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Is biodiesel a more social fuel than ethanol? A comparative analysis from public policies in Brazil

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As a promising source of renewable energy, biodiesel has received incentives through public policies in various countries. While some countries have adopted policies based on economic incentives for production and consumption, political discourse in Brazil has placed emphasis on the social role that biodiesel can play. The main goal of this paper is to carry out an analysis of public policies in Brazil to identify whether there is indeed a social bias associated with biodiesel or both ethanol and biodiesel, which has had its macro-environment configured from the same footprint. The methodology uses text mining techniques to extract information from policy and program documents of the Brazilian government involving these liquid biofuels. After collection and preparation, a total of 624 official documents published between 1997 and 2006 comprised the textual basis of the research. The results indicate some similarities when the configurations of the macro-environment for ethanol and biodiesel have been compared. However, it is clear that biodiesel is more strongly identified with the social dimension. In conclusion, this study suggests that public policy in Brazil has, in fact, characterized biodiesel as a social fuel.

Key words: Biodiesel, ethanol, macro-environmental analysis, public policy, government, biofuels, text mining.

INTRODUCTION

The increase in supply and demand for liquid biofuels as an alternative and renewable energy is a relatively recent phenomenon. The macro-environment in which the industries of ethanol and biodiesel are located has been undergoing intense transformation for more than a decade.

According to the theoretical approaches, there can be many drivers and reasons for changes in the macro-environment of a particular industry or sector of economic activity. However, no other factor has had a greater influence in guiding the future directions and strategies in this new moment of the liquid biofuels industry than the

public policies of governments in the larger producers (Tyner and Taheripour, 2007; Tyner, 2008).

In Brazil, the situation is much the same. That is, the Brazilian government's policies directly influence the strategies and decisions of economic agents involved in the production and consumption of ethanol and biodiesel. As a result of various governmental interventions, the liquid biofuels sector in Brazil has evolved considerably. Public policies to encourage ethanol production that began in 1970 with the launch of National Alcohol Program (Proálcool), along with public and financial institutional support for the maintenance of production were reflected both in the formation of a solid economic sector and technological advances in the auto industry (Biodiesel-BR, 2010). After periods of reflection, ethanol, commonly known as alcohol, has gained new strength with the world trend of seeking renewable energy sources

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in response to ongoing climate change (Intergovernmental Panel on Climate Change, 1990). With this new approach, public policies supporting ethanol production have consolidated, and ethanol production has grown considerably, as can be proven by the statistics of the Union of Sugar Cane Industry (Unica, 2010).

With global discussions about the inclusion of new sources of renewable energy, biodiesel has emerged as a potential alternative for some countries. In Europe, for instance, climate and soil conditions make biodiesel the main alternative among liquid biofuels. Public policies in European countries, such as Germany, for instance, supported the rise of the biodiesel industry, from the setting of targets to include renewable energy sources, according to the targets set by the Renewable Energy Act (Germany, 2000); compulsory warranty to its growing use, blended with fossil fuels (EC, 2006); and tax incentives and subsidies that facilitate the reduction of the price of biodiesel to consumers (Frondel and Peters, 2007).

In Brazil, the inclusion of biodiesel in the agenda of public policy makers is a relatively recent event. Policy Directives on Agroenergy, established by the Brazilian government in 2005, predicted the "implementation of the biodiesel production chain," demonstrating that this sector was incipient and lacked structure and better organization among the different productive agents (Brazil, 2005). This and other guidelines were observed and included in the National Plan of Agroenergy, which defines the actions for the four main sources of bioenergy: ethanol, biodiesel, biogas, and forests (Oliveira and Ramalho, 2006). Although the National Plan of Agroenergy defines objectives related to economic, social and environmental matters for all bioenergy chains, public policies for the biodiesel chain seem to have a social bias that is more prominent than for others. This can be illustrated by the creation of the National Program for Production and Use of Biodiesel and by the launch of the social fuel seal to be provided for industries that meet certain social requirements (PNPB, 2005). As for the ethanol production chain, the focus seems to have been more of an economic and technological one, once it is "recognized as the world's most efficient, which is driven by dynamic entrepreneurial class, accustomed to innovate and take risks" (Oliveira and Ramalho, 2006).

In a context in which public policies play a central role in the formation and consolidation of economic sectors, thereby influencing the decision making by economic agents from their analysis of the macro-environment in which economic activities are inserted, several questions must be asked: How has the Brazilian government shaped the macro-environment for liquid biofuels in their public policies? In what way is the macro-environment configuration from public policy different for ethanol and biodiesel? Is it, in fact, correct to say that biodiesel is a social fuel? The main goals of this paper are to scan the

macro-environment for liquid biofuels based on the Brazilian government's public policies, to analyze the macro-environment configuration for ethanol and biodiesel from content analysis of texts related to public policy, and to compare the macro-environment configuration for ethanol and biodiesel, deepening the analysis of the social dimension.

The remainder of the paper is organized as follows: Review of Brazilian public policies for the two main liquid biofuels, discussing the public policies for ethanol first, and then the public policies for biodiesel; methodological procedures; discussion of findings related to the macro-environment configuration for biodiesel and ethanol and makes a comparison between biodiesel and ethanol regarding the co-occurrence of social issues; concluding remarks is presented.

PUBLIC POLICIES FOR LIQUID BIOFUELS IN BRAZIL

Public policies for alcohol (ethanol)

Alcohol (a fuel product extracted from sugarcane) has emerged in Brazil basically for two reasons: to mitigate the crisis of the sugar industry and to reduce the internal dependence on imported oil. However, despite these reasons of recent origin, the product is one of long standing in Brazil. It seems that, as far back as the 1930s, the government was intervening in the market because the state was responsible, among other things, for the production and marketing of a range of products related to sugar and alcohol (Moraes, 2007).

As a result of the crisis of 1929, there was a reduction in sugar exports and in 1933 the Institute of Sugar and Alcohol (IAA) was created with the purpose of centralizing the operations of sugar exports inside the country.

The year 1973 saw the first major oil crisis and, in light of this, in 1975, a state intervention was made by the National Program of Alcohol (Proalcool, Decree No. 76593/75), the objective of which was to reduce dependence on imported oil. After the launch of Proalcool, five major phases in the sector can be observed (Paulillo et al., 2007; Leite and Cortez, 2008; Moraes, 2008; Vieira et al., 2008):

1975 to 1979: The oil crisis and the reduction of sugar prices influenced the emergence of Proalcool. The goal was to encourage the production of anhydrous ethanol for use as a fuel blended with gasoline. At the time, the state intervened heavily in the sector.

1980 to 1985: The peak period of Proalcool, characterized by the structure of tax and financial public incentives. In the years 1981 to 1985, the government was concerned with technological development in the sugarcane industry;

1986 to 1995: In the second half of the 1980s, the Brazilian economy went through a thorough process of deregulation that has been reinforced since the 1990s, when the IAA was removed. Since then, the sugar and ethanol market has been deregulated continually, the process being completed with the release price of cane sugar, hydrated alcohol, and crystal sugar (Paulillo et al., 2008). Responsibility for policies for the sector were handled by the Ministry of Agriculture, Livestock and Supply, which incorporated a specific department for sugar and alcohol, called the Secretary of Production and Marketing (Oliveira and Ramalho, 2006). In 1989, there was a scarcity of hydrated alcohol due to the substantial reduction in the share of public investment in the Brazilian ethanol industry, creating an imbalance between supply and demand for ethanol fuel, which affected the confidence of the final consumer. In 1993, through Federal Law No. 8.723/93, the government determined the blend of anhydrous ethanol in gasoline at a proportion ranging from 20 to 25% (Unica, 2007).

