recent harvests.

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[6]Namely "Conselho Administrativo de Defesa Econômica". Brazil's national antitrust authority.

Brazilian sugarcane production has not been enough to promote the expansion of the supply of biomass at the rate called for the by the10-year Energy Expansion Plan (EPE, 2011),and the domestic supply of sugarcane ethanol in 2013 was 12% lower than the amount registered two years before. In the recent scenario of a lower participation of hydro-generated power and with the increase in oil imports, Brazilian society is asking itself what the role sugarcane biomass will play in coming decades. The answer to this question will define to a large extent the rate of investment in industrial capital and in input industries related to the sugar-energy sector and, consequently to changes in its market structure.

3. Procedures and data used

The first step taken in this study was to establish a definition for relevant market. The concept of relevant market is of utmost importance to analyse the potential anticompetition effects of operations that are capable of restrainingthe market and exerting market power by a firm. However, it is fundamental that studies of concentration and (potential) market powerbegin with a correct delimitation of the relevant market. The concept (and its application) is crucial because of what is being delimited is thelocuswhere the market poweris being effectively or potentially exercised (SEXTON, 2000; POSSAS, 2002).

In this regard,we adopt the concept of relevant market known as antitrust market, i.e., a group of products and a geographic area where a single supplier would be capable of exertingsignificant market power(CHURCH andWARE, 2000). According to Possas (2002), Brazilian jurisprudence adopts this definition of relevant market as set forth by the Merge Guidelines of the US Dept of Justice which states that"the relevant market is defined simply as the smallest possible market; i.e., lowest number of products in the smallest area, meeting the above criteria [Hypothetical Monopolist Test]"[7] (POSSAS, 2002, p. 4).

Once the relevant market has been defined, the second step is the calculation of the concentration index. Market concentration is the simplest form used to describe and analyse market structures. One of the most widely used to calculate market concentration is the concentration ratio (*CR*) that provides the market share of the*k* largest businesses of the market (generally the 4, 8 or 16 largest). Another widely used form is the calculation of the Herfindahl-Hirschman Index (*HHI*), which corresponds to the sum of the square of the market

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[7]Translation by the authors.

share all the firms present in the relevant market. By raising the market share of each firm to the square, a greater weight is attributed to the largest businesses.

The concentration rate (*CR*) and theHerfindahl-Hirschman Index (*HHI*) are calculated for the firms owning the sugarcane plants, defined in each relevant market, and are respectively defined by the following equations:

$$CR(k) = \sum_{i=1}^{k} S_i \qquad (1)$$

$$HHI = \sum_{i=1}^{n} S_i^2 \qquad (2)$$

whereS_i is the market share, measured in percentages terms of i-thsugarcane purchasing firm, and *k* represents the *k*-th largest firms.

In calculating*CR(k)*, we consider*k* = 4 and 8 in order to analyse what market percentages are held by the four and eight largest firms, respectively. The index may be easily interpreted, since it varies between 0 and 100. The closer to 100, the greater the concentration of the relevant market, i.e., a small number of firms is responsible for a large proportion of sugarcane processing. With regard to HHI, the index may vary between0(equal market shares among the market participants) and 10,000 (maximum concentration). To assessthe HHI results we adopted the same criteria used by the Federal Trade Commissionand CADEthat consider the following ranges: between 0 and 1000 as a market of controlled concentration; between 1,001 and 1,800 indicating a drop in competition and moderate concentration; and over 1,800 representing a scenario of low competition and high concentration.

For the calculation of the indexes, we observed data on processing plants installed in Brazil and the quantity of sugarcane milled per harvest, specifically regarding the production of sugar and/or ethanol for the 2008/09 to 2011/12 harvest period. UNICA data are used and the database extracted from the *Anuário da Cana* regarding market shares, quantity of sugarcane sold and bought. The period was defined according to the available data. The data were used to construct maps of the South-Central regionindicating the coordinates of the plants, as well as tables and graphs depicting the amount of processing of each plant, the rate of growth, and the level of market concentration of the relevant regions.

Our analysis shall focus exclusively on the South-Central region due to its importance for the sector and the representativeness of the available data. As highlighted previously, for the 2012/13 harvest, 94% of the total Brazilian production was concentrated in this region,

and of a total of 313 plants we were able to collect data to comprise a251-plant sample (approximately 80% of the region's total).

4. Delineation of the relevant market

The Hypothetical Monopolist Test (HMT) is, theoretically, the appropriate procedure to delineate the relevant market. This is supported by the fact that this test is used by the CADE, the US Department of Justice, and the European Competition Commission to (conceptually) define the relevant market[8]. The HMT is a systematic method used to determine the possibility of substitution among products. This allows the grouping of all the demand substitution possibilities in the smallest possible space. This test also aims to determine whether there is a sufficient level of arbitrage and/or substitution among different groups of products or geographic areas. If so determined, the products group or regions are within the same relevant market (HALDRUP, 2003).

Empirically, however, its application is quite limited. Problems of a theoretical and/or technical order place constraints on its use. Consequently, a wide variety of techniques and procedures, alternatives to the direct approach, have been described in the empirical literature to delineate the relevant market (CHURCH andWARE, 2000; HALDRUP, 2003; GEROSKI andGRIFFITH, 2004; FARINA et *al*., 2008).

In the case of the sugarcane market however certain problems related to the delineation issue are attenuated. For being a production chain that has vertical integration characteristics based on the link between rural producers and mills, we are able to more clearly define the members of both sides of this market: sugarcane producers providing a basic input, which is consumed virtually exclusively by the sugar and ethanol production plants (the buyers).

On the product level, for being a basic input used to produce sugar and ethanol, sugarcane has no substitutes. Even if sugar could be obtained from other sources (such as the sugar beet) and the ethanol from maize, production in Brazil is based predominantly on sugarcane. Brazilian plants are designed and built to process exclusively sugarcane, which limits the relevant market here analysed to a single product, in this case, sugarcane. Thus the problem consists, in this study, of delineating the relevant market only in geographical size.

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[8] For more details see CADE (2010),FTC (2010) and OJEU (2004).

According to Neves and Conejero (2009), there are nearly 70,000 sugarcane suppliers in Brazil, and this product has locational specificities that affect distribution and limit the distance the product may be transported to mills in acceptableconditions. The authors also point out that to avoid deterioration sugarcane must be processed within a maximum of 48 hours, after which biochemical changes take place (sucrose loss, for example) significantly reducing the industrial yield. The product thus cannot be stored, and must be transported immediatelyafter harvestingfrom the farm to the mill. In addition, given its low value in relation to transportation costs, a very low sale price/freight cost ratio is established.

