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The Macro-Environment for Liquid Biofuels in the Brazilian Science, Mass Media and Public Policies

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1. Introduction

The economic interest for renewable fuels production and consumption has increased considerably in the last decade. In the liquid biofuels field, the main interest is being driven to biodiesel and ethanol production and consumption. Therefore liquid biofuels industry has become a new opportunity for investment allocation. Biodiesel and ethanol production has risen worldwide, mainly in United States, Brazil, Germany, France, Italy and Spain (International Energy Agency [IEA], 2006). In Brazil, the ethanol production was strongly supported by public policies from the middle 1970's to the early 1990's, when the market for ethanol was liberalized. On the other hand, biodiesel has been strongly supported by public policies since Lula's administration, remarkably by its inclusion in the National Plan of Agroenergy and National Program of Production and Use of Biodiesel - PNPB.

Regarding the government incentives for liquid biofuels production, the Brazilian ethanol production has increased significantly since the National Alcohol Program – PROÁLCOOL was launched to the present days. According to National Petroleum Agency – ANP (2001, 2010), the ethanol production increased from 10,7 billion liters in 2000 to more than 26,1 billion liters in 2009, an increasing rate superior to 140% in ten years. The biodiesel production, on the other side, went up and turned expressive in the last five years. In 2005 the Brazilian biodiesel industry comprised no more than eight biorefineries with a production capacity close to 85,3 million liters per year, but producing less than 0,75 million liters in that year. The scenario changed fast and five years later the biodiesel industry comprised 63 biorefineries online with a production capacity fifty times higher than in 2005 (National Petroleum Agency [ANP], 2006, 2010).

The previous results show that the Brazilian liquid biofuels industry is attracting even more investments along the production chain, from farming to processing and distributing stages. As stated by Stiglitz (2001), "the information affects the decision making in every context … and affects their [market participants] behavior". So, decision makers may be interested in scan the macro-environment for liquid biofuels properly, supporting their strategic planning and decisions on a structured scanning process which can return not just information, but organized, categorized, and assessed one. The macro-environmental scanning is a first and important stage in the strategic planning process through which the decision makers would

look out for the patterns and changes in the industry environment as a way to gather information which help them in the decision making process (Johnson et al., 2008; Grant, 2008; Wheelen & Hunger, 2008; Thompson et al., 2009; David, 2009).

The configuration of the macro-environment within it an industry or sector is embedded is a dynamic process once it may be the outcome of interactions between a wide range of stakeholders, mainly policy makers, scientists and journalists, along the public (society) and the industry actors. As a new field of interest and investments, the liquid biofuels sector demands for a set of particular public policies to regulate, to create incentives and/or to put some restrictions on it. In such case, the Brazilian government may play an important role in framing the liquid biofuels picture (Talamini & Dewes, 2009). On the other side, the scientific knowledge and scientists can bring in some influence on the macro-environment configuration interacting with policy-makers, journalists and society (Jasanoff, 1987; Sabatier, 1991; IPCC, 2004; Kalil, 2006; Nature, 2007). Journalists, on the other hand, may have a powerful ascendance on society and/or policy makers so that they can be able to lead a new frame for liquid biofuels (Gamson & Modigliani, 1989; Strömberg, 2001, 2004; Moirand, 2003; Kim, 2007).

Taking into account that, firstly, the Brazilian liquid biofuels industry has been attracting investments once the production and use of such kind of energy seems to be in expansion; and, secondly, scanning the macro-environment within the liquid biofuels industry is embedded could be relevant for decision makers as well as for scientists, journalists and policy makers, this chapter aims to answer the following questions: under which dimensions scientists, journalists and policy makers have configured the macro-environment for liquid biofuels in Brazil? Are the Brazilian public policies for liquid biofuels more science-based or mass media-based? How investments and liquid biofuels production in Brazil do react to the agenda of mass media, science and government? The main goal of this chapter is to identify the dimensions under which Brazilian scientists, journalists and policy makers have configured the macro-environment for liquid biofuels, correlating it with the investments (production) done in this industry.

2. Strategic planning and the macro-environmental scanning

In their widely-used book on strategic management, Johnson et al. (2008) identify the presence of three basic and required core elements for the strategic planning process: strategic position, strategic choice and strategy into action. The first core element concerns the evaluation of impacts of the external environment, internal resources and competences of firms, and expectation and stakes of interest groups on the strategy to be adopted. The analysis of the environment in which the organization is located is actually the first step of strategic planning for all reputed writers of strategy-handbooks, like Grant (2008), Wheelen & Hunger (2008), Thompson et al. (2009), David (2009), and Leidecker & Bruno (1984).

This prioritizing of the environment in strategic analysis goes back to Dill (1958). In his study, the author stated that the influences of the restrictions imposed by the environment were essential for the science of management, since the behavior of firms depend on autonomous environmental circumstances in which the firms are located, and how these are interpreted and turned into action by managers. Likewise, Terry (1977) states that the environment is the prime determinant of the form and behavior of an organization. Although criticized by adherents of the resource-based view in management (e.g. Rumelt, 1991, Barney & Hesterly, 2008) the environment is still the starting-point in almost all strategic planning.

But what is the environment? What are the variables that compose it? A widely accepted definition in the literature is that one proposed by Hall (2004), for whom the environment represents all those elements existing beyond the limits of the organization that may influence, directly or indirectly, the organization. In the management field, Thomas (1974) comments that the term environment should be understood as in the open systems approach. According to the writer, one should attach great importance to the idea that, since organizations exist in a dynamic environment, their resources are strongly affected by the forces of this environment.

As for the variables that make up a certain environment, it is necessary to identify which environment level is being analyzed. Thomas (1974), and in a similar manner Leidecker & Bruno (1984), proposes three different environment levels: general environment, operational environment and internal environment. In other words, the environment of a firm is made up of layers ranging from generic to specific. The general environment is made up of social, political, regulatory, economic and technological conditions existing in a national or global context.

With the purpose of utilizing macro-environment analysis for strategic planning, the variables found at the level of the general environment are usually grouped in factors or dimensions. When defining which dimensions or factors make up the general macro-environment, some writers use additional or supplementary dimensions to those originally proposed by Thomas (1974). A summary of the macro-environmental dimensions used by some writers is presented in Table 1.

As a conclusion about the dimensions that make up a given macro-environment, it could be said that a single or preferred set of dimensions does not exist. The variety and number of dimensions seem to depend on the line of business of a certain industry. However, a specific set of dimensions is found to be recurring among the consulted writers: the dimensions represented by the PESTEL acronym (see Table 1), as proposed by Walsh (2005) and Johnson et al. (2008), seem to cover most classifications of a macro-environment. We adopt this standard.

Following the determination of the concept and dimensions that make up the macro-environment of firms, it should next be understood how the macro-environment investigation process for the preparation of the strategic planning is carried out. Ginter & Duncan (1990) and Ginter et al. (1992) state that the macro-environmental analysis process is made up of four interrelated activities:

a. *Scanning* – scanning the macro-environment means to investigate the threat signals and possible opportunities that may affect the business;

b. *Monitoring* – the activity of monitoring the macro-environment is associated to the process of tracing the issues identified in the investigation process;

c. *Forecasting* – it is the process of estimating forecasts of directions, scope, speed and intensity of environmental changes on a plausible basis; and,

d. *Assessment* – the process of assessing the projected trends for the organization in terms of its relationship with the external environment.

These steps are also present in the strategic planning model proposed by Bates (1985)[1]. Based on these four steps in the macro-environmental analysis, it can be concluded that the scanning process is the first step and one of the main elements of strategic planning. This paper focuses on this scanning of the macro-environment. Therefore, it is important to

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[1] The author defines the model as MAPing: *Monitor*, *Analyze* and *Predict*.