1996 to 2000: In 1996, due to the worldwide concern with greenhouse gas emissions and an increase in the greenhouse effect, 55 countries signed the Kyoto Protocol, ratifying it in 1999. In the same year, according to Moraes (2007, 2008), there was the effective liberalization of the sugar and ethanol market when the state moved away from the sector. In 2000, the Inter-ministerial Council for Sugar and Ethanol (CIMA) was established through Decree No. 3546 of July 17, 2000. In that same year, the federal government also encouraged agricultural production through the National Bank of Economic and Social Development (BNDES, in Portuguese (Faveret Filho et al., 2000).

2001 onward: The Kyoto Protocol became effective since 2004 and outlined the policy for countries on the environment through control goals for CO₂ emissions from 2008 (Paulillo et al., 2007). Because of this and other aspects of macroeconomic policy, alcohol was again the target of public policies. Law No. 9478 of August 6, 1997, and Constitutional Amendment No. 33 of December 11, 2001, later supplemented by Law No. 10336 of December 19, 2001, and Law No. 10453 of May 13, 2002, were the pillars of the sector's regulatory framework. These laws drove the deployment of the free-market environment (end of state monopoly in the oil industry) and the definition of the fuel tax model (Oliveira and Ramalho, 2006). However, the government still intervened in the market through two mechanisms: By setting the levels of anhydrous alcohol blended with gasoline and reducing the tax burden on ethanol-fueled cars, exempting from IPI those below a thousand cubic centimeters. The Incentive Program for Alternative Sources of Electric Energy (PROINFA: Decree 5.025/2004) is another important mechanism that aims to diversify sources of energy by increasing the participation

of renewable sources of energy (Oliveira and Ramalho, 2006).

Public policies for biodiesel

In 1975, PROÓLEO (production program of vegetable oils for energetic purposes) began encouraging the production of biodiesel in Brazil, generating surpluses of vegetable oil with production costs that were competitive when compared to those of petroleum. However, at that time, due to counter-shock oil, investments were not sufficient for sustaining biodiesel production, since there was no government incentive to create a biodiesel program in Brazil. Only in 2004, nearly 30 years after PROÓLEO, did tax incentives for biodiesel production and use emerge again, through the National Program for Production and Use of Biodiesel (PNPB, in Portuguese), the regulatory cornerstone of the introduction of biodiesel in the Brazilian energy matrix (Siniscalchi, 2010).

Biodiesel can be blended in various proportions with petroleum diesel or can be used neat. As an example, a mixture of 2% biodiesel to petroleum diesel is referred to as B2, a mixture of 3% is B3, and so on, continuously, until you reach pure biodiesel, B100. The biodiesel market is a recent phenomenon and is certified by the publication of Law No. 11097 of January 13, 2005, with a perspective of eight years. This law established that, from January 2008, there would be a mandatory minimum percentage of biodiesel with diesel in Brazilian territory and that it would start using the B2 mixture. Soon, all diesel oil fuel sold in Brazil would have 2% biodiesel. It was also decided that the minimum would rise to 3% in 2009, with a further rise to 5% for the beginning of 2013. It is worth noticing that this law considers that with the increase in productive capacity and the availability of raw materials, the timing could be anticipated by a resolution of the National Council of Energy Policy (CNPE).

In accordance with CNPE Resolution No. 3 of September 23, 2005, it was expected that production of the B2 mixture would begin in January 2006, although the obligation to do so was restricted to the volume of biodiesel produced by holders of the social fuel seal (SFS), which was created to generate jobs and income and encourage social inclusion (Brazil, 2005). In July 2008, the mandatory use of B3 came into effect. The second half of 2009 saw the mandatory use of B4 introduced, and in January 2010, the use of B5 became mandatory.

In other words, there was an anticipation of scheduling the blend of biodiesel to diesel, according to Law No 11.097/2005, showing that productive agents had responded satisfactorily to public policies aimed at the introduction of biodiesel in the Brazilian energy matrix.

The PNPB aims to implement the production and use of biodiesel in a sustainable way, both technically and economically, with a special focus on social inclusion and

regional development by generating employment and income (Biodiesel, 2010; Biodiesel-BR, 2010). In this context, the federal government created the SFS, which is a set of specific goals and procedures seeking to encourage the social inclusion of small farmers and creating opportunity for farmers' families to provide the raw materials for biodiesel production. The SFS was created by Decree No. 5297 of December 06, 2004, to identify biodiesel producers who promote social inclusion, generating jobs and income for farmers participating in the National Program to Strengthen Small Farmers Agriculture (PRONAF, in Portuguese). Moreover, the organizations (biorefineries) involved in projects with SFS have a better access to financing conditions from the BNDES credit lines and other financial institutions; rights to participate in auctions to sell biodiesel to the National Petroleum Agency (ANP, in Portuguese); and, some tributary benefits. For their part, biorefineries guarantee the purchase of raw materials, paying a pre-set price, and provide market security to small farmers (Biodiesel, 2010). To this end, public policies for biodiesel have considered that, it is a product in phase of consolidation in Brazil due to the country's economic attractiveness and large-scale oilseed production with a low cost, higher productivity, and superior yield of oil/soybeans (Biodiesel, 2010). Anyway, in the current scenario, it can be seen that both ethanol and biodiesel have become part of the agenda of public policy makers, especially in light of challenges set by the Kyoto Protocol and the growing demand for renewable fuels. In the case of ethanol, we could verify that the product has a long history in Brazil, compared to biodiesel. Until the 1990s, the government played a central role in the sugar and ethanol market. Today, Brazilian public policies seek only to stimulate the competitiveness of ethanol by influencing the actions of economic agents in a highly liberalized market. For biodiesel, unlike ethanol, the government is concerned about the need to encourage producers, especially small ones, to produce oilseeds. In this sense, much of public policy deals with tax exemptions, reducing taxes, lending facilities, and funding to increase job positions, income generation, and social inclusion. For this, we should emphasize that Brazil is the world's second-largest producer of ethanol, possessing advanced production technology and an extensive knowhow in producing ethanol from sugarcane. Biodiesel, on the other hand, requires stimuli to allow its production on a large scale. Moreover, there is a core concern of the government with social issues, and a large number of public policies that favor the social inclusion of small farmers in the biodiesel chain can be found.

METHODOLOGICAL PROCEDURES

After following its particular course, the final contents of public policies are published in documents in the form of laws, decrees, instructions, regulations, and official documents of government programs aimed at specific areas, among others. Public policies on

bioenergy follow the same path. Therefore, to analyze the content of public policy on liquid biofuels (ethanol and biodiesel) for the Brazilian government it is necessary to do a documental analysis taking into account the textual content of a set of official documents.