Thus suppliers are hindered for being limited to the number of mills they are able to supply. There are factors that inhibit the entry of new suppliers in addition to the great degree of bilateral dependence, since producers sell their production only to the mills, which in turn depend on the input for production.The sugarcane market is thus characterized by a large number of suppliers who sell to a small number of mills in a given region, configuring a situation with few (oligopsony) or even a single (monopsony) mill in the proximities.

The evidence clearly indicates that very small physical distance between the mill and the sugarcane field is needed for the operation to be profitable without a loss in the quality of the sugarcane. However, it may not be stated that there is a certain distance constraint that would determine the economic infeasibility of transporting sugarcane to various mills. In practice, this distance is determined by parameters such as the relief of the region, quality of highways and back roads, and the type of vehicles used.

Waack and Neves (1998), for example, suggest that the cost to transport sugarcane to mills located outside a 50km radius would definitely not make processing feasible. CaixetaFilho and Martins (2001)and a report made by Strategic Studies Management Center[9] (CGEE, 2009) indicate, however, that this radius would actually be approximately 30km. Marquesini, Sanches and Souza (2006), based on a case study conducted on 17 harvesting units of the São Domingos mill inCatanduva (SP), has found an average radius of 42.7 km from the mill. The largest radius spanned 53.4 km, supporting the position that distances outside this radius would make logistics economically infeasible.

Therefore, based on the evidence found, we have stipulated the relevant market as having a radius of 40km between mill and sugarcane suppliers. We establish the assumption that mills demand sugarcane produced by the mills themselves or by independent producers

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[9] Social organization supervised by the Brazilian Ministry of Science, Technology and Innovation – MCTI.

located within the delineated area. Similarly, producers only supply sugarcane to buyers located within the same radius.

Based on this definition, it was possible to generate a map with the locations of the mills, in order to conduct an initial geographical assessment of the market structure. The map in Figure 1 shows all the mills located in the South-Central region. Each mill is identified by its geographical location (latitude and longitude), and a circle (40km radius)show its relevant market.
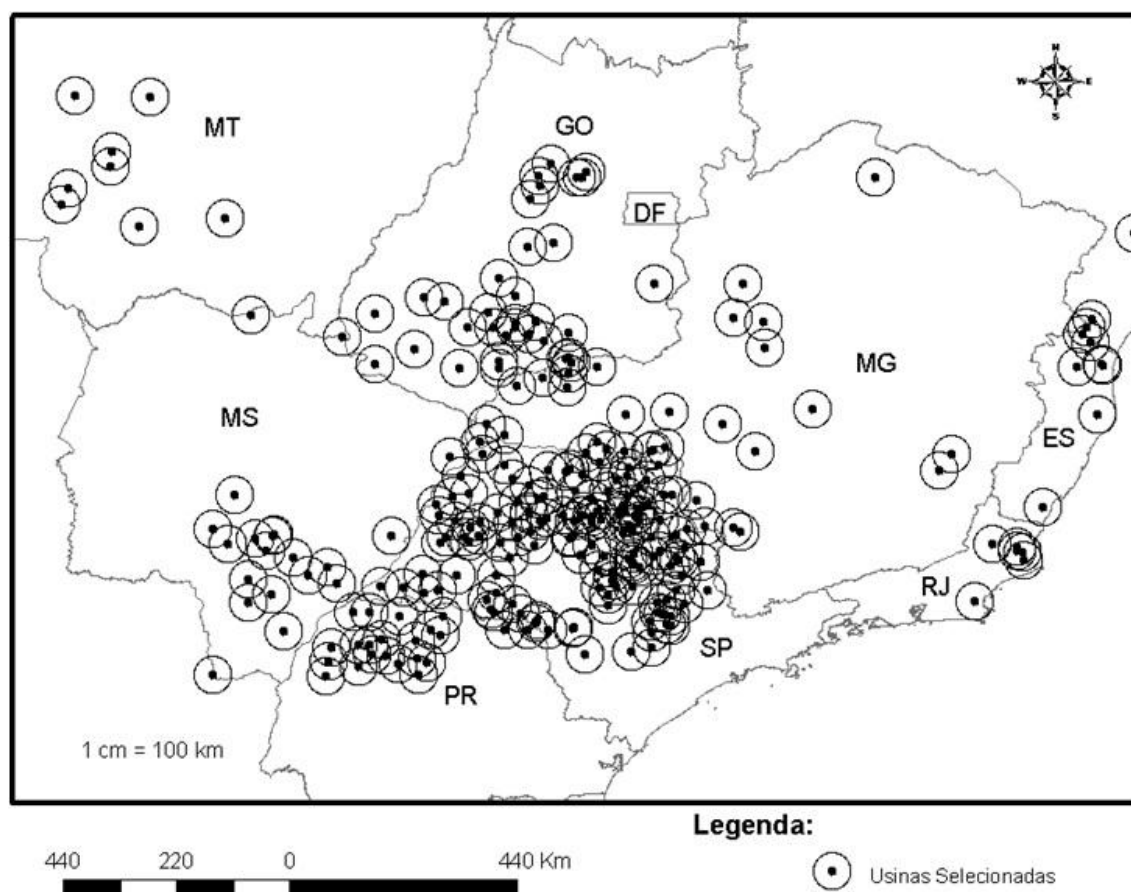
Source: Prepared by the authors: results of the study

Figure 1 – Location of the sugarcane mills in the South-Central region and their relevant markets.

A total of 251 plants were located in theSouth-Central region. Of these, 131 units were located in the state of São Paulo, 36 in Minas Gerais, 32 in the state of Goiás, 22 in Paraná, 19 in Mato Grosso do Sul, and11 in Mato Grosso. For the last harvest registered (2011/12), 395 million tons of sugarcane were processed in the region, representing 85% of the total volume milled in Brazil.

The first characteristic observable on the map is that in regions such as the southeast of Goiás, Midwest of Minas Gerais, and the state of Mato Grosso most plants are distributed in such a way that their relevant markets do not overlap. On the other hand, in regions such as the south of Goiás, Mato Grosso do Sul, Minas Gerais, north of Paraná and practically the entire state of São Paulo, there is a large number of mills located in close proximity to each other, with several instances of relevant market overlapping.