Writers	Macro-environment Dimensions
Thomas (1974)	Social, Political, Regulatory, Economic and Technological
Fahey & King (1977)	Economic, Political, Regulatory, Social, Cultural, Technological, Energy, Marketing/Industrial and Financial
Preble et al. (1985)	Legal, Economic, Political, Competitive, Technological and Cultural
Ginter et al. (1991)	Economic, Political, Social, Technological and Regional
Costa (1995)	Political, Economic, Social and Technological – PEST
Leonidou (1997)	Physical, Demographic, Sociocultural, Economic, Political/Legal and Technological
Fleisher & Bensoussan (2002)	Social, Technological, Economic, Ecological and Political or Legal – STEEP
Walsh (2005); Johnson et al. (2008)	Political, Economic, Sociocultural, Technological, Environmental and Legal - PESTEL

Table 1. The different macro-environment dimensions according to different writers

understand how firms carry out this scanning: What kind of information is usually assessed? What are the information sources? And, how is this information processed?

By studying the strategic planning processes, the first conclusion one reaches is that there are different levels for the deployment of scanning techniques by firms, and even the intensity of use by the same firm may vary over time (Fahey & King, 1977; Fahey et al., 1981; Stubbart, 1982). However, in an environment marked by speed and intensity of changes, macro-environmental scanning is highly recommended to monitoring the strategy of firms. Costa (1995) highlights some of the reasons why the deployment of a systematized analysis of the environment of the organization is relevant. In its essence, 'scanning' is a process based on the search and treatment of information on a certain macro-environment.

Ginter et al. (1992) illustrate clearly how the macro-environment scanning process captures and treats information. Figure 1 shows that, before scanning, the various pieces of information about the general macro-environment and the specific sectors of environment are dispersed. Although the information may be available, the identification of any pattern turns out to be a daunting task. After the scanning process, the result is a set of categorized, organized, accumulated and assessed information. The illustration demonstrates that scanning is a sorting filter for the pieces of information accessed by the firms or industry, so that, after its application, the macro-environmental patterns may be identified and assessed.

What are the different information's sources used for the purpose of the macro-environment scanning process? Figure 1 shows that information is the raw material which feeds the monitoring process. By analyzing different studies in this field, it was possible to detect the presence of two information sources: company internal and external, which in turn can be subdivided into: personal and impersonal sources. The studies of Keegan (1974), Ginter & Duncan (1990), Ngamkroeckjoti & Johri (2000) and Jogaratnam & Law (2006) show that the main information sources are still the people inside or outside the organizations.

However, evidently more recent studies in the scanning field have drawn the attention to the importance of the World Wide Web as an information source. The Internet has promoted a significant growth in the information volume available for decision-taking. Auster & Choo (1993, 1994), Choo (1994, 1999), Liu (1998), Liu et al. (2000) and Decker et al.

(2005) are just some of the studies conducted in recent years drawing attention on the importance of electronic information sources for business executives.
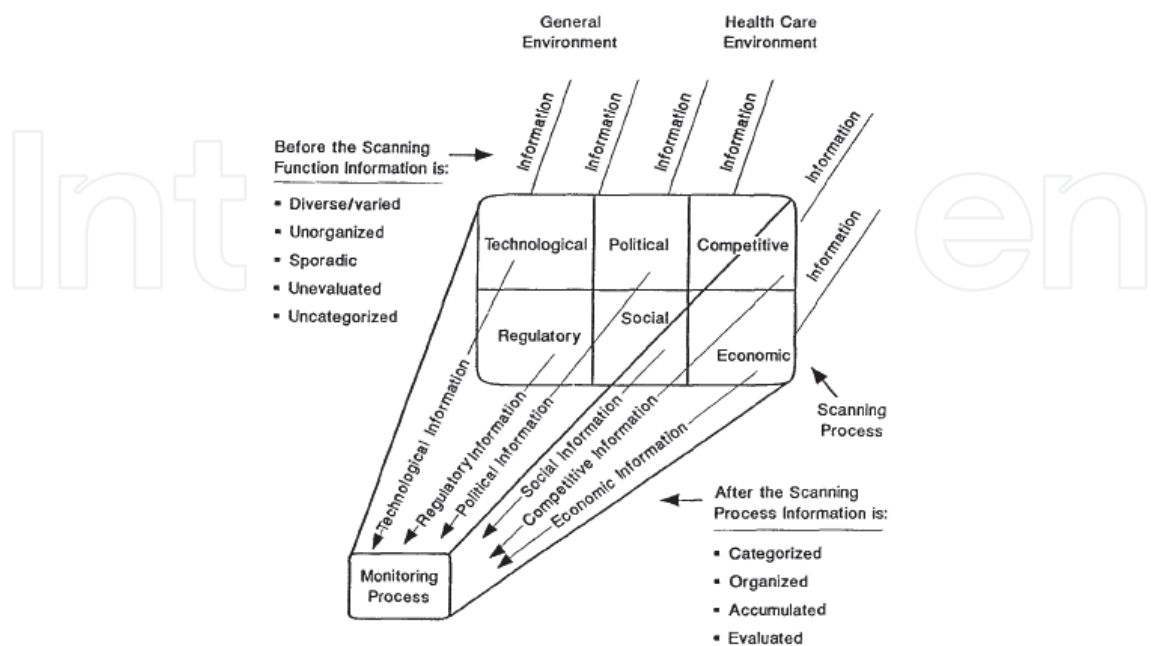

Fig. 1. Treatment of information through the 'scanning' process
Source: Ginter et al. (1992, p. 255)

If on the one hand access to information was made easier, we find that, on the other hand, there is the difficulty of analyzing such a large volume of data and information so as to extract the essential elements for planning the organizations' activities. The solution to this problem seems to be the combination of: (i) the theory and concept of scanning the macro-environment; and (ii) new information technologies (ITs) developed for electronic data treatment so as to extract a reduced and structured set of pieces of information. The studies of Liu (1998), Myers (1999), Wei & Lee (2004), Decker et al. (2005), Aasheim & Koheler (2006) are examples that the electronic 'scanning' of macro-environmental dimensions tends to be a powerful tool to better understand the current global environment, where information is in abundance, and in digital form.

Within the set of new techniques and technologies for macro-environmental scanning, the use of Text Mining is being discussed and presented as one of the intelligent techniques for the treatment of a large amount of information. In his book on this topic, Halliman (2001) discussed the use of Data Mining in depth and shows practical applications both to determine macro-environmental forces and to analyze scenarios. We will take up Data Mining, in line with Halliman (2001) and Lau et al. (2005) who used Text Mining as an analysis tool to identify macro-environmental dimensions associated to the business environment in the communication and hotel industries.

3. Method and procedures

The research method used in this research was based on the documental analysis of scientific articles published by Brazilian scientists, of mass media news and of official documents of Brazilian government. Karanikas & Theodoulidis (2002) e Hale (2005) assert

that 80% of all available information occurs in a diverse range of written documents. To transform this information in knowledge this work used the concept of Knowledge Discovering in Texts – KDT, and Text Mining - TM techniques (Halliman, 2001). The procedures adopted for text mining were followed by a composition of phases, which came from the studies of Liddy (2000), Karanikas & Theodoulidis (2002), El Wakil (2002), Silva et al. (2004) e Hippner & Rentzmann (2006).

The selection of scientific papers, mass media news and governmental documents was made based on a key-words list, representative of the research object "liquid biofuels", both in English and Portuguese language, given the frequency in which these key-words have occurred in the literature on the issues related to bioenergy, bioeconomy, and biofuels. The key-words selected were: ETHANOL, ALCOHOL, BIOFUEL, BIOFUELS, BIO-FUEL, BIO-FUELS, BIODIESEL e BIO-DIESEL. The documents in which the term alcohol was related to an alcoholic beverage were discharged.