Reinforcing the importance of analyzing textual content of documents, Karanikas and Theodoulidis (2002) and Hale (2005) stated that 80% of information is present in different types of written documents. Transforming the high volume of information presented in thousands of documents into a manageable form of knowledge requires the use of modern tools of information technology. In this context, the concept of knowledge discovery in texts (KDT) and the technique of text mining (Halliman, 2001) were used for the analysis of textual documents of public policies focused on liquid biofuels in Brazil. The procedures adopted for text mining followed a hybrid structure, based on studies by Liddy (2000), Karanikas and Theodoulidis (2002) and Hippner and Rentzmann (2006).

The search and collection of textual documents of public policy were made from a list of keywords that represent the research topic "liquid biofuels," according to the frequency with which they occurred in the literature addressing issues related to bioenergy, bioeconomy (bio-based economy), and biofuels. The selected keywords were biofuel, biofuels, bio-fuel, bio-fuels, ethanol, bioethanol, alcohol, biodiesel, and bio-diesel. Any documents in which the keyword "alcohol" appeared and was related to alcoholic beverages and/or to alcoholism were discarded. From the set of keywords, textual documents were searched in different government agencies using as a starting point the Brazilian government's official portal on the world wide web (<http://www.brazil.gov.br>).

In the next step, the websites from all federal ministries, departments and agencies were accessed, and by using search engines available on their own websites, a search was made for documents containing the keywords earlier listed. The information available in the "press room" of the various federal entities accessed was not collected.

The search, selection, and collection of textual documents of public policy and the construction of the primary text-base began in February 2007 and were completed in June 2007. In addition, given the proposed analysis of this longitudinal study, which sought to examine a ten-year period, we collected electronic text documents covering annually the period from 1997 to 2006. At the end of this step, 673 textual documents of official public policy of the Brazilian federal government relating to liquid biofuels had been collected.

Once the documents were collected, their contents were transferred to an electronic text-base built using the software QDA Miner®, preparing documents for further implementation of the mining process (text mining). Because the QDA Miner® software uses * rich text format (RTF) as the file extension for the construction of text-bases, 49 documents were lost because of blocked access to their contents. Consequently, the final composition of the text-base consisted of 624 government documents. In fact, liquid biofuels have become part of the public policy agenda in Brazil, especially in recent times.

Since there is no a single methodology specifically for the extraction of knowledge from textual content, it was necessary to build an analytical framework capable of extracting the desired information. The use of a list of keywords is often suggested and used, as can be seen in Vincent (2006), Crawley (2007) and Singh et al. (2007). The first step towards building our specific analytical framework was related to the definition of micro-environmental dimensions to be used in our analysis. According to the management literature on macro-environment analysis, the dimensions most frequently used are those relating to the acronym "PESTEL," namely, political, economic, socio-cultural, technological, environmental and legal (Walsh, 2005; Johnson et al., 2008). The number of dimensions and their identities vary from one study to another, depending on the specific interest of each case, the environment studied, and/or the activity, allowing for

some flexibility. For this study, we used nine dimensions: Agronomic, environmental, cultural, economic, geopolitical, legal, political, social, and technological.

The challenge of macro-environmental dimensions was to define how to capture the presence of these dimensions in the textual content of public policy documents. We decided to use a set of discriminating terms for each dimension, but then faced with the problem of how to reach them. The next step was to identify the keywords representing each dimension, each of which will be treated here as a "dimension-word" or just "d-word." The "d-words" are those relevant terms that best discriminate a certain macro-environmental dimension.

Thus, nine different lists of "d-words" were defined. The set of "d-words" for each dimension was defined using the TF*IDF index of relevance of the words in the content of scientific papers published in journals in the areas of knowledge closed related to the macro-environmental dimensions (Jing et al., 2002; Aizawa, 2003). To identify the "d-words" that better discriminate the economic dimension, for instance, a number of scientific journals in the field with high impact factor were selected: Quarterly Journal of Economics (IF = 3,938), Review of Economic Studies (IF = 2,000), Oxford Economic Papers (IF = 1,132), Journal of Economic Theory (IF = 1,046), and Cambridge Journal of Economics (IF = 0,571). Each journal issue was randomly selected for the following years: 1998, 2000, 2002, 2004, and 2006. These years cover the same period proposed for the study (1997 to 2006). The same criteria and procedures were adopted for the other dimensions.

The amount of "d-words" assigned to each dimension was defined by using percentile measures, selecting the amount of terms that best discriminated each dimension. On average, we used 14 "d-words" for each dimension. Because some "d-words" were common to two or more dimensions, some rules were associated to them in each specific dimension. The rules took into account the co-occurrence of terms in the same document. The Jaccard coefficient was used to define the rules (Chung and Lee, 2001). The "d-words" were originally obtained in the English language, but because textual documents found on public policy could be in both English and Portuguese, the final list was composed by "d-words" in both languages. To enable comparative analysis of the macro-environment configuration for ethanol and biodiesel, two categories were included in the analytical framework beyond the nine macro-environmental dimensions previously described. The category "Biodiesel," defined by the terms "biodiesel" and "bio-diesel," and, "Ethanol," defined by the terms "bio-ethanol," "ethanol," and "alcohol."

The text mining was performed using the text-basis of written textual documents in electronic format and the analytical structure for knowledge extraction built from the macro-environmental dimensions and their respective "d-words." Using the WordStat module from SIMStat® software, it was possible to count the frequency with which each "d-word" occurred in the aggregate set of documents and over the ten years searched and studied.

The frequency revealed under which macro-environmental dimension the Brazilian government had framed the liquid biofuels over time.

The low observed frequency of the social dimension in the first set of results ran contrary to the empirical evidence of public policies, especially those related to biodiesel. For this reason, a new dimension, called "social 2" was developed. To this new "social 2" dimension we assigned "d-words" extracted from several specific documents: Policy Guidelines for Agroenergy, the National Plan of Agroenergy, and the National Program for Production and Use of Biodiesel. We tried to identify "d-words" that would appeal or be related to social issues. The list of "d-words" for the "social 2" dimension can be viewed in Figures 7 and 8.

For the analysis of the results, the absolute and relative frequencies of occurrence of each of the frameworks under macro-environmental dimensions were used. From the frequencies,

dendrograms were constructed by grouping the dimensions using the Jaccard coefficient to analyze the cluster formation of the dimensions most frequently used in set the macro-environment setting. The Jaccard coefficient was also used to evaluate the co-occurrence of the macro-environmental dimensions with both ethanol and biodiesel in the documents as a whole and in parts of them (paragraphs). The Jaccard coefficient measures the degree of association between two terms, "x" and "y," (Provalis Research, 2005). The homogeneity test was used to evaluate the existence of similarities between the macro-environmental configuration for ethanol and biodiesel. The null hypothesis of homogeneity test assumes that two populations have the same proportion of a particular characteristic (Triola, 2005).

The results were presented in the form of a heat map and figures. It is worth noting that, for some outcomes, data were analyzed in increasing levels of closeness: The first set of results for the macro-environmental configuration for liquid biofuels in general; the second for the co-occurrence of both ethanol and biodiesel with macro-environmental dimensions, using the "documents" as the unit of analysis (more extended comprehensive analysis); the third advancing to the "paragraphs" as the unit of analysis, where the co-occurrence between liquid biofuels and macro-environmental dimensions is more expressive.