In the first case, this characteristic describes a monopsony structure for the mills in said markets for each being located within a single relevant market. To the sugarcane suppliers of that region it is very difficult to sell their production to more distant mills.On the other hand, forregions with a large number of mills (and consequently overlapping relevant markets) it is possible to assume that competition among mills looking for landowners is more intensebecause they would be able to sell their production to competing mills offering higher prices.

However, this conclusion becomes erroneous if we do not consider the forming of business groups resulting from M&A in the sugar-energy sector.In this regard, in the map in Figure 2 we identify the main business groups, allowing us to clearly observe the existence of a spatial concentration of the main groups in certain geographic areas. The main groups identified include the Raízengroup, that owns three plants near the municipality ofCatanduva, five plants in Andradina, four in Assis, three in Jaú, and five in Piracicaba(all in the state of São Paulo); the Biosevgroup with six plants inSertãozinho, and the Guarani group with six mills between the regions of Catanduva and Sertãozinho. In the state of Minas Gerais, in the region near Uberaba, there are four mills belonging to the Coruripe group, and three to theCaeté group and, inthe state ofParaná, the Santa Terezinha group stands out with eight plants, all within close proximity to each other in thePorecatu region.

In this context, it may be observed that these business groups tend to cluster spatially, clearly adopting a strategy aiming to secure market power in specific regions, ultimately leading to lower competition in these regions, contrary to the initial impression that a large number of plants located close to each other with overlapping relevant markets would be evidence of greater competitionfor input.
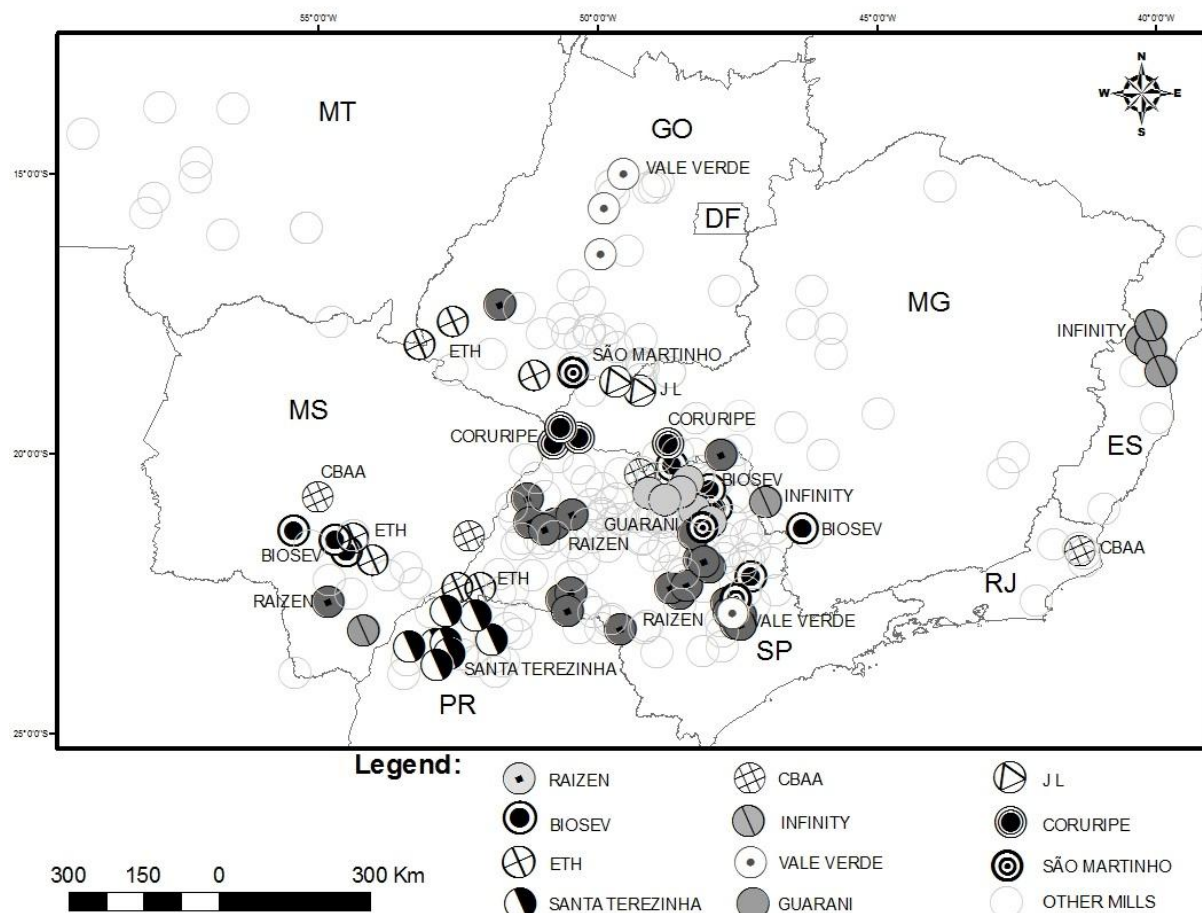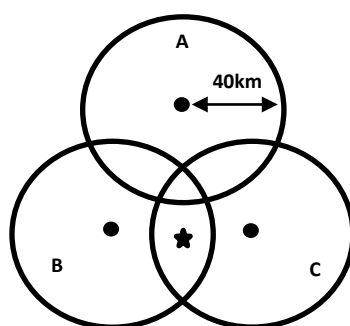
Source: Prepared by the authors: results of the study

Figure 2 − Location of sugarcane mills in the South-Central region, according to business group.

From the above, it may be concluded that basically there are two types of market structure for the sugarcane sector. The first is the existence of dispersed plants with no overlapping of relevant markets. In this case, we have a local monopsony situation, which practically eliminates the existence of competition. In the second, the predominant characteristic is the existence of a large number of plants located close to one another, with overlapping relevant markets, but many belonging to the same business group. This structure would characterize mostly local oligopsonies, dominated by large business conglomerates, spatially concentrated, which could increase their market power given their local importance.

In this context, the calculation of market concentration indexes may provide important information regarding the structure of these local markets and principally of the competition dynamics in these regions. However, since several plants may belong to the same business group, it becomes more difficult to delineate the geographic area covered by the relevant marketand, consequently, to calculate the respective concentration indexes.

In this situation, information on the volume of sugarcane provided by each producer would be needed in order to correctly delineate such markets. Let us considerthe situation depicted in Figure 3. Hypothetically, there would be three adjacent mills,A, B and C. The central point in each circle represents the geographical location of each mill, their circumferences being their relevant markets. According to this delineation, each market would have a radius of approximately 40km. The star located where the relevant markets of mills B and C intersect represents one sugarcane supplier. In this example, this sugarcane producer would be able to supply mills B and C for being located within both relevant markets, but would be outside the 40km radius of the relevant market of mill A.This distinction can only be made if data is available for individual suppliers and not for mills, as in our case.