With all the key-words, searches were made in the following scientific papers websites: Scielo (www.scielo.br), *Portal de Periódicos CAPES* (www.periodicos.capes.gov.br) and Web of Science (http://portal.isiknowledge.com). Searching for mass media news two important newspapers with national circulation in Brazil were selected: *Folha de São Paulo* and *Valor Econômico*. Accessing the archives of such newspapers and by using the searching engine available in both newspapers, the news were retrieved and collected. The governmental documents were searched in the Brazilian government official web pages, from the Brazilian Government official website (www.brasil.gov.br). After that, all the web pages of the Ministries, Federal Offices and Autarchies were consulted using the browser on these pages and the documents were identified and downloaded. It is important to highlight that the governmental information which appeared in the "Press Room", available on most of the web pages accessed, were excluded as a way to distinguish official public policies and program from political discourse.

The search and collection of the textual documents from science, mass media, and government and the preliminary construction of the text-base had started on the first week of February 2007 and was concluded on the last week of following July. To analyze the performance of scientists, journalists and policy-makers along the time documents were collected within the timeframe 1997-2006. At the end of the browsing process, 219 scientific papers with at least one of authors from Brazilian scientific institutions, 4,121 mass media news, and 673 official documents of the Brazilian government were collected and archived into the text-base.

In the next phase, the electronic content of the documents were uploaded to a database built up with the help of QDA Miner® software, which prepares the documents for the text mining process. As the QDA Miner® software utilizes the *.RTF (Rich Text Format) extension to build its textual basis, 12 scientific articles and 49 governmental documents were lost because their .PDF files were protected or blocked. Then, the final set of the database were formed by 207 scientific papers, 4,121 mass media news, and 624 governmental documents.

To extract the knowledge from documents it was necessary to build an analytical structure able to extract the relevant information, because it was not found in the literature any methodology suitable to this purpose. Lists of appropriate key-words are frequently used, as can be seen in Vincent (2006), Crawley (2007) e Singh et al. (2007). In this direction, the first step to construct a specific structure to reach the proposed objectives was the definition of the macro-environmental dimensions to be used in this study. Accordingly to the literature about the macro-environment analysis, the most frequently used dimensions are

those related to the "PESTEL" acronym, what stands for Politics, Economic, Socio-Cultural, Technological, Environmental and Legal (Walsh, 2005; Johnson et al., 2008). The number of dimensions and its label change from one study to another, depending upon the specific interest of the study, the environment and/or the activity researched, allowing some flexibility. For this study, nine dimensions were used, namely: Agronomical, Environmental, Cultural, Economical, Geopolitical, Legal, Political, Social, and Technological.

After the setting of the macro-environment dimensions, steps were carried out aiming at identifying the key-words which represent each dimension respectively, called here and onward "dimension-words" or shortly "d-words". The "d-words" are those relevant terms, which better discriminate a specific macro-environmental dimension. Therefore, nine different sets of "d-words" have been defined. The respective sets of "d-words" for each dimension were defined from the TF*IDF[2] index relevant to the words which occur in scientific texts published in journals specialized in the area of knowledge close related to the respective macro-environmental dimension. The number of "d-words" for each dimension was defined by using the percentile measure, selecting the "d-words" that quantitatively better discriminated each dimension. The average number of words selected was 14 "d-words" for each dimension. As low consistent, when single "d-words" were found in two or more dimensions, additional rules were added to the analytical structure for the knowledge extraction. The added rules took into account the simultaneous occurrence of defined terms in a same document. For the rules definition, the Jaccard's Coefficient was used (Chung & Lee, 2001).

The text mining was done using the textual basis in electronic format and the analytical structure for the knowledge extraction was made out of the macro-environmental dimensions and their respective "d-words". Using the WordStat module from the SIMStat® software it was possible to determine the frequency of each "d-word" in each set of documents and thereafter the frequency of use of the different macro-environmental frames by science, mass media, and government for liquid biofuels.

Absolute and relative frequencies of macro-environmental dimensions counted from documents by text mining were the main source of data. Data about ethanol and biodiesel production used in the analysis were mainly obtained from National Petroleum Agency – ANP. Cluster analysis using Jaccard's coefficient of agglomeration order was applied in analyzing the discourse in documents, paragraphs, and sentences. Granger causality tests were carried out to investigate how ethanol production reacts to scientific publication, mass media news, governmental documents, and the configuration of macro-environment as done by scientists, journalists, and policy-makers.

4. Results

This section is splitted up into three main sub-sections. The first one is dedicated to present and analyze the evolution of liquid biofuels industry along the last fifteen years, mainly how ethanol and biodiesel production increased (and also decreased) in response to internal and external phenomena. In the second sub-section, data on how Brazilian scientists, journalists and policy-makers have configured the macro-environment for liquid biofuels along the time are presented. Finally, in the third sub-section the results on how science', mass media'

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[2]TF*IDF, Term Frequency (TF) multiplied by Inverse Document Frequency (IDF). For a more detailed review see Aizawa (2003) and Jing et al. (2002).

and government's agenda regarding liquid biofuels are correlated to the performance of liquid biofuels industry in Brazil.

4.1 Investments and liquid biofuels production

The ethanol is a relative well established market in Brazil since the National Program of Alcohol (*Proálcool*) was launched at the middle of 1970s. The *Proálcool* emerged as a series of governmental incentives for ethanol production and consumption. Such public policies were based on the perspective that ethanol could be an interesting and successful alternative for the raising in petroleum prices at international market. For almost two decades the ethanol production was supported by public policies which made compulsory the use o ethanol blended in gasoline, since there were no vehicles equipped with engine powered exclusively by ethanol. The public policies were also the main driver of changing in auto industry. The manufacture of vehicles with engines able to run exclusively on ethanol gave new impetus to *Proálcool*. Step by step the ethanol market has becoming a less government regulated market and more a price regulated market.

As such, the ethanol supply and demand were affected by a set of variables and balance changed frequently. At the end of 1990s the ethanol market was in decline, as proved by data shown in Table 2. But things were about to change the direction. The worldwide discussion about global warming has put new light on ethanol. The targets for reducing the Greenhouse Gases emissions as proposed in the Kyoto Protocol drove the governments to look for clean fuels alternatives. Then, the liquid biofuels appear as a potential solution for transportation fuel. Attentive to new demands, the automobile industry has invested in new technologies and launched hybrid cars. The production and sale of flex fuel vehicle (FFV) increases dramatically in Brazil since it was launched about 2004.

Year	Production (billion liters/year, anhydrous + hydrated ethanol)	Variation (%)
1995	12,746	-
1996	14,133	+10,88
1997	15,493	+9,62
1998	14,122	-8,85
1999	12,982	-8,07
2000	10,700	-17,58
2001	11,466	+7,16
2002	12,589	+9,79
2003	14,470	+14,94
2004	14,647	+1,22
2005	16,040	+9,51
2006	17,764	+10,73
2007	22,557	+26,98
2008	27,133	+20,28
2009	26,103	-3,79

Table 2. Ethanol production in Brazil
Source: ANP (2001, 2010)

The perspectives for ethanol market became better and the ethanol industry responded promptly. The sector reacted positively and new investments were done. New plants were installed and production capacity was expanded. During the 2000s years the production increased in almost all. From 2000 to 2008, the ethanol production increased from 10,7 billion liters to more than 27,1 billion liters, an increase rate higher than 150%. The decrease in ethanol production from 2008 to 2009 can be seen as an occasional phenomenon. For the future, the prospective scenarios are favorable to Brazilian ethanol market. Brazil has a cost-based competitive fuel produced mainly from sugarcane, a culture well adapted to soil and climatic conditions of major agricultural regions of the country and where there is still land to be used for agriculture purposes. The increasing demand for energy (renewable sources of energy also) around the globe may drive Brazil as an important global ethanol exporter. Taking into account the recent performance of Brazilian economy and the real increases of people income, the FFV's sales tend to grow even more demanding for more ethanol or blended gasoline/ethanol fuel.