RESULTS AND DISCUSSION

The macro-environment for liquid biofuels in Brazilian public policy

Applying the methodological procedures previously described was possible to identify under which dimensions the Brazilian government has configured the macro-environment for liquid biofuels. This first set of results was obtained in the aggregate that is, for both types of liquid biofuels (ethanol and biodiesel) over the ten years analyzed. Illustrated in Figure 1 are the dimensions, sorted in descending frequency and the intensity with which they were found in public policies on liquid biofuels.

According to the results, we find that the order of intensity with which the macro-environmental dimensions have occurred in public policies related to liquid biofuels in Brazil are as follows: Technological, geopolitical, economic, environmental, agronomic, political, legal, cultural, and social. The technological aspects related to liquid biofuels seem to have dominated the public policy agenda over the ten years analyzed, sharing that dominant position with the geopolitical, environmental and agronomic dimensions in some years.

An interesting result that deserves to be pointed out is the increasing intensity with which the geopolitical dimension has been used in public policy since 2000. The highlighting of this dimension may be related to the country's growing importance in the international production and use of liquid biofuels as an alternative source of renewable energy. The international pressure on the social, economic and environmental issues involved with the supply chains of liquid biofuels (slave labor, child labor, and carbon credits, for instance) may be another reason. On the other hand, the low intensity

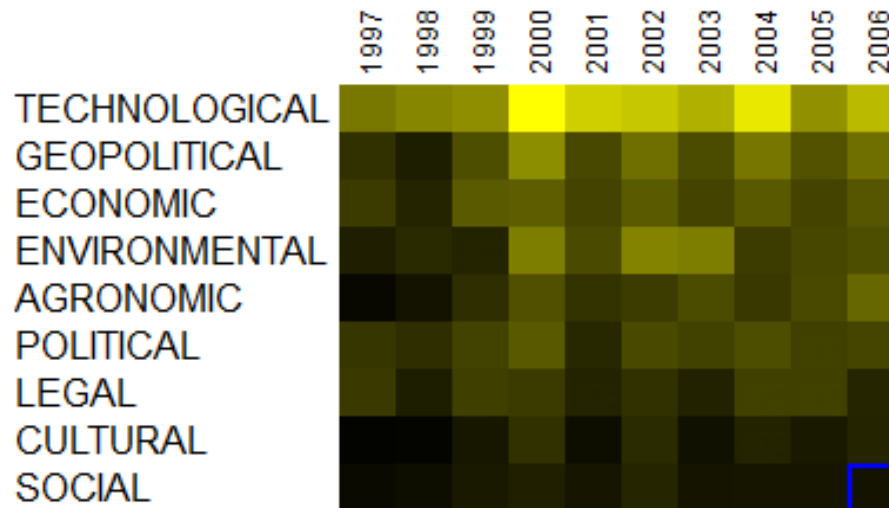


Figure 1. Intensities heat map according the occurrence of micro-environmental dimensions in the public policies on liquid biofuels in Brazil, 1997 to 2006; + ■ = frequency more intense + ■ = frequency less intense. Source: Research data.

with which the social dimension has occurred over the whole period analyzed is a result at odds with the public discourse of the Brazilian government regarding the social aspects related to liquid biofuels, in particular and especially to biodiesel. Moreover, as stated in the methodological aspect, this result may have been biased by the criteria used in constructing the analytical framework applied to extract knowledge by text mining procedures; it may be that the selected “d-words” were not able to capture those terms most frequently used in Brazil. Further analysis on the social dimension, motivated solely by the results observed in Figure 1.

There is another aspect that deserves mention in Brazilian public policies over these ten years. From the year 2000 in particular, there is evidence of a broad move in public policies toward including other macro-environmental dimensions on the policy makers’ agenda. Somehow, this may signal that public policies have moved toward a broader examination of the subject, seeking to approach it from different angles and aspects that can affect the development of activities related to liquid biofuels. In other words, it seems that public policy makers have sought to look at the subject of liquid biofuels in a holistic manner, observing and inserting different aspects that may be relevant to the systemic functioning of the sector, for example, the inclusion of environmental aspects, which have been relevant to the development of liquid biofuel production chains. More aspects regarding the general macro-environment for liquid biofuels in Brazilian public policies can be seen in Talamini and Dewes (2009, 2012).

Departing from a broader to a more specific analysis of the content of textual public policy documents, we can analyze the arrangement or the agglomeration of macro-

environmental dimensions into public policies. This type of analysis enables us to identify the sets of dimensions from which public policy has been developed. Figure 1 illustrates the results of the agglomeration of macro-environmental dimensions, taking into account documents as a whole as unit of analysis. Thus, a document can present textual content in its early stages that can be framed in a certain dimension (technological, for instance) and in its final content that can be framed in another dimension (economic, for instance). This implies that the recurrence of this pattern in several documents results in a high value for the Jaccard coefficient and therefore these dimensions are grouped into same cluster. In general, the interpretation of these results refers to the understanding of the composition of public policies regarding the scope of their written documents and a co-occurrence between some macro-environmental dimensions, even if the rapprochement between them, while defining a meaning for public policies, is tenuous.

The results shown in Figure 2 indicate that Brazilian public policies related to liquid biofuels can be grouped into three sets (clusters) of distinct documents: the first, wider and more frequent, consisting of text documents that reveal public policies built in a context or approach of technological, geopolitical, economic, environmental, and agronomic issues; the second, consisting of public policies that address political and legal aspects; and the third, a less frequent set of documents dealing with cultural and social aspects. It is also noticed that there is greater proximity between the second and third sets of public policies, which only in some cases are associated with the first group. It is worth noting also that the high frequencies with which technological issues are present

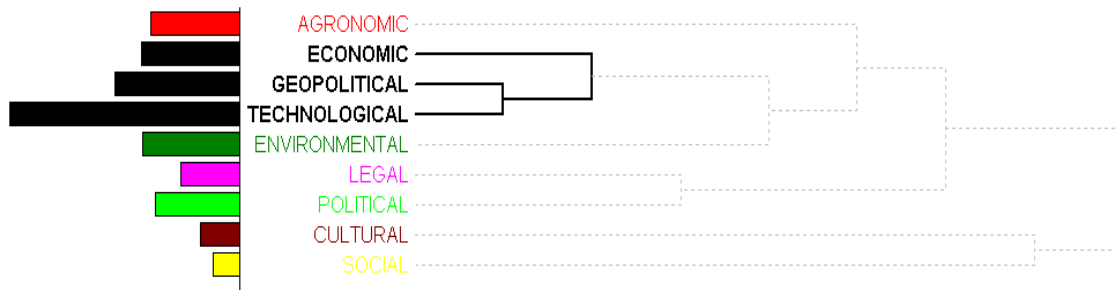


Figure 2. Agglomeration order of macro-environmental dimensions in public policy – “document” as the unit of analysis. Source: Research data.