Source: prepared by the authors

Figure 3 – Geographic delineation of the relevant market with overlapping areas

In view of the overlapping of markets and no available data from suppliers, we are forced to abandon the 40km radius around the mill for the relevant market and adopt another parameter to calculate the concentration indexes. As an alternative in this case we shall use a regional delimitation, as established by the PECEGE (2012)[10], that divides the South-Central regions into 14 sub-regions, according to specific characteristics of the sugar-energy sector. In this case, delineation would be considerably greater than the geographic distance from the mills of the relevant market, but would be significantly smaller than the delineation used by Vian *et al.* (2007), and Siqueira and Castro Júnior (2010).

The Table 1 summarizes the information of the 14 sub-regions, distributed among the six states in the South-Central region. In addition to the sub-regions, also summarized are information regarding sugarcane milling between the 2008/09 and 2011/12 harvests, and the number of plants in each sub-region for the last year of the sample. From 251 plants initially verified, Table 1 shows only 224. This difference is because 27 mills did not inform the

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[10] Large producing regions, delineated by the Continued Education Program in Economics and Business Management of the Luiz de Queiroz College of AgricultureoftheUniversityof São Paulo (ESALQ-USP).

sugarcane milled for the last harvest and therefore were not included in the study. Among the mills identified, 131 were located in São Paulo state, 36 in Minas Gerais, 32 in Goiás, 22 in Paraná, 19 in Mato Grosso do Sul, and 11 in Mato Grosso.

Of the sub-regions, to be highlighted are the plants located in the state of São Paulo which are among the largest producers in the South-Central region. Sertãozinho is the largest, producing 75 million tons, followed by Catanduva and Andradina with 59 and 35 million tons, respectively. However, the sub-region of Catanduva has the largest number of plants, with a total of 33. Next are Sertãozinho and Andradina, with 27 and 23, respectively. Also to be highlighted are the regions of Uberaba, in Minas Gerais, Quirinópolis inGoiás, and Maracaju inMato Grosso, which are also important producing regions, and where a high number of plants are located.

Table 1 – Sugarcane processing by sub-region, as defined by the PECEGE in theSouth-Central region.(in tons)

State	Sub-region	Volume processed				Number of Mills
		2008/09	2009/10	2010/11	2011/12	
São Paulo	Andradina	44,774,556	43,712,860	42,981,602	35,645,144	23
	Assis	16,492,253	12,368,478	14,328,301	12,429,811	6
	Catanduva	66,730,761	66,057,822	71,461,666	59,422,560	33
	Jaú	23,600,873	21,657,884	23,432,647	20,895,294	10
	Piracicaba	40,009,566	35,472,962	33,217,684	33,832,725	18
	Sertãozinho	84,796,399	82,659,054	87,403,078	75,209,259	27
Minas Gerais	Ituiutaba	5,823,217	6,602,422	5,209,992	7,441,064	9
	Uberaba	30,879,182	19,679,703	35,404,165	34,259,756	22
Goiás	Goiatuba	11,908,283	10,839,792	8,289,362	10,931,296	9
	Quirinópolis	17,808,174	26,054,548	31,965,810	31,794,999	21
Paraná	Jacarezinho	4,087,669	-	1,746,801	1,626,620	1
	Porecatu	30,793,067	25,984,476	12,212,329	26,332,562	18
Mato Grosso do Sul	Maracaju	18,015,598	13,983,610	29,911,057	31,580,752	18
Mato Grosso	Nova Olímpia	15,041,055	14,037,011	13,657,203	13,153,779	9
South-Central	**Total**	**410,760,653**	**379,110,622**	**411,221,697**	**394,555,621**	**224**

Source: prepared by the authors, based on study results.

5. Market concentration indexes

Based on the above, and on the available data on volumes processed by each mill for the 2008/09 to 2011/12 harvest period, market concentration indexes were calculated for each sub-region listed in Table 1.

Table2presents the market concentration index results for all the sub-regions of the state of São Paulo for the period under study. Also included in the table is a column with the number of mills in each sub-region for the last harvest considered in this study (2011/12). The regions with the most plants, and consequently the lowest concentration rates, areAndradina, Catanduva, Piracicaba andSertãozinho.

The concentration indexes*CR(4)* and*CR(8)* reveal that the sub-regions of Assis andJaú are highly concentrated. Not by coincidence, these two regions also have the least number of plants. In Assis where there are only four mills, both the*CR(4)*and the *CR(8)* reached 100%, and in Jaú, in the last harvest, the *CR(4)* and*CR(8)*were respectively 78.8% and 100%. In the other regions, the indexes were lower, but nevertheless of concern. Overall, we verified that*CR(4)* surpassed 50% for all sub-regions, and that *CR(8)* was normally over 80%.

Table2 – *CR(4)*, *CR(8)* concentration indexes and*HHI* of the sub-regions of São Paulo.

Sub-regions	Concentration indexes	2008/09	2009/10	2010/11	2011/12	Nº of plants
Andradina	CR4	55,36	60,05	61,27	61,39	
	CR8	75,63	78,37	82,77	82,13	23
	HH	1.030	1.730	2.026	1.881	
Assis	CR4	94,68	97,20	91,44	100,00	
	CR8	100,00	100,00	100,00	100,00	4
	HH	4.419	4.235	3.639	6.409	
Catanduva	CR4	45,55	49,32	44,81	49,55	
	CR8	72,36	77,92	65,77	71,93	33
	HH	824	1.086	815	864	
Jaú	CR4	79,81	85,30	77,82	78,82	
	CR8	99,10	100,00	98,32	100,00	10
	HH	2.656	3.035	2.460	2.572	
Piracicaba	CR4	59,59	63,53	58,62	57,13	
	CR8	78,40	87,29	81,08	79,48	18
	HH	1.367	1.612	1.543	1.487	
Sertãozinho	CR4	51,15	53,89	50,37	48,28	
	CR8	72,77	78,15	77,93	75,66	27
	HH	1.044	1.134	1.012	926	

Source: prepared by the authors, based on study results.

In a similar fashion, the *HHIs* also reveal significant market concentration rates in the selected sub-regions. With the exception of Catanduva, whose*HHI*was more modest for the period, the indexes of all other regions were normally above 1,800 points, indicating a high level of concentration. Included here are the regions of Assis, Jaú andAndradina.