If the Brazilian market for ethanol is already established to another liquid biofuel the things are still under development. The history's timeline of biodiesel is short in Brazil. The biodiesel production and consumption emerged from worldwide tendency of searching for renewable and clean sources of energy at the end of 1990's and beginning 2000's. Before 2000 the biodiesel industry was only a few experimental plants. As occurred with ethanol in years before, the biodiesel sector has changed its future from a set of public policies. Two major programs from Brazilian government were launched about 2005: the National Plan of Agroenergy and the National Program for Production and Use of Biodiesel. The National Plan of Agroenergy established objectives and goals for the agroenergy sector as a whole, while the National Program for Production and Use of Biodiesel defined the set of incentive policies to expand production and consumption of biodiesel. Following some lines of the past experience of *Proálcool*, the Brazilian government made mandatory the addition of biodiesel into the diesel fuel. At the beginning, was mandatory a blended fuel called B2 (2% of biodiesel added to diesel). Since 2010 the B5 is the mandatory blending. In the government of President Lula's view, the biodiesel could be also used as a "social fuel", promoting the social and economic inclusion of small farmers as raw material suppliers. The governmental support to biodiesel sector, via public policies, sounded well among investors, as shows Table 3.

Year	Biodiesel Refineries	Nominal Capacity (Million liters/year – B100)	Variation in Nominal Capacity (%)	Production (Million liters/year – B100)	Variation in Production (%)	Production/ Nominal Capacity (%)
2005	8	85,320	-	0,736	-	0,86
2006	19	638,620	+648,50	68,548	+9,213.59	10,73
2007	45	2,475.069	+287,56	402,176	+486,71	16,25
2008	62	3,315.339	+33,95	1,167.128	+190,20	35,20
2009	63	4,391.815	+32,47	1,608.053	+37,78	36,61
2010	68	6,198.268	+41,13	3,349.702	+108,30	54,04

Table 3. Biodiesel production in Brazil
Source: Primary data from ANP (2006, 2010)

From 2005 to 2010, the number of plants processing biodiesel (B100) grew from eight to sixty-eight, a growth rate of 750%. In the same period, the nominal capacity of producing B100 biodiesel grew more than 7,000%, jumping from just 85 million liters in 2005 to more than six billion liters in 2010. With the enlargement of biodiesel market by increasing mandatory blends (B2, B3, B4 and B5), the production also grew tremendously at the same time period. The future for biodiesel in Brazil is promising. Brazilian government has signalled it will raise levels of addition of biodiesel to diesel in the near future, generating a growth in demand for biodiesel. New biodiesel plants are in construction and the production can be doubled just with the nominal capacity currently installed. Research and technology development are being in course to improve the biodiesel industry competencies and productivity. New crops which can be used as raw material are studied and new production processes are continuously incorporated. The natural conditions presents in Brazil may lead the country to also be an exporter of biodiesel.

Summarizing, the market for two major liquid biofuels (ethanol and biodiesel) in Brazil have been affected by a set of phenomena. Economical and geopolitical events, like the price oil crisis and the power of the main petroleum producers; environmental issues, like global warming; social action, as the inclusion of small farmers; agronomic developments, like the adaptation of crops to the soil and climatic condition; cultural events, like decision-taking process of investors based on government signals and incentives; legal issues, like the official decrees defining the level of biofuels to be blended with fossil fuels; technological advances, like in the auto industry with the production of FFV. However, none of those dimensions was more important to the development of the market for liquid biofuels in Brazil than the political one. Policy-makers and the public policies proposed by them were decisive along the time and cannot be considered as incorrect to reserve to the Brazilian government the central role in such journey. At the same time, we cannot ignore the particular role of science and mass media in framing and configuring the macro-environment for liquid biofuels.

4.2 The macro-environment for liquid biofuels: science, mass media and government

In this section, the results on how the macro-environment for liquid biofuels has been configured by Brazilian scientists, journalists and policy-makers are presented and discussed. At first, we will present and discuss the results from Brazilian science. As shown in Table 4, Brazilian scientists have configured the macro-environment for liquid biofuels under three main dimensions: technological, environmental and agronomical. Economical and political dimensions have occurred with an intermediate frequency in Brazilian scientists agenda. Social, cultural and legal aspects were less frequently observed in the content of scientific publications.

Some changes in the main dimension under which the macro-environment for liquid biofuels have been configured can be seen. The environmental dimension, for instance, was the most frequently used by Brazilian scientists in 1998, 1999, 2001, 2003 e 2004, but it was overcome by economical dimension in 2002 and by agronomical in 2006. Such findings illustrate that the macro-environmental configuration is a dynamic process. In addition, the findings suggest that the interest of scientists can be affected by a dimension which may be more in evidence at a time. On the other hand, a trend analysis can also be carried out. In such case, it is possible to observe that among the most frequently macro-environmental dimensions used by scientists just technological dimension presents an increasing tendency along the time, especially in the last six years of the time series studied. Agronomical and

environmental aspects related to liquid biofuels also presented a decreasing tendency regarding their presence in the scientists' agenda. On the other hand, geopolitical and political aspects have gained importance from 2001 and the trend analysis indicates an increasing importance of such matter in scientific field for the future.

| Dimensions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Agronomical	103	190	323	508	183	254	465	534	3625	3826	10011
	(43.6)	(11.1)	(18.6)	(27.0)	(24.0)	(6.6)	(21.6)	(20.3)	(21.8)	(23.4)	(20,9)
Cultural	6	100	23	41	33	89	48	101	546	526	1513
	(2.5)	(5.9)	(1.3)	(2.2)	(4.3)	(2.3)	(2.2)	(3.8)	(3.3)	(3.2)	(3,2)
Economical	7	200	221	87	28	1247	239	183	1413	1984	5609
	(3.0)	(11.7)	(12.7)	(4.6)	(3.7)	(32.5)	(11.1)	(7.0)	(8.5)	(12.1)	(11,7)
Environmental	67	342	446	509	325	812	596	856	3627	2445	10025
	(28.4)	(20.1)	(25.6)	(27.1)	(42.7)	(21.2)	(27.7)	(32.6)	(21.8)	(14.9)	(20,9)
Geopolitical	16	248	225	90	55	199	203	169	1840	1945	4990
	(6.8)	(14.5)	(12.9)	(4.8)	(7.2)	(5.2)	(9.5)	(6.4)	(11.1)	(11.9)	(10,4)
Legal	5	66	58	31	14	104	34	43	622	653	1630
	(2.1)	(3.9)	(3.3)	(1.6)	(1.8)	(2.7)	(1.6)	(1.6)	(3.7)	(4.0)	(3,4)
Political	1	184	124	78	11	259	116	116	1288	1026	3203
	(0.4)	(10.8)	(7.1)	(4.2)	(1.4)	(6.8)	(5.4)	(4.4)	(7.7)	(6.3)	(6,7)
Social	0	69	24	3	6	36	29	36	205	187	595
	(0.0)	(4.0)	(1.4)	(0.2)	(0.8)	(0.9)	(1.4)	(1.4)	(1.2)	(1.1)	(1,2)
Technological	31	306	297	532	106	832	418	591	3463	3793	10369
	(13.1)	(17.9)	(17.1)	(28.3)	(13.9)	(21.7)	(19.5)	(22.5)	(20.8)	(23.1)	(21,6)
Total	236	1705	1741	1879	761	3832	2148	2629	16629	16385	47945
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: Relative frequency in parenthesis

Table 4. Macro-environment configuration for liquid biofuels by Brazilian scientists

To better understand how Brazilian scientists have been using the set of dimensions in configuring the macro-environment for liquid biofuels an additional analysis of documents content was carried out. At this point, we were interested in identifying what are the main dimensions used in a conjoint way to compose the scientists' discourse. The mining process from scientific documents allow us group the macro-environmental dimension in clusters according its co-occurrence in three different levels of analysis: in a same document (a), in a same paragraph (b), and in a same sentence (c), as can be seen in Figure 2.