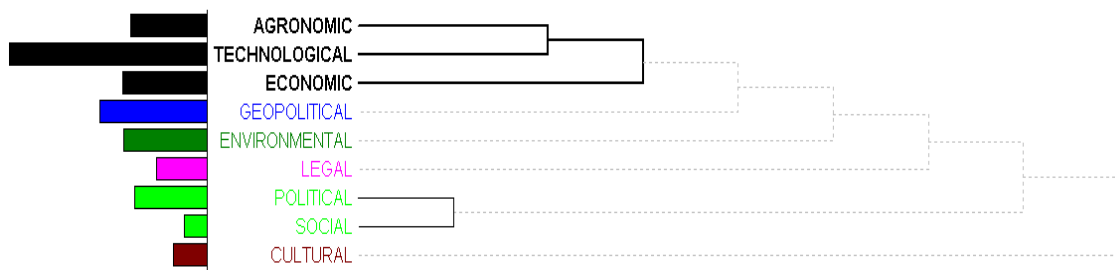


Figure 3. Agglomeration order of micro-environmental dimensions in public policy – “paragraph” as the unit of analysis. Source: Research data.

in Brazilian public policies. The technological dimension has presented an often substantially higher frequency than the other dimensions, as has been already shown in Figure 1. However, this dimension forms the most prominent cluster in the textual documents of public policies on liquid biofuels in Brazil, together with the geopolitical and economic dimensions. In short, these results reveal some direction to public policies. If a number of text documents of public policies in this area are taken at random, the probability of such documents addressing technological, geopolitical, and/or economic aspects is higher than the probability that they address a cultural and/or social aspect.

On the other hand, the analysis can be refined by reducing the unit of analysis from documents to paragraphs. One paragraph, by its definition and structural composition, should express a unified idea. That is, the elements that are included in the content of a paragraph are more closely related to each other than elements present in different paragraphs of the same document. So, when any two dimensions co-occur frequently in paragraphs of a set of documents, it implies that the direction of public policy has emphasized that these dimensions are related to one another. In other words, it implies that these two dimensions constitute the same idea and therefore, are strongly connected to each other, in a relationship of cause-effect or influence-dependency, and to the public policies setting process. Figure 3 shows the results of the macro-environmental

dimensions clusters grouping taking into account paragraphs as the unit of analysis.

Unlike the results shown in Figure 2, the results presented in Figure 3 indicate that the Brazilian public policies on liquid biofuels could be grouped into just two main sets (clusters) of distinct paragraphs: the first, with larger amplitude and frequency, consisting of paragraphs that reveal public policies built on a framework for addressing the technological, agronomic, economic, environmental, geopolitical, and legal issues; and the second, consisting of paragraphs that address political, social, and cultural aspects.

However, it highlighted the high value of the Jaccard coefficient obtained for the agglomeration of political and social dimensions. These findings suggest that although the Political and social dimensions have occurred with low frequency in public policies documents, the content of Brazilian public policy expresses an idea of a unified approach between political and social issues, since they co-occur with high frequency in the paragraphs of such documents.

It is possible that the idea of a unified social policy linked to liquid biofuels is more associated with biodiesel than ethanol. The public-political discourse of the federal government has suggested that there are distinct macro-environmental configurations for these two types of liquid biofuels. The results that would be discussed seek empirical evidence to determine whether or not there are differences in public policies related to ethanol and biodiesel.

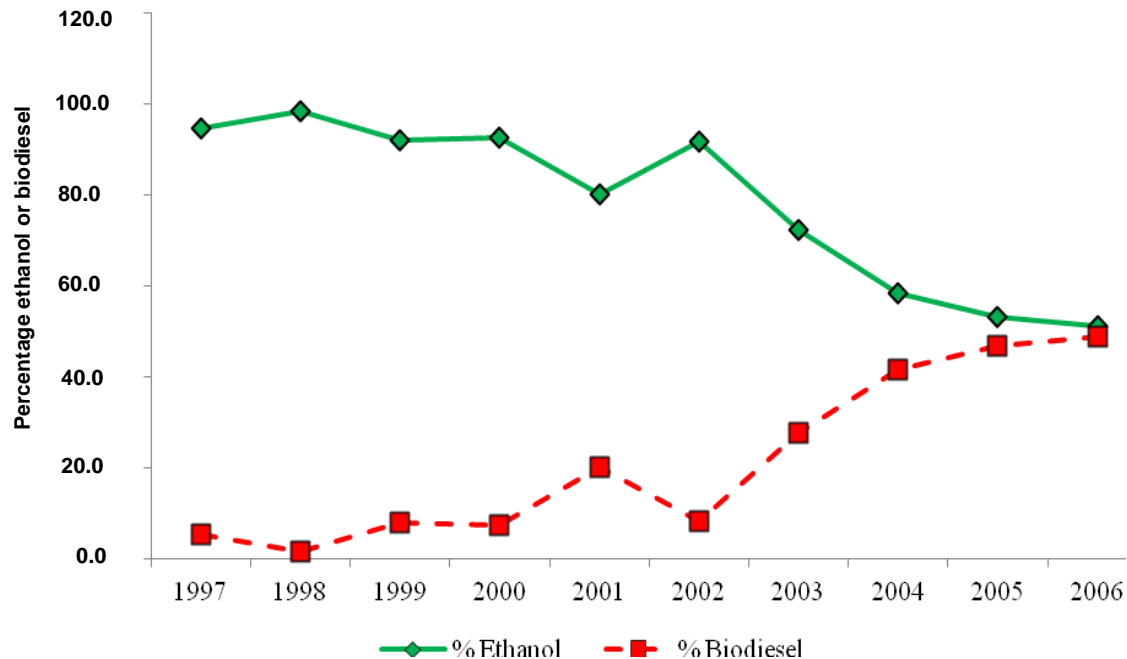


Figure 4. Documents addressing "ethanol" or "biodiesel" (percent) Source: Research data.

Comparing the macro-environmental configuration for ethanol and bio-diesel

A first aspect to be considered concerns the volume of public policy documents dealing with different types of liquid biofuels. The results presented in Figure 4 show how recent public policies for biodiesel are in Brazil. Between 1997 and 2002, there was a predominance of documents discussing public policy for ethanol. During that period, the percentage of documents on biodiesel did not exceed 15%. However, from 2003 on, biodiesel is part of the agenda of Brazilian public policy makers. From that year, the number of documents dealing with public policies for biodiesel increases, and from 2005, they have a relatively greater share than documents relating to ethanol. Possibly, this fact has been strongly motivated and driven by government policy proposed by President Lula and by the opportunities envisioned by economic agents, who have also sought regulation in the biodiesel market.

For comparative analysis of the macro-environmental configuration for ethanol and biodiesel, we identified their co-occurrence with macro-environmental dimensions at two levels: Documents and paragraphs. The analysis of co-occurrence at each of these levels shows how often each biofuel has co-occurred with each dimension in the content of documents of public policy as a whole and in the content of its paragraphs. Thus, one can infer that the more often a biofuel and a dimension occur in the same document, the greater the importance of this dimension in configuring the macro-environment for that biofuel. Otherwise, the smaller the unit of analysis (paragraph

rather than document), this relationship is more significant. In Figure 5, the frequencies of co-occurrence between ethanol and biodiesel and the macro-environmental dimensions are plotted.