Table 3 shows the concentration indexes for the sub-regions of the state of Minas Gerais. For the sub-region of Ituiutaba, the indexes were calculated as specified by the

methodology. However, it must be pointed out that in this region the plants are dispersedly distributed and, in most cases, with no overlapping of the relevant markets, as delineated previously, meaning that each plant would be a monopsonist in its relevant market. In spite of this, the*CR(4)* and*CR(8)*indexes were respectively 75.6% and 100%, and the*HHI* 1.686, indicating a high level of concentration.The sub-region of Uberaba, with more than twice the number of plants ofItuiutaba, also presented relatively high concentration indexes. The *HHI*was greater than the considerably high level of 1,800 points, indicating a highly concentrated market.

Table3 – CR(4), CR(8) concentration indexes and HHI of the sub-regions of Minas Gerais.

Sub-regions	Concentration indexes	2008/09	2009/10	2010/11	2011/12	Nº of plants
Ituiutaba	CR4	82,51	94,01	68,74	75,67	
	CR8	100,00	100,00	100,00	100,00	9
	HH	2.105	2.350	1.509	1.686	
Uberaba	CR4	73,33	81,91	68,56	60,16	
	CR8	90,60	95,72	86,96	80,61	22
	HH	1.879	2.595	1.674	1.265	

Source: prepared by the authors, based on study results.

The state of Goiás also comprises two sub-regions, as may be seen in Table 4. The sub-region of Goiatuba has a small number of participants. There are 11 plants but which belong to only six groups. This explains the high rates of concentration found. The*CR(4)* and*CR(8)* were respectively 85% and 100%. The*HHI*, which reached 2,294points indicates a very high degree of concentration. We verified that there are two dominant groups, Vale Verde and Jalles Machado which, during the 2010/11 harvest, held respective market shares of 45.26% and 31.70%, the rest being distributed among the smaller groups.

Table4 – CR(4), CR(8) concentration indexes and HHI of the sub-regions of Goiás.

Sub-regions	Concentration indexes	2008/09	2009/10	2010/11	2011/12	Nº of plants
Goiatuba	CR4	99,57	97,93	100,00	85,08	
	CR8	100,00	100,00	100,00	100,00	9
	HH	2.483	2.728	3.319	2.294	
Quirinópolis	CR4	60,96	55,12	50,00	50,02	
	CR8	84,64	77,54	76,48	77,27	21
	HH	1.344	1.096	925	871	

Source: prepared by the authors, based on study results.

InQuirinópolis there is a larger number of plants, and thus the region has higher indexes thanGoiatuba. The*CR(4)* and*CR(8)* indexes were respectively 50% and 77%, and

the*HHI* reached 871, indicating a controlled market concentration rate.If we observe the groups individually, it may be verified that Vale Verde, the largest in the sub-region, had an average market share of only22.09% over the last four harvests.

Table 5 below presents the concentration indexes for the state of Paraná. In the sub-region of Jacarezinho there were two plants operating in 2008/09. In the following harvest there was data available for only one plant, which may be explained by the fact that one of the groups present in the region had left the region. This characterizes this market as a monopsony, as may be seen in the table.

Table5 – CR(4), CR(8) concentration indexes and HHI of the sub-regions of Paraná.

Sub-regions	Concentration indexes	2008/09	2009/10	2010/11	2011/12	Nº of plants
Jacarezinho	CR4	100,00	0,00	100,00	100,00	
	CR8	100,00	0,00	100,00	100,00	1
	HH	5.633	0	10.000	10.000	
Porecatu	CR4	76,29	81,38	66,24	80,86	
	CR8	89,32	94,45	100,00	96,46	18
	HH	2.992	3.314	1.542	3.331	

Source: prepared by the authors, based on study results.

In the sub-region of Porecatu, the indexes are quite high, particularly if we consider the number of plants. There is the strong presence of the Santa Terezinha group, whose market share has always been greater than 50% for all the harvests. This also explains the high*HHI*found, indicating the extremely high market concentration in this sub-region.

In the state of Mato Grosso do Sulthere is only the sub-region ofMaracaju, and the respective data appears in Table 6. The indexes show a moderate level of concentration, with*HHI* reaching 1,147 and the*CR(4)* and*CR(8)* being respectively 51% and 81%. The only group deserving mention in this sub-region is the Biosev group, whose market share reached a maximum of 32% of overall production (2008/09 harvest).

Table6 – CR(4), CR(8) concentration indexes and HHI of the sub-regions of Mato Grosso do Sul.

Sub-regions	Concentration indexes	2008/09	2009/10	2010/11	2011/12	Nº of plants
Maracaju	CR4	64,49	55,54	48,47	51,83	
	CR8	92,35	91,91	79,32	81,84	18
	HH	1.615	1.154	1.415	1.147	

Source: prepared by the authors, based on study results.

Similarly, the sub-region of Nova Olímpia is the only one in the state of Mato Grosso, and the respective concentration indexes are summarized in Table 7. With regard to the

location of the plants, this sub-region possesses geographical characteristics similar to those of theItuiutaba sub-region. The plants are distributed in a more disperse fashion, with no overlapping of relevant markets, characterizing the presence of monopolized local markets (in this case, monopsoniestowards the suppliers). Nevertheless, when the concentration indexes were calculated a high level of concentration was detected, with the *CR(4)*and*CR(8)*being respectively 74% and 100%, and a*HHI*of 1.856.

Table 7– CR(4), CR(8) and*HH*concentration indexes in the sub-regions of Mato Grosso.