Taking the documents as units of analysis (Fig. 2, a) and clustering the macro-environmental dimensions in seven clusters, results show that the most frequently co-occurrence in Brazilian science discourse are shown by the topics related to agronomical and technological aspects of liquid biofuels production and consumption. Such aspects of liquid biofuels are followed by environmental matters. Departing from a more general (Fig. 2, "a", document) to a more specific level (Fig. 2, "b", paragraph and "c", sentence) of content analysis in scientific publications it is possible to identify what issues are highlighted by the scientists when reporting their studies and research on liquid biofuels. Thus, when two dimensions appear together in sentences of scientific documents, one can assume that the relationship between these two aspects of macro-environment are more revealing of the scientific approach than when such dimensions occur only at the document level. Although some minor changes can be perceived at a paragraph level, it is important to note what the configuration of a six-clusters analysis at sentences level revealed. In such case, it is possible

to identify three main clusters: agronomical and environmental; political and legal; and, economical and technological. The findings reveal that Brazilian scientists are interested in agronomical, technological and environmental issues at a general approach, but to develop the knowledge on liquid biofuels they need to put particular emphasis on agronomical-environmental, political-legal, and economical-technological aspects.

(a)

(b)

(c)
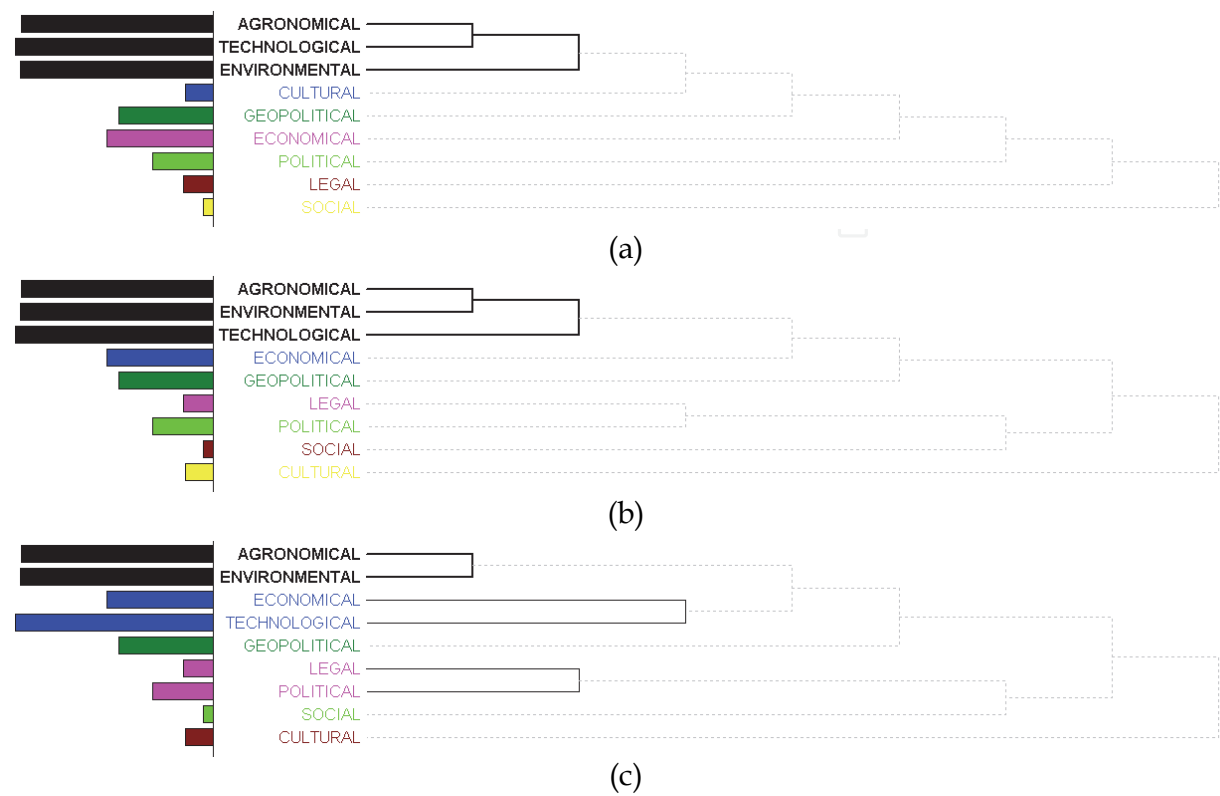
Note: "a", in the same document; "b", in the same paragraph; "c", in the same sentence

Fig. 2. Science document content analysis by dimensions agglomeration order using Jaccard Coefficient

The second group of stakeholders to be analyzed is composed by Brazilian journalists. As well established in the literature, the mass media plays an important role both in disseminating the knowledge produced by science, both to the lay public and to policy-makers, as in the discussion of relevant topics on public policies. As the liquid biofuels is a relative emerging sector which needs an intermediation between scientists, policy-makers and the lay public, and the mass media can properly performs this role, it is interesting to investigate how the macro-environment for liquid biofuels have been configured by Brazilian journalists along the time.

Compared to science, the macro-environmental configuration done by mass media is more stable. There is not much change between the most frequently used dimensions during the time. In general, Brazilian journalists have focused on four main dimensions when framing liquid biofuels: economical, technological, political and geopolitical (see Table 5). The agronomical and environmental dimensions have occurred in an intermediate frequency level, while cultural, social and legal can be considered as irrelevant for journalists regarding its low level of occurrence in the mass media news.

Despite the journalists present a more uniform framing of liquid biofuels over time, based on four main dimensions, trend analysis shows that those dimensions that were most

frequently used have a trend of declining its relative importance in setting the macro-environment. In this direction, the geopolitical issues related to liquid biofuels have gained importance in the journalists' agenda, mainly from 2000 on. Other aspects of liquid biofuels production that journalists have driven an increasing attention at are those related to agronomical dimension, followed by technological matters. On the other side, economical, political and environmental issues are losing relative importance in setting the macro-environment made by journalists.

| Dimensions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Agronomical	102	43	84	134	155	286	217	567	877	2133	4598
	(3.8)	(2.6)	(3.3)	(4.8)	(8.8)	(8.3)	(6.6)	(8.5)	(9.4)	(11.3)	(8.7)
Cultural	62	27	40	40	41	88	102	220	207	445	1272
	(2.3)	(1.7)	(1.6)	(1.4)	(2.3)	(2.5)	(3.1)	(3.3)	(2.2)	(2.4)	(2.4)
Economical	538	535	1094	1005	406	844	805	1573	1913	4119	12832
	(20.1)	(32.7)	(42.6)	(35.8)	(23.0)	(24.5)	(24.6)	(23.6)	(20.5)	(21.8)	(24.2)
Environmental	309	99	243	231	228	277	349	541	848	1273	4398
	(11.5)	(6.1)	(9.5)	(8.2)	(12.9)	(8.0)	(10.7)	(8.1)	(9.1)	(6.7)	(8.3)
Geopolitical	391	177	133	213	176	520	399	974	1388	3071	7442
	(14.6)	(10.8)	(5.2)	(7.6)	(10.0)	(15.1)	(12.2)	(14.6)	(14.9)	(16.3)	(14.0)
Legal	199	71	77	60	74	191	147	253	444	720	2236
	(7.4)	(4.3)	(3.0)	(2.1)	(4.2)	(5.5)	(4.5)	(3.8)	(4.8)	(3.8)	(4.2)
Political	498	386	396	607	270	556	512	876	1259	2487	7847
	(18.6)	(23.6)	(15.4)	(21.6)	(15.3)	(16.1)	(15.6)	(13.1)	(13.5)	(13.2)	(14.8)
Social	52	38	49	39	42	68	81	120	211	364	1064
	(1.9)	(2.3)	(1.9)	(1.4)	(2.4)	(2.0)	(2.5)	(1.8)	(2.3)	(1.9)	(2.0)
Technological	525	258	452	477	370	621	660	1544	2164	4261	11332
	(19.6)	(15.8)	(17.6)	(17.0)	(21.0)	(18.0)	(20.2)	(23.2)	(23.2)	(22.6)	(21.4)
Total	2676	1634	2568	2806	1762	3451	3272	6668	9311	18873	53021
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: Relative frequency in parenthesis
Table 5. Macro-environment configuration for liquid biofuels by Brazilian journalists

Following the same analysis as done in scientific publications, also in mass media news further analysis is relevant to identify the discourse composition made by Brazilian journalists when publishing news on liquid biofuels. In Figure 3 are presented the results of clustering analysis taking into account the documents (a), paragraphs (b), and sentences (c) as units of analysis. The meaning and interpretation of these results have been discussed previously. As can be seen in Figure 3 ("a" and "b") there are no significant differences in the clusters when compared "documents" and "paragraphs". In both cases, the findings suggest that there are two main groups of mass media news. The most relevant is the group of mass media news that drives attention to a composition of political and geopolitical aspects of liquid biofuels sector. In the second group remains those news in which journalists have driven attention on economical and technological issues of liquid biofuels market.