From the results of co-occurrence in the same document, it can be verified that the configuration of the macro-environment presents some differences between two types of liquid biofuels. The documents of public policies that, at some point, discuss ethanol, deal mainly with issues related to technological, legal, political, economic, geopolitical, and environmental dimensions, whose co-occurrences with ethanol were observed in range from 309 to 378 documents. That is, from 49.5 to 60.6% of the documents of public policies on ethanol are linked to those macro-environmental dimensions. The other dimensions are also present in the configuration of the macro-environment for ethanol, but at lower levels of prominence.

On the other hand, the macro-environmental configuration for biodiesel has a distinct pattern in some aspects. The first observation is that there are a greater number of dimensions close to biodiesel and whose co-occurrences present lower frequency amplitude. In other words, the cultural dimension, which occurred less frequently, co-occurs with biodiesel in 109 (17.5%) documents, while the most frequent, the technological dimension, occurred in 229 (36.7%) documents (amplitude inferior than 20% points). Therefore, in the case of biodiesel, excluding the social and cultural dimensions, the macro-environment for biodiesel has been set up under a broader range of dimensions and thus is different from the macro-environment configured

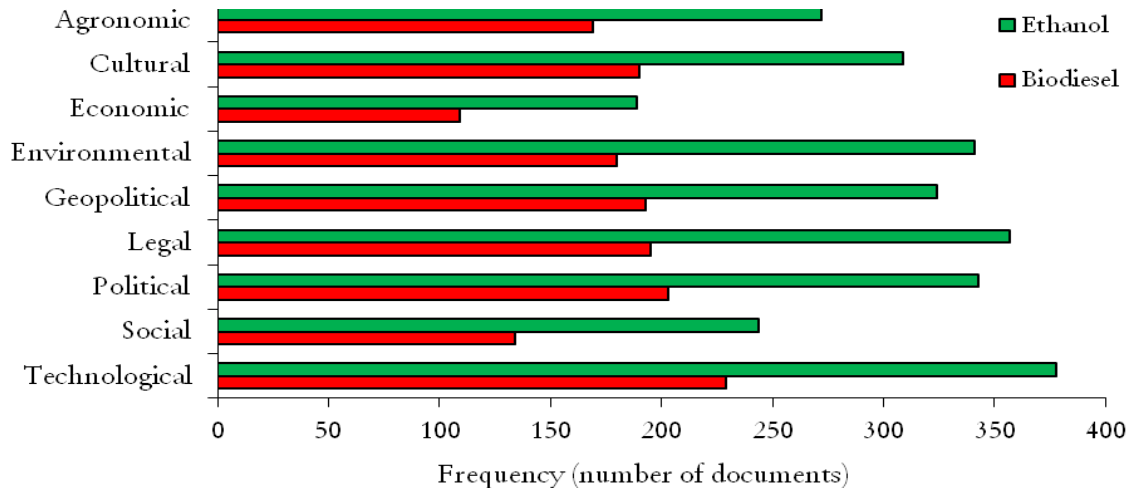


Figure 5. Co-occurrence between ethanol and biodiesel with macro-environmental dimensions – “document” as the unit of analysis. Source: Research data.

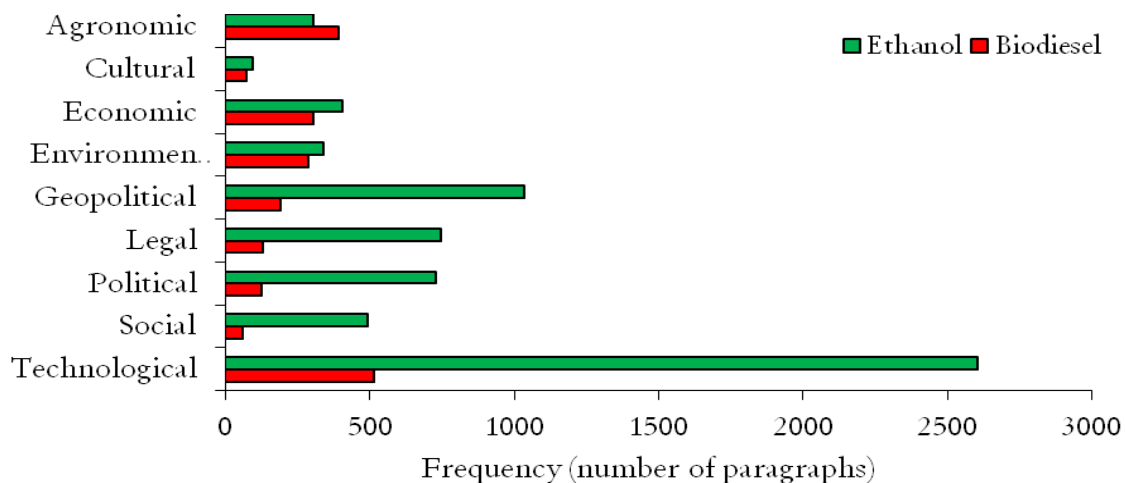


Figure 6. Co-occurrence between ethanol and biodiesel with the macro-environmental dimension – “paragraph” as the unit of analysis. Source: Research data.

for ethanol. The dimensions that have most frequently co-occurred with biodiesel were the technological, political, legal, environmental, geopolitical, and agronomic. This order of frequency with which the macro-environmental dimensions co-occur with the biodiesel also shows differences with respect to ethanol. However, despite the differences pointed out earlier, we find a relatively common order among dimensions that co-occur more frequently with ethanol and those that co-occur with biodiesel. This similarity is also supported by the results obtained in the homogeneity test between ethanol and biodiesel using the chi-square statistic. Test results for the configuration of the macro-environment at the “document” level show that the hypothesis of homogeneity

between the macro-environment configuration for ethanol and biodiesel must be accepted at a significance level of $\alpha = 0.001$ ($\chi^2 = 3.0598$; p-value = 0.9305, df = 8).

That is, although there are differences in the frequency with which the dimensions co-occur with the two bio-fuels, the proportion with which each dimension is used together with each biofuel does not differ statistically. The second level of analysis compared the macro-environmental configuration for ethanol and biodiesel in the content of the paragraphs of public policy documents. Figure 6 shows the frequency with which each macro-environmental dimension co-occurred with ethanol and biodiesel in the same paragraph.

The analysis of the macro-environment configuration

from the contents of paragraphs reveals a larger divergence between the two biofuels than that observed at the document level. Besides the fact that the number of paragraphs dealing with ethanol are more frequent than those that deal with biodiesel, the use of dimensions for the configuration of the macro-environment is less consistent between the two biofuels. The most significant difference is that the main dimensions relating to ethanol are the technological, geopolitical, legal, and political ones, while for biodiesel they are the technological, agronomic, environmental, and economic dimensions. Among the four dimensions that co-occur more frequently between the two biofuels, only the technological dimension is common to both. Still, this dimension presents a large domain scale in public policies related to ethanol.