Sub-regions	Concentration indexes	2008/09	2009/10	2010/11	2011/12	Nº of plants
Nova Olímpia	CR4	80,74	81,10	79,13	74,65	9
	CR8	99,72	100,00	98,83	100,00	
	HH	2.323	2.358	2.140	1.856	

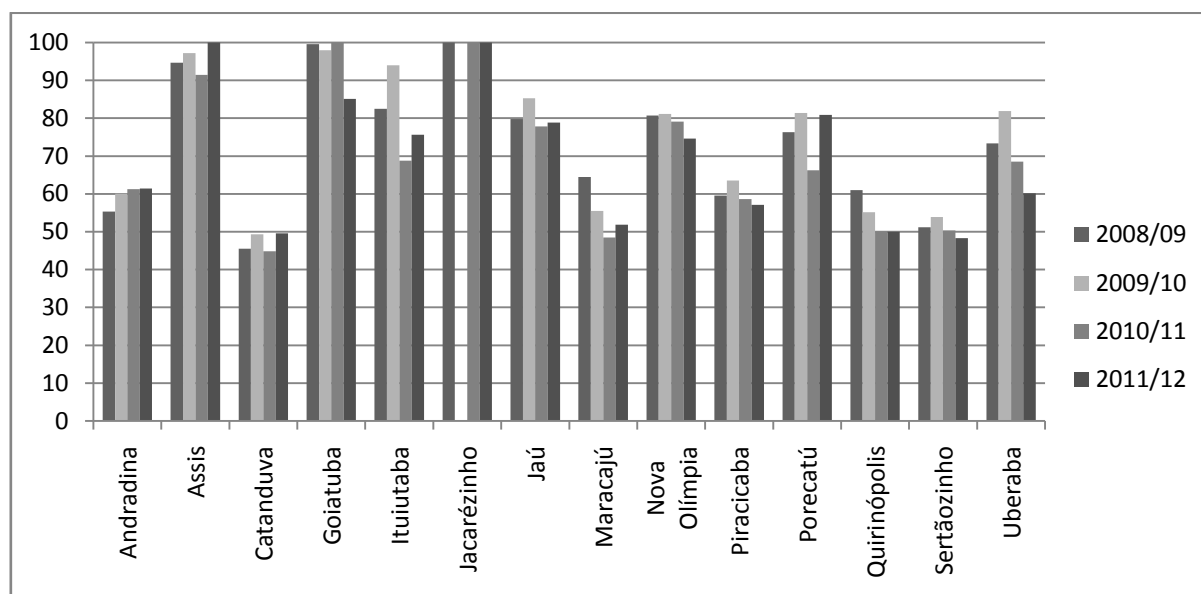Source: prepared by authors, based on study results.

After analyzing all the sub-regions of all the states in the South-Central region, it was possible to determine that they did not follow a common pattern with regard to market concentration.Each sub-region had different index values, which associates them to markets with different characteristics. In certain sub-regions, it was possible to identify characteristics of competitive structures, but in othersmonopsonies, oligopsonies, or oligopsonies with fringes predominated, where concentration is much higher, and competition potentially lower.

Of the 14 sub-regionsanalysed, 12 comprise groups that have a high level of market power. In nine, namely Assis, Jaú, Maracaju, Nova Olímpia, Piracicaba, Porecatu, Quirinópolis e Sertãozinho, there is only one dominant group holding the largest market share. This share, in certain cases, is expressive, and may grant market powerto the group holding the share. In 3 of the sub-regions there was the dominance of two or more groups indicating a better distribution, although not being equal.

The bar graphs in Figures 4, 5 and 6 present another general and also historical perspective of the concentration indexes. The graph in Figure 4 shows the evolution of the*CR(4)* index over the four harvest periods for all the sub-regions. To be noted is that, except for Catanduva, all the other sub-regions surpassed the 50% mark. In other words, the values indicate that a 50% market share was held by only four companies in each sub-region, clearly indicating a high degree of concentration. This type of market structure indicates that the dynamics of the sugarcane industrywith regard to sugarcane purchasingare not very competitive.

The sub-region of Catanduva, the only one where the indexes did not surpass the 50% threshold, is precisely where there are the most competing groups, reaching a total of 20. This characterizes, in comparison with the previous case, a situation where none of the groups has a strong presence in the market of the sub-region, and indicates that there may be a higher degree of competition in the region.

Also verified was a decreasing trend in the concentration indexes calculated over the period analysed, particularly in the sub-regions ofGoiatuba, Ituiutaba, Jaú, Maracaju, Nova Olímpia, Quirinópolis, Sertãozinho and Uberaba.

Source: Prepared by the authors, based on study results.
Figure4 – Evolution of the*CR(4)*concentration index in all sub-regions analysed, between the 2008/09 and 2011/12 harvests.

The graph inFigure5summarizes the results calculated for the*CR(8)*. The first characteristic that may be noted is that, overall, the eight largest groups dominate practically 100% of production, in all markets analysed. This was the case of the sub-regions of Assis, Goiatuba, Ituiutaba, Jacarezinho, Jaú and Nova Olímpia. In other regions, although the indexes do not reach 100%, they nevertheless are quite close to this mark. Another characteristic is that as opposed to the *CR(4)*, the*CR(8)*index did not have the same declining trend, i.e., it does not apparently indicate a reduction in the concentration levels. This may be explained by factors such as the entry of new participants in the sector and mainly, the restructuring of the market caused by M&A strategies adopted by smaller groups aiming to increase their market share.
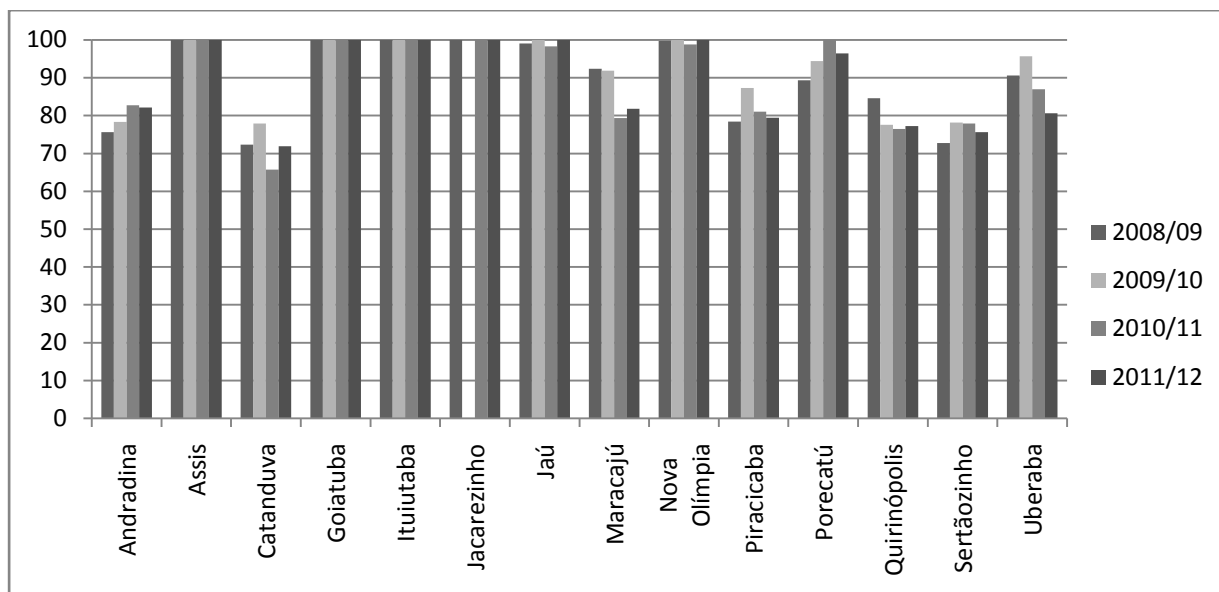
Figure5 – Evolution of the *CR(8)*concentration index for all sub-regions analysed between the 2008/09 and 2011/12 harvests.