As deeper the analysis goes, reaching the sentences as the unit of analysis (Fig. 3, "c"), more clear became the pattern in content of discourse done by journalists. The most relevant cluster of issues used in mass media is that composed by political, legal, and geopolitical aspects related to liquid biofuels. It is important to note that legal dimension occurs with a low relative frequency in the content of mass media news as a whole. However, such legal

issues are relevant when composing the complete ideas proposed by journalists regarding liquid biofuels topic.

Last, but not least, we are interested in investigating how the macro-environment for liquid biofuels have been configured by Brazilian policy-makers along the time. Despite the central role of Brazilian Government in giving support to *Proalcool* first and recently to biodiesel production and consumption, the analysis of public policies on liquid biofuels is a fundamental subject. The general findings can be seen in the Table 6.

(a)

(b)

(c)
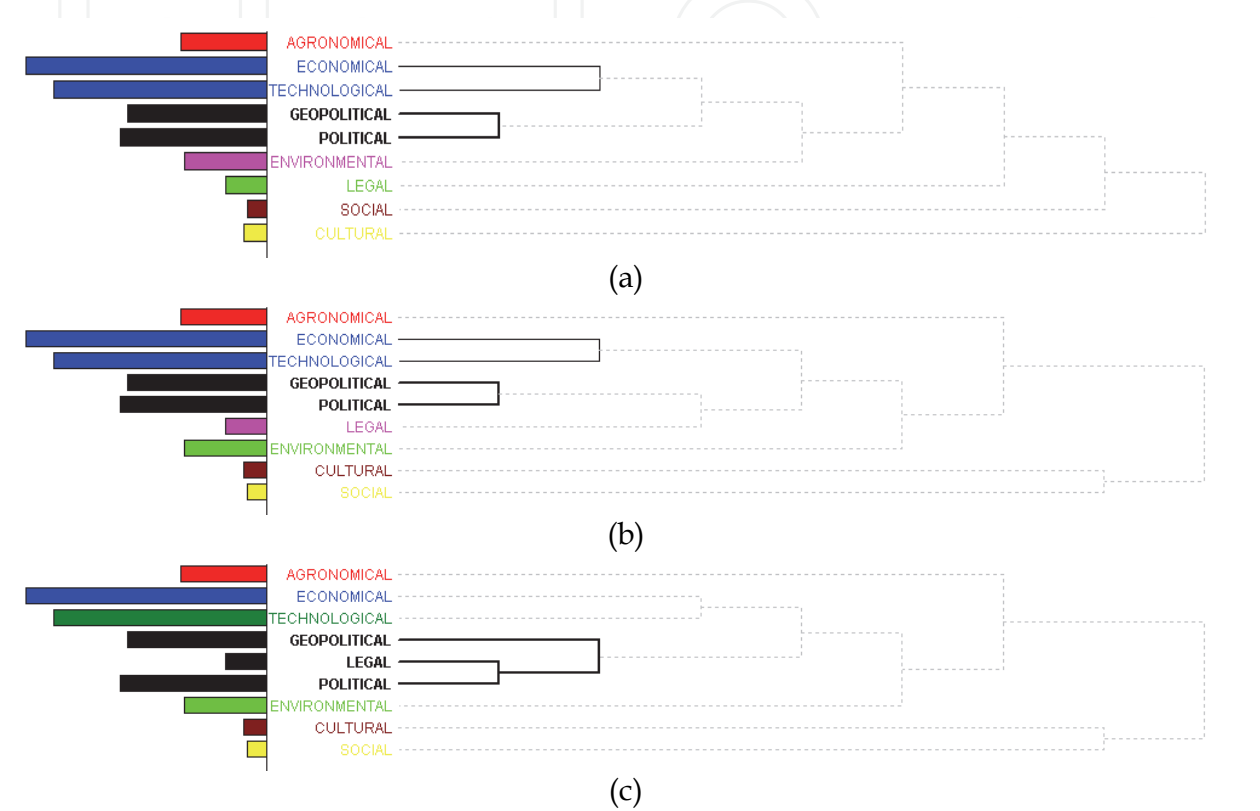
Note: "a", in the same document; "b", in the same paragraph; "c", in the same sentence

Fig. 3. Mass Media news content analysis by dimensions agglomeration order using Jaccard Coefficient

The findings obtained from text mining procedures on public policies documents have revealed that Brazilian policy-makers have focused mainly on technological aspects of liquid biofuels. The technological dimension have predominated absolutely along the ten years studied, not been surpassed by any other dimension in no time. The relative importance of technological dimension in Brazilian public policy may be related to Petrobrás, a public-private company which controls the liquid biofuels supply throughout the country. The second dimension most frequently observed in public policies is the geopolitical one, which also presents a trend of increasing its relative importance along the time. The economical, environmental, agronomical and political dimensions are in a set with intermediate relative frequency as observed on public policies documents. Legal, cultural and social dimension have presented the lowest frequency on public policies. Contrary to expectations, the social dimension did not appear as one of the main approaches of public policies, even in years after the inauguration of first President Lula's Government in 2002.

Looking for the future, the trend analysis reveals that liquid biofuels public policies in Brazil signal some change in the issues to be addressed in such policies. The most frequently used

| Dimensions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Agronomical	16	94	1204	3284	372	1410	950	2407	2551	8960	21248
	(2.1)	(5.2)	(8.2)	(8.6)	(8.8)	(7.7)	(11.7)	(7.4)	(12.0)	(14.1)	(10.5)
Cultural	7	21	601	2023	104	992	219	1513	881	3166	9527
	(0.9)	(1.2)	(4.1)	(5.3)	(2.5)	(5.4)	(2.7)	(2.7)	(4.1)	(5.0)	(4.7)
Economical	112	185	2323	3850	501	2102	849	3844	2359	7486	23611
	(15.0)	(10.3)	(15.8)	(10.1)	(11.8)	(11.4)	(10.4)	(10.4)	(11.1)	(11.8)	(11.6)
Environmental	60	213	908	5146	538	3055	1545	2575	2454	6794	23288
	(8.0)	(11.8)	(6.2)	(13.5)	(12.7)	(16.6)	(19.0)	(7.9)	(11.5)	(10.7)	(11.5)
Geopolitical	93	148	1994	5793	524	2563	937	5083	2864	9708	29707
	(12.4)	(8.2)	(13.6)	(15.2)	(12.4)	(13.9)	(11.5)	(11.5)	(13.5)	(15.3)	(14.6)
Legal	110	150	1607	2426	253	1127	409	2747	2220	3269	14318
	(14.7)	(8.3)	(10.9)	(6.4)	(6.0)	(6.1)	(5.0)	(5.0)	(10.4)	(5.2)	(7.0)
Political	104	238	1740	3675	286	1681	816	3345	2216	6074	20175
	(13.9)	(13.2)	(11.8)	(9.7)	(6.8)	(9.1)	(10.0)	(10.0)	(10.4)	(9.6)	(9.9)
Social	19	69	658	1324	149	853	248	966	726	1616	6628
	(2.5)	(3.8)	(4.5)	(3.5)	(3.5)	(4.6)	(3.0)	(3.0)	(3.4)	(2.5)	(3.3)
Technological	228	681	3676	10508	1509	4628	2174	9981	4981	16322	54688
	(30.4)	(37.9)	(25.0)	(27.6)	(35.6)	(25.1)	(26.7)	(26.7)	(23.4)	(25.7)	(26.9)
Total	749	1799	14711	38029	4236	18411	8147	32461	21252	63395	203190
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: Relative frequency in parenthesis

Table 6. Macro-environment configuration for liquid biofuels by Brazilian policy-makers

dimensions, like technological and economical, tend to lose their relative importance at the expense of inclusion of other aspects such as agronomical, geopolitical, and environmental. Such findings may indicate a set of public policies more aligned with the context of contemporary global energy sector. After being set the technological, economical, legal, and political standards, public policies tend to include other relevant aspects today, as: geopolitical issues, which involve the world's supply of fuel; and, environmental issues, in evidence due to global warming.