In general, and to the extent that meaning can be ascribed to co-occurrence, given that the biofuel and dimensions occur together in the contents of paragraphs where the idea expressed is unified, these results show that the configuration of the macro-environment for ethanol and biodiesel from public policies are defined on different bases from those proposed for biodiesel, with a different focus, other constraints, and other priorities. Except for a few similarities to the co-occurrence of the technological dimension, this conclusion finds support in the homogeneity test between ethanol and biodiesel using a statistical chi-square test. The test results show that the hypothesis of homogeneity between the macro-environment configuration for ethanol and biodiesel should be rejected at a significance level of $\alpha = 0.001$ ($\chi^2 = 1030.89$, $p\text{-value} = 0.00000$, $df = 8$). That is, although there is little similarity in order of importance of a dimension in terms of its co-occurrence with the two biofuels, the proportion with which each dimension is used together with biofuels for the configuration of the macro-environment differs statistically.

Analyzing the results extracted from the documents and paragraphs, it can be concluded that the documents as a whole appear to be objects of broader public policies, addressing a broad range of themes and dimensions that are relatively common to both biofuels. However, when analysis of the content becomes more detailed and when more specific standards are sought for each of the biofuels, it can be seen that Brazilian public policies configure the macro-environment for ethanol and biodiesel in distinctive ways.

A particularly surprising result was the greater proximity of the social dimension with ethanol than with biodiesel (Figure 6). The public discourse of the Brazilian government has associated biodiesel, rather than ethanol, with social issues, but the results of this study show the opposite. Aiming to deepen the comparative analysis of ethanol and biodiesel, we constructed another set of "d-words" for a second social dimension (social 2), in light of considerations made in methodological

procedures and in the previous aspects. The results of co-occurrence of "d-words" in the social 2 dimension with ethanol and biodiesel in the documents of public policies in Brazil are illustrated in Figure 7.

Out of the 27 "d-words" that discriminate the social 2 dimension, only ten co-occur more frequently with biodiesel than with ethanol. They are family_farming, social_inclusion, farmer*, semi_arid, family_agriculture, rural_settlement*, social_fuel_seal, small_farmers, social_fuel, and social_seal. For both the biofuels, "d-words" that co-occurred with the greatest frequency are development, social, income, and employment. Again, the main differences are the frequencies with which the "d-words" co-occurred with biofuels; there were no significant differences in ranking of importance of these "d-words" to the ethanol or biodiesel. Thus, one can deduce that the documents of public policies are broad and include both biofuels and different aspects of the social dimension.

Results derived from analysis of co-occurrence of "d-words" associated with the social 2 dimension with ethanol and biodiesel in the same paragraph were obtained to refine the analysis. These significant findings are shown in Figure 8.

As previously mentioned, the co-occurrence of terms in the same paragraph is more representative of the fact that some kind of direct relation between them exists than the co-occurrence in the same document. So, observing Figure 8, it is clear that public policies for biodiesel in Brazil reveal a greater bias towards being social than do the policies for ethanol. Out of the 27 "d-words" that compose the social 2 dimensions, only five co-occur more frequently with ethanol. All other 22 "d-words" present a predominant relationship with biodiesel.

It is also worth noting that the analytical structure built for the social 2 dimension has proven reliable, since the "d-word" formed by "social_fuel_seal," which belongs to the National Program of Production and Use of Biodiesel (PNPB), co-occurred only with biodiesel, as was expected. In short, observing these results, we can say that biodiesel fuel is more social than ethanol, at least according to analysis of the content of public policies in Brazil.

Concluding remarks

This study was developed in order to scan the macro-environment for liquid biofuels based on the public policy of the Brazilian government, to analyze the macro-environmental configuration for ethanol and biodiesel in a comparative way, and to further investigate the social perspective of public policy for both types of liquid biofuels. To achieve these objectives, an analysis of documents from official written documents of the federal government's public policies related to liquid biofuels published over ten years was carried out. The concept of

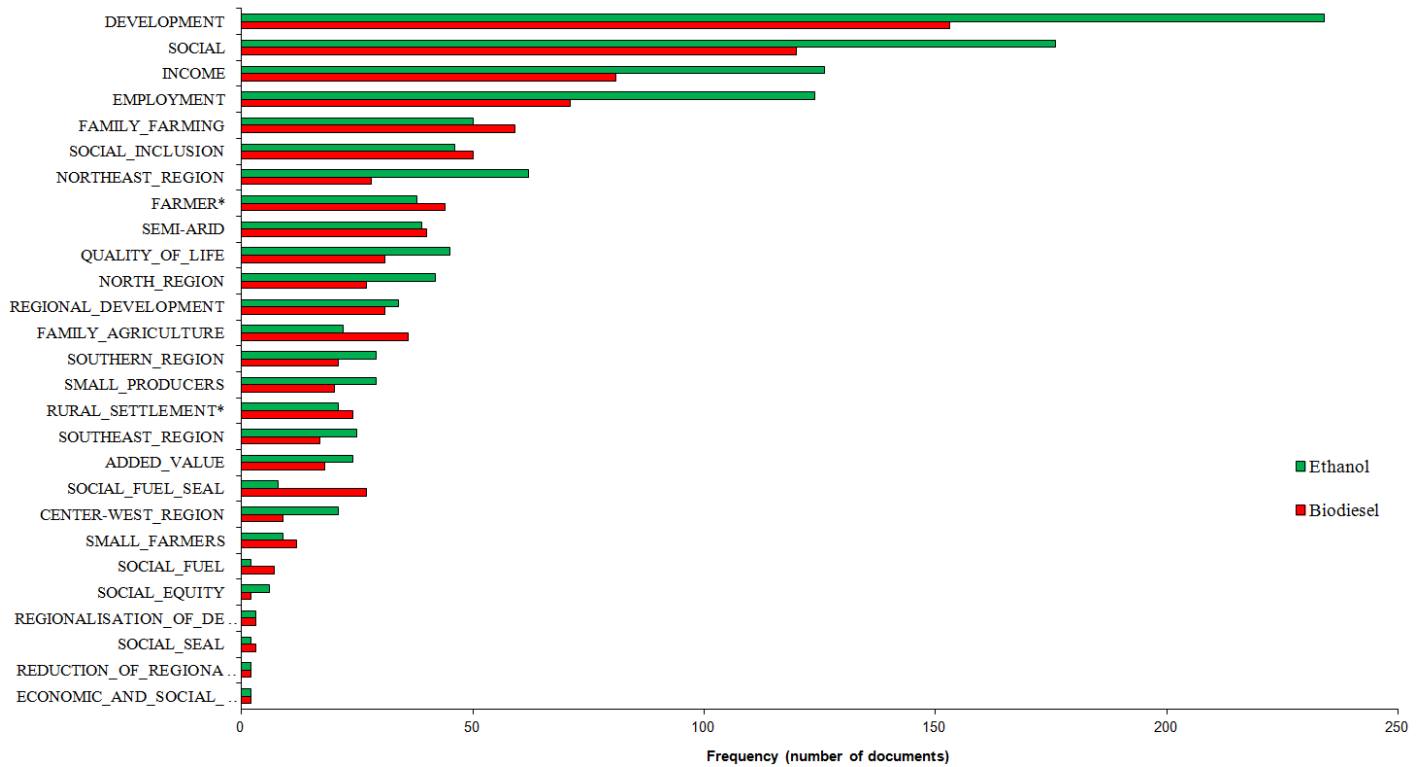


Figure 7. Co-occurrence between ethanol/biodiesel and social 2 dimension - "document" as the unit of analysis. Source: Research data.