In Figure6, we have summarized the*HHI* results. Overall, it may be seen that they follows a trend similar to the*CR(4)*, indicating that during the period there was a drop in concentration rates. However, also to be noted is that the14 sub-regions analysed all surpassed 1,000 points for at least one of the registered harvests, thus indicating moderate concentration. Of the 14 sub-regions, nine presented values above 1,800 points which, according to recommendations made by the CADE and other similar international institutions, a high level of concentration and a low level of competition.

To be highlighted is the variation verified in Uberaba where a significant change in the concentration levels took place during the studied harvest period, going from highly concentrated to a low level of concentration. This is evidence of the constant changes taking place in the sugarcane sector, principally in the sugarcane purchasing market, which may be explained by the entry of new plants, the leaving of others, and by M&A.

Also to be noted are the slight variations in the indexes of the sub-regions of São Paulo, which have a higher number of groups participating in the market, such as Catanduva, Piracicaba and Sertãozinho. No significant changes nor high values were found, thus indicating moderate levels of concentration. This characteristic may explained by the fact that these markets are already consolidated in a region with greater and more traditional production, indicating a higher degree of competition.
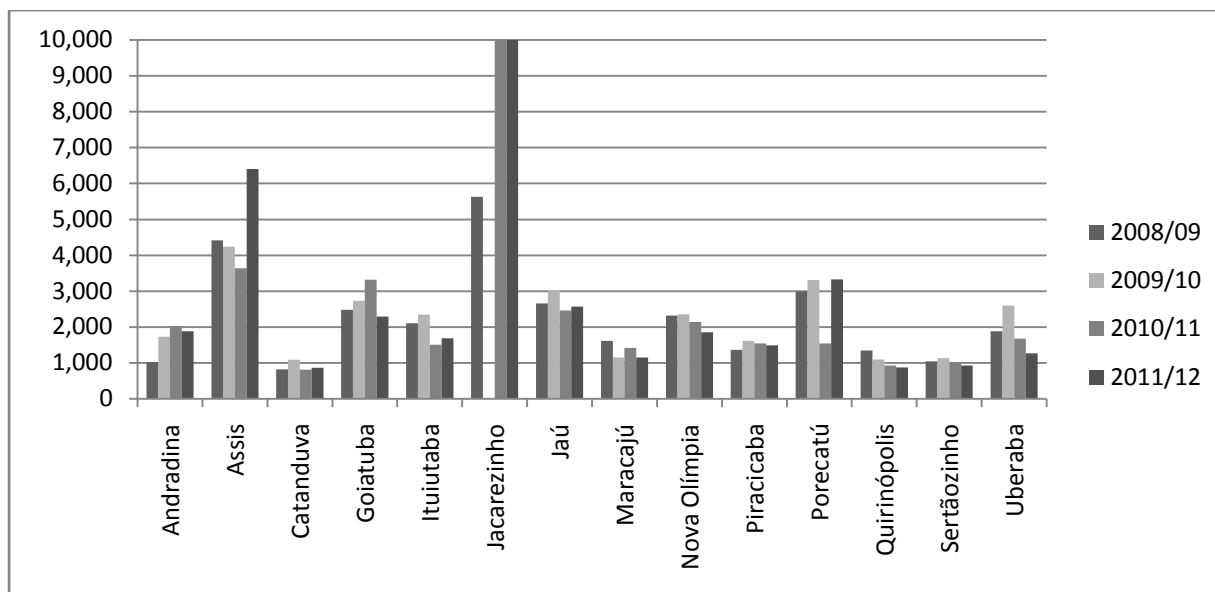
Source: Prepared by the authors, based on study results.
Figure6 – Evolution of the *HHI* in all sub-regions analysed between the 2008/09 and 2011/12 harvests.

5. Concluding remarks

The aim of this study was to analyse the market structure regarding an important link in the ethanol and sugar production chain: the sugarcane buyers' market. The analysis and definition of the relevant market was an important step in this study, and consequently it was possible to determine that certain characteristics, unique to sugarcane production, such as perishability, high transportation costs, quality control, and productivity significantly limited the geographic area of the relevant market.

Thus, once the relevant market was delineated, it was possible to construct a map with the geographical distribution of the plants in theSouth-Central region of Brazil, which indicated that, basically, two market structures prevail in the sugarcane sector. The first is the presence of plants that are disperse in geographical terms and, according to the delineation used, comprise monopsony markets, i.e., markets where there is only one potential sugarcane buyer. These plants were concentrated mainly in the regions of the southwest of Goiás, Midwest of Minas Gerais, and in the state of Mato Grosso.

Secondly, also identified was a market structure where several plants were concentrated in certain geographic regions where their relevant markets tend to overlap those of others. These plants are located principally in regions such as the south of Goiás, Mato Grosso do Sul, Minas Gerais, north of Paraná, and practically the entire state of São Paulo.

Although this suggests a high level of competition, this hypothesis was discarded due to the presence of large business groups, who distribute their plants in a strategic and concentrated manner, in certain geographic regions. Thus the concentration indexes calculated in this study reveal that, overall, the sugarcane buyers' markets are highly concentrated, and it is common to find the presence of one, or a maximum of four groups dominating a significant share of these markets.

Consequently, we verified the predominance of market structures characterized by monopsonies, oligopsonies or, at the most, oligopsonies with fringes. The presence of groups comprised of several plants in a specific sub-region gives these groups important market powerwhich could ultimately be prejudicial to the competition dynamic of the respective regions.The establishing and/or creation of business groups, comprised of plants in close proximity to each other, may be a strategy adopted by the groups to precisely secure a level of dominance of the market they are operating in.

It is thus concluded that information presented in this study provides evidence of the potential exertion of market powerby the millsover sugarcane producers. However, more research needs to be conducted to be able to reach a definite conclusion regarding the sector's competitive behavior. More detailed assessments of prices, contracts, sales and other aspects are fundamental to further the understanding of this subject. Further research is expected to better clarify the characteristics of the sector, allowing a better understanding of the actual competition context.