Following the same analysis pattern used in science and mass media, Figure 4 shows the results of a deeper inside document analysis. Taking into account the whole documents as unit of analysis (Fig. 4, "a") and a seven-cluster agglomeration, the findings are accurately in line with the configuration of macro-environment for liquid biofuels in Brazilian public policies. That is, the order of clustering of documents indicates that public policies have taken into account especially the technological, geopolitical, and economical issues. A second set of documents could be joined in a cluster of political-legal issues on liquid biofuels.

Using the paragraphs of public policies documents as unit of analysis (Fig. 4, "b"), the results reveal two main clusters of complete ideas used by Brazilian policy-makers. The cluster with higher Jaccard's Coefficient agglomeration order is that one composed by paragraphs which deal with political and social issues. Although the social dimension is one of the lowest frequency found in documents as a whole, the findings make sense regarding the recent public policies stated by Brazilian government on biodiesel. At last, the analysis using the sentences present in the public policies documents (Fig. 4, "c") reveals a main cluster composed by sentences which deals with technological-agronomical aspects, firstly, and adding economical ones, afterwards. It is important to note that the more close ideas expressed on sentences differ a bit from that general approach found in documents as whole, changing geopolitical issues by agronomical matters.

(a)

(b)

(c)
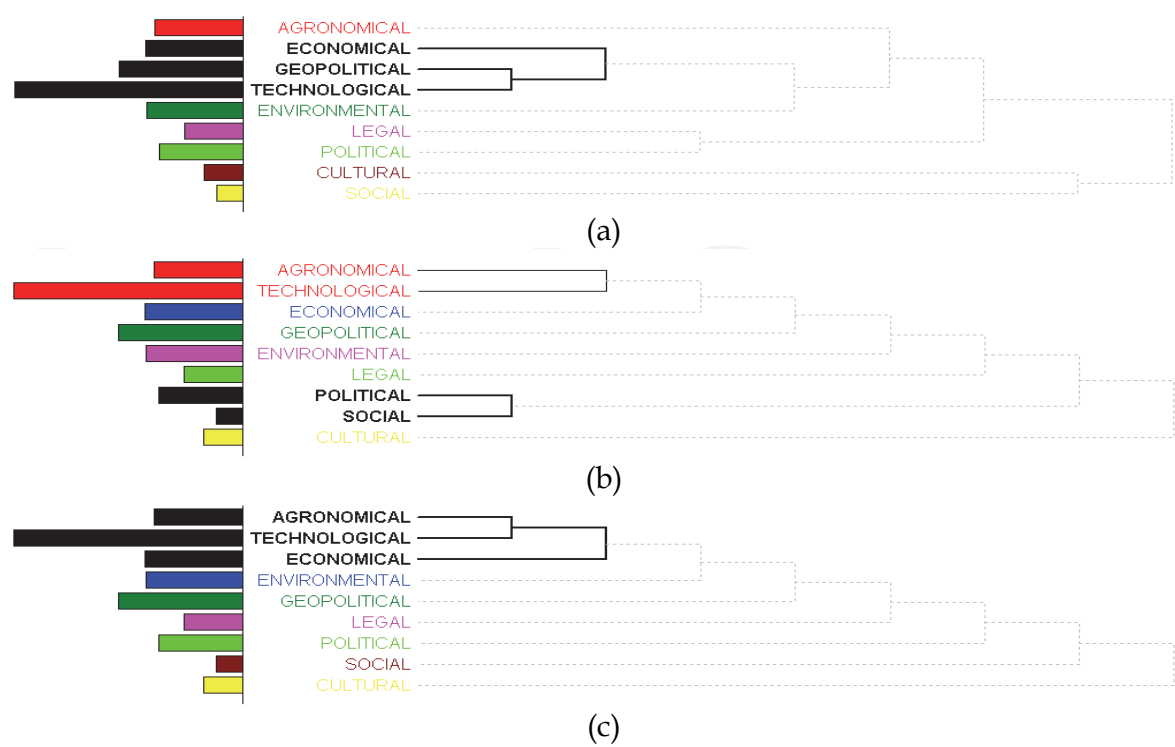
Note: "a", in the same document; "b", in the same paragraph; "c", in the same sentence
Fig. 4. Government documents content analysis by dimensions agglomeration order using Jaccard Coefficient

4.3 Correlating liquid biofuels production with macro-environment configuration

In this section we will search for some significant correlation between liquid biofuels production (ETP), number o scientific publication (SCP), mass media news (MMN), and governmental documents (GVD). As there is no sufficient data on biodiesel production to accomplish a correlation analysis, the Brazilian ethanol production was used as a proxy for investments on and liquid biofuels production in Brazil. The Pearson correlation values are shown in the Table 7.

|	ETP	SCP	MMN	GVD
ETP	1.000			
SCP	0.761*	1.000		
MMN	0.765*	0.968**	1.000	
GVD	0.713*	0.918**	0.918**	1.000

Note: *correlation is significant at the 0.05 level
         **correlation is significant at the 0.01 level

Table 7. Correlation matrix

As indicated by results the variables present a high level of correlation between each other. The higher correlation level was found between the number of scientific publication and mass media news. The number of governmental documents presents the same correlation value for both mass media news and scientific publications. Ethanol production presents higher correlation with mass media news, followed by scientific publications and governmental documents, although all values are significant at a same 0.05 level.

Taking into account that organizations react to macro-environmental configuration, more important than analyse the correlation between liquid biofuels and number of documents is to check for some correlation between production and macro-environmental configuration. In this direction in the Table 8 are presented the values for Pearson correlation between the amount of ethanol production and the total frequency that each macro-environmental dimension was counted in the scientific publications, mass media news, and governmental documents.

Macro-environmental dimensions	Ethanol Production – ETP
Agronomical by science	0.696*
Cultural by science	0.703*
Economical by science	0.592
Environmental by science	0.604
Geopolitical by science	0.718*
Legal by science	0.698*
Political by science	0.662*
Social by science	0.726*
Technological by science	0.679*
Agronomical by mass media	0.724*
Cultural by mass media	0.767**
Economical by mass media	0.688*
Environmental by mass media	0.777**
Geopolitical by mass media	0.771**
Legal by mass media	0.827**
Political by mass media	0.737*
Social by mass media	0.782**
Technological by mass media	0.761*
Agronomical by government	0.498
Cultural by government	0.282
Economical by government	0.367
Environmental by government	0.208
Geopolitical by government	0.325
Legal by government	0.293
Political by government	0.342
Social by government	0.146
Technological by government	0.290

Note: *correlation is significant at the 0.05 level
          **correlation is significant at the 0.01 level

Table 8. Pearson Correlation – ethanol production and macro-environmental dimensions

In general, the higher Pearson correlation values were observed between ethanol production and macro-environmental dimensions used by journalists. Regarding this, the ethanol production is mainly correlated with the frequency that legal, social, environmental, geopolitical, and cultural dimensions were counted in documents during the text mining procedures. All of those correlations are significant at a 0.01 level. The correlations of ethanol production with other macro-environmental dimensions present in mass media were significant at the 0.05 level. The findings also indicate a medium correlation between

ethanol production and the frequency that macro-environmental dimensions were counted in scientific publications. Just economical and environmental dimensions in science return a no significant correlation with ethanol production. All others correlations are significant at the 0.05 level. At last, there were no significant level of correlation between ethanol production and the frequency with which any macro-environmental dimension appeared in governmental documents. This is a somewhat surprising finding in spite of the historical importance that public policies on liquid biofuels have had over time. Summarizing, what we can learn from the correlation analysis is that the decision making process in the organizations is using more mass media as a source of information regarding its investments in ethanol production than governmental approach or scientific knowledge.