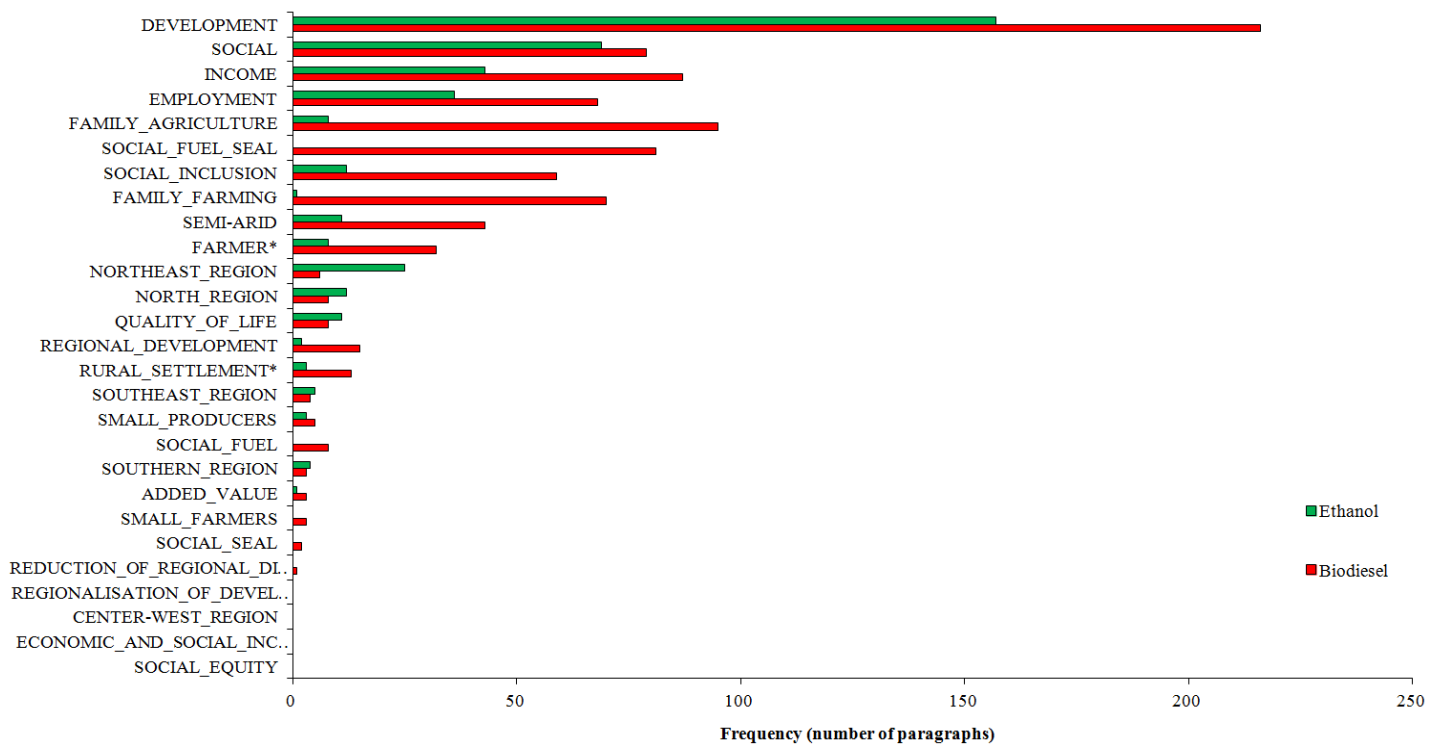


Figure 8. Co-occurrence between ethanol/biodiesel and social 2 dimension - "paragraph" as the unit of analysis. Source: Research data.

knowledge discovery in text and a set of text mining techniques were used to extract the necessary information.

When the analysis is performed, taking into account documents of public policies as a whole that is, including all documents, without carrying out a comparative analysis of ethanol and biodiesel, we observe that public policy has had a predominantly technological focus. That was the macro-environmental dimension that was the most outstanding over the years analyzed. Geopolitical issues related to liquid biofuels are also gaining space in the content of public policies of the federal government, being the second dimension usually found. In descending order, concerns about economic, environmental, agronomic, political, and legal issues have occupied intermediate positions. The cultural and social aspects have received less attention. These same conclusions are valid for agglomeration order analysis, or clustering of macro-environmental dimensions, which was done based on the content of all parts of all documents.

When scanning the configuration of the macro-environment for liquid biofuels advances to a higher level of significance, using the paragraphs of the documents as the unit of analysis, the formation of two main clusters can be identified, one formed by the agronomic, technological, economic, environmental, and geopolitical dimensions, with a higher Jaccard coefficient for the agglomeration among the first three dimensions, and another, formed by the political, social, and cultural dimensions. Although, there were some changes in the order of formation of the clusters, the configuration of the macro-environment for liquid biofuels in general remains focused on technological, geopolitical, economic, agronomic and environmental aspects.

Another conclusion drawn from this study is that there is a growing trend of public policy documents directed or related to biodiesel, especially from the year 2003. This indicates that, from the perspective of public policy makers, biodiesel constitutes a new possibility for the national energy matrix, requiring the government to define those aspects that guide the production chain implementation and consolidation. Ethanol, which has relied on public policies since the 1970s and already has a consolidated production supply chain, requires less space on the agenda of public policy makers today.

Comparatively, the conclusion is that the macro-environmental configuration for ethanol and biodiesel follows a similar pattern when the units of analysis are the documents as a whole. Although there is some difference in the relative relevance of each dimension in its co-occurrence with ethanol and biodiesel, the fact is that the order of frequency with which the dimensions co-occur with these biofuels has not significantly changed. The conclusion is that the content of public policy documents on liquid biofuels is broad and covers a variety of similar aspects in their full content. On the other hand, when the paragraphs are taken as units of

analysis, some differences can be observed. Apart from the technological dimension, which occupies a prominent position in the joint occurrence for both biofuels, there is a difference among the set of dimensions that most co-occur with each biofuel. Regarding the particularities from the analysis presented in paragraphs, we can conclude that, in fact, the context in which the macro-environment for ethanol and biodiesel is set varies. Thus, one can assume that there are specific public policies for each liquid biofuel (ethanol and biodiesel), highlighting aspects inherent to their peculiarities.

The results from a methodology used revealed a macro-environment in which the social dimension had low salience. Comparative analysis of the social dimension from the use of "d-words" extracted from certain documents of public policy revealed significant differences between ethanol and biodiesel. The difference between them was more prominent when the units of analysis were the paragraphs instead of documents. In this case, the results showed a wide prevalence of co-occurrence of biodiesel with the social dimension. In short, the conclusion is that while the social dimension has not been in wide use for configuring the macro-environment for ethanol and biodiesel, the social aspects of the introduction of biodiesel in the matrix of energy could be captured. These results have been aligned with the public discourse of the federal government to use biodiesel as a generator of regional development, employment, and income, and thus social inclusion, especially through farmers settlements and support for small farmers, although these are not the most important issues in the content of federal public policies.

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