REFERENCES

BEIRAL, P. R. S. **O mercado brasileiro de etanol: concentração e poder de mercado sob a ótica da Nova Organização Industrial Empírica**. 2011. 111 p. M.Sc. Dissertation. Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo, Piracicaba, 2011.

CADE – Conselho Administrativo de Defesa Econômica. Delimitação de Mercado Relevante - Versão Pública. **Documento de Trabalho No. 001/10.** Brasília: CADE, 2010. Availableat:<http://www.cade.gov.br/upload/Delimitacao_de_mercado_relevante.pdf>.Accessed on:Nov. 03rd2015.

CAIXETA-FILHO, J. V.; MARTINS, R. S. **Gestão logística do transporte de cargas**. São Paulo: Atlas, 2001.

CGEE – Centro de Gestão e Estudos Estratégicos. **Bioetanol combustível: uma oportunidade para o Brasil**. Brasília, DF: Centro de Gestão e Estudos Estratégicos, 2009

CHURCH, J.; WARE, R. **Industrial Organization: A strategic Approach**. San Francisco: McGraw-Hill, 2000. 926p.

CONAB - Companhia Nacional de Abastecimento. **Perfil do Setor do Açúcar e do Álcool no Brasil, Edição para a safra 2008-2009**. Brasília, May 2010. 77 p.

EPE – Empresa de Pesquisa Energética. **Plano Decenal de Expansão de Energia 2020**. Ministério de Minas e Energia. Empresa de Pesquisa Energética. Brasília: MME/EPE, 2011 (EPE, 2011).

_____. **Análise de Conjuntura dos Biocombustíveis – Ano 2013.** Ministério de Minas e Energia. Empresa de Pesquisa Energética. Brasília: MME/EPE, 2014. 63 p. EPE-DPG-SDB-Bios-NT-01-2014 Report, Jun. 04 jun. 2014. (EPE, 2014).

FARINA, E. M. M. Q.; NUNES, R.; FARINA, T. M. Comportamento dos preços e identificação do mercado relevante: o caso CVRD. In: MATTOS, C. (Org.). **A resolução Antitruste no Brasil II**. São Paulo: Singular, 2008. p. 95-118.

FARINA, E. M. M. Q.; ZYLBERSZTAJN, D. **Competitividade no Agribusiness Brasileiro**, São Paulo, v. 5, 1998.

FTC – Federal Trade Commission.**Horizontal Merger Guidelines.**U.S. Department of Justice and the Federal Trade Commission.Washington, DC, 2010. Available at:<http://www.justice.gov/atr/horizontal-merger-guidelines-08192010>. Accessedon: Feb. 05th 2016.

GARCIA, J.R.; LIMA, D.A.L.L.; VIEIRA, A.C.P. A nova configuração da estrutura produtiva do setor sucroenergético brasileiro: panorama e perspectivas. **Revista de Economia Contemporânea.** v. 19(1): p. 162-184, 2015.

GEROSKI, P.; GRIFFITH, R. Identifying anti-trust markets.**The Institute for Fiscal Studies Working Paper**.N. WP03/01. Jan. de 2003.Available at:<http://eprints.ucl.ac.uk/2944/1/2944.pdf>. Accessed on: Feb. 05th 2016.

HALDRUP, N. Empirical analysis of price data in the delineation of the relevant geographical market in competition analysis.**Economics Working Papers**. Set. de 2003. Available at:<ftp://ftp.econ.au.dk/afn/wp/03/wp03_09.pdf>. Accessedon: Feb. 05th 2016.

MARQUESINI, A. G.; SANCHES, R. B.; SOUZA, J. W. M. Modelo matemático para otimizar a roteirização mensal das frentes de colheita de cana-de-açúcar em usinas sucroalcooleiras. In: Anais... XII SIMPEP – Bauru/SP, Nov. 2006.

NEVES, M. F.; CONEJERO, M. A. **Estratégias para a Cana-de-Açúcar no Brasil**. v. 1. São Paulo: Atlas, 2009. 312p.

OJEU – Official Journal of the European Union.On the control of concentrations between undertakings (the EC Merger Regulation).**Council Regulation (EC) No 139/2004** . 2004. Availableat:<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004R0139&from=EN>. Accessedon: Feb.5th 2016.

PECEGE - Programa de educação continuada em economia e gestão de empresas. **Custos de produção de cana-de-açúcar, açúcar e etanol no Brasil: Fechamento da safra 2011/2012**. Technical Report. Piracicaba: Esalq/USP, 2012. 50 p.

POSSAS, M. L. Os conceitos de mercados relevante e poder de mercado no âmbito da defesa da concorrência. In: ____(Org.). **Ensaios sobre economia e direitos da concorrência**. 1 ed. São Paulo: Singular, 2002, p. 75-95.

PROCANA – ProCanaBrasil.**Anuário da Cana**. São Paulo: ProCanaBrasil, 2013. 422p.

RESENDE, T. Cade aprovacompra de ativos da Louis Dreyfus pela São Martinho. **Valor Econômico**, São Paulo, SP. 2013. Availableat:<http://www.valor.com.br/empresas/2978116/cade-aprova-compra-de-ativos-da-louis-dreyfus-pela-sao-martinho> Accessedon: Feb. 05th 2016.

SEXTON, R. Industrialization and Consolidation in the U.S. Food Sector: Implications for Competition and Welfare. **American Journal of Agricultural Economics**. v. 82(5), p. 1087-1104, 2000.

SIQUEIRA, P.H.L; CASTRO JUNIOR, L.G. Fusões e aquisições das unidades produtivas e da agroindústria de cana-de-açúcar no Brasil e nas distribuidoras de álcool hidratado etílico. **Revista de Economia e Sociologia Rural.** v. 48, n.4, p. 709-735, out/dez. 2010.

VIAN, C.E. de F.; LIMA, R.A.deS.; FERREIRA FILHO, J.B.S. Estudo de impacto econômico (eis) para o complexo agroindustrial canavieiro paulista: desafios e agenda de pesquisa. **Revista de Economia Agrícola**. v. 54, n. 2, p. 5-26, Jul./Dec. 2007.

WAACK, R. S.; NEVES, M. F. Competitividade do Sistema Agroindustrial da Cana-de-açúcar. In: FARINA, E. M. M. Q.; ZYLBERSZTAJN, D. (Org.) Competitividade no Agribusiness Brasileiro, vol. V. Pensa/FIA/FEA/USP: São Paulo, Jul. 1998.