On the other hand, there may be a time lag between the macro-environmental setting made by scientists, journalists and politicians and the increasing in production of liquid biofuels. Searching for evidences in that direction pairwise Granger causality tests were accomplished with one and two years of time lag. Main findings can be seen in the Figure 5 ("a" and "b").
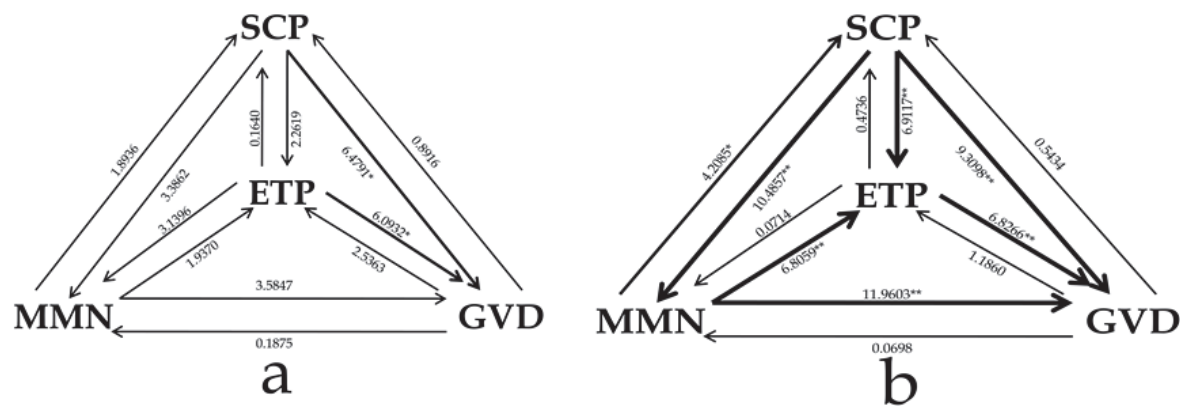
Notes: "a": two years time lag
          "b": one year time lag
          *significant at the 0.05 level
          **significant at the 0.01 level

Fig. 5. Granger Causality Test (F-Statistic)

The Granger causality test is a statistical procedure to refuse or not the null hypothesis than a variable A does not cause a variable B. According to results presented in Figure 5 (a), we can accept the null hypothesis for almost all pairwise tests with a two years time lag. The exceptions are that: (i) the hypothesis that the number of science publications (SCP) does not cause the number of governmental documents (GVD); and, (ii) the hypothesis that the amount of ethanol production (ETP) does not cause the number of governmental documents (GVD), both cannot be refused. Also the hypothesis that the number of mass media news (MMN) precedes the ethanol production (ETP) and the number of governmental documents (GVD) cannot be refused.

On the other hand, the results change when just one year is used as time lag in Granger causality tests (Fig. 5, "b"). Many of the pairwise Granger causality test indicate that we cannot refuse the null hypothesis. Then, we cannot refuse the hypothesis, at a 0.01 level of significance, that the number of scientific publications precedes the number of mass media

news, the governmental documents and also the ethanol production. Such findings suggest that science plays a leading role in prospecting the liquid biofuels trends, being followed by other stakeholders. The results also suggest that government reacts to ethanol production instead of the contrary, suggesting that the main role performed by government is regulating the market after its emergence and not to be central agent which stimulates the raising of liquid biofuels to a new industry. The Granger causality test revealed that government is preceded by all other stakeholders and does not precede any of them.

Additional analysis using Granger causality tests revealed that we cannot refuse the hypothesis that ethanol production is preceded mainly by macro-environmental dimensions used by journalists to frame liquid biofuels. Results indicate that ethanol production is preceded by agronomical, cultural, environmental, geopolitical, legal, political, social, and technological dimensions present in the mass media content. Ethanol production is also preceded by economical, environmental, and technological dimensions explored by scientists in producing knowledge on liquid biofuels. Once more, any macro-environmental dimension present in public policies precedes the ethanol production.

5. Conclusions

Three main questions were addressed in this paper regarding the macro-environmental configuration for liquid biofuels in the Brazilian science, mass media, and government and its implications for investments on and liquid biofuels production. From a content analysis accomplished by text mining procedures applied to scientific publication, mass media news, and governmental documents, some conclusions can be pointed out.

In general the conclusion is that Brazilian scientists, journalists, and policy makers have configured the macro-environment for liquid biofuels under different dimensions along the time. Scientists have emphasized more agronomical, environmental and technological aspects of liquid biofuels production and consumption. Journalists, as a characteristic of day-to-day agenda, have based their agenda mainly on economical and geopolitical issues. Technological standards and geopolitical issues are among the main topics present in the policy-makers' agenda. However, the relative importance of macro-environmental dimensions changes along the time. That means that investors in Brazilian liquid biofuels sector may find different macro-environments according to the source of information they use. So, a properly macro-environmental scanning practice should be encouraged before the accomplishment of strategic planning and decision-taking process.

As results suggested, the public policies for liquid biofuels in Brazil seem to be more a mass media-based process than a science-based one. Regarding the alignment between public policies and mass media news we could suggest that managers should use mass media ways of information (newspaper, magazines, broadcasts and so on) in scanning the macro-environment for liquid biofuels, once they will reproduce or influence the public policies in liquid biofuels field. On the other hand, despite the time lag between a scientific recommendation and its adoption as a public policy, we could suggest that managers should also look for information (scan the macro-environmental configuration) in science in advance, as a way to prospect possible public policies in the future.

The macro-environmental scanning in the liquid biofuels sector seems to be a useful tool in strategic planning process, agreeing with the results found by previous studies in the same direction. Regarding the public policy-making process in Brazil, the policy-makers and scientists seem not to work close to each other. It implies that in the liquid biofuels matter

the Brazilian science seems to play a secondary role in public policy orientation. The results suggest that there is a distance between knowledge creation and its application by policy makers. Of course, there are many reasons for it. So, for scholars and for policy makers also, we can suggest a close cooperation and interaction in putting scientific knowledge creation in line with public interest, or conversely.

Taking into account the results obtained in this study, we can suggest some future studies in a sense to analyze this topic widely and deeper. For instance, to analyze the perception (positive, negative or neutral) of each stakeholder group on the liquid biofuels and correlate their perception with the investments and production of ethanol and/or biodiesel; to identify the gap between a scientific topic prescription and its real adoption by policy-makers including it into the public policies; and, future analysis should be done to understand how biodiesel production and consumption, specifically, react to macro-environment configuration.

6. Acknowledgments

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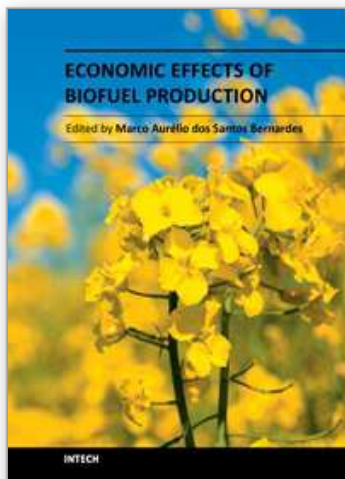
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