

# The Macro-Environment for Liquid Biofuels in German Science, Mass Media and Government

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## Abstract

This paper aims to investigate the dimensions under which the macro-environment for liquid biofuels has been structured during the time, respectively by German scientists, journalists, and policy-makers, and how these three stakeholders related to each other. Research was carried out on German official government documents (168 documents), mass media news (760 news), and scientific articles (168 articles) on the topic 'liquid biofuels'. Text Mining techniques were used to extract knowledge from textual documents' content. The results indicate that German scientists have used environmental, agronomic and technological dimension more frequently; journalists focused more on geopolitical and economics dimensions; and, policy-makers have emphasized more technological, geopolitical and environmental dimensions. Adherence and Homogeneity Tests suggest that there is some degree of proximity between mass media and government, less between mass media and science, and the least between government and science when configuring the macro-environment for liquid biofuels.

**Keywords:** bioenergy, ethanol, biodiesel, text mining, macro-environmental scanning

## 1. Introduction

Economic interest on renewable fuels has grown considerably, particularly the production and consumption of liquid biofuels, namely biodiesel and ethanol. Biodiesel and ethanol production soared around the globe, mainly in United States, Brazil, Germany, France, Italy and Spain (IEA, 2009). According to Bockey (2009) biodiesel is one of the most promising renewable fuels in Germany, followed by ethanol. Biodiesel has emerged as the leading liquid biofuel option partially because of the ready availability of raw materials for its production, mainly rapeseed (Bockey, 2009). According to European Biodiesel Board – EBB, from 1998 to 2008 German biodiesel production has moved from a modest level near 100,000 metric tonnes to 2,819,000 metric tonnes (EBB, 2009). The EBB data show that Germany not only is the leader European country in biodiesel production, but also that Germany has the highest production capacity among the EU-27 members.

The increase in the production level and production capacity means that the liquid biofuel businesses are attracting more and more investments along the production chain, from farmers to processors and distribution stages. Therefore, it seems that decision-makers in German liquid biofuels sector and related to it would be interested in scanning the industry macro-environment properly as a way to support their strategic planning and the decision making process. The macro-environmental scanning is a first and important stage in the strategic planning process through which the decision makers can look out for the patterns and changes in the industry's environment as a way to gather informations which help them in the decision making process (Johnson, Scholes, & Whittington, 2008).

The macro-environment for a specific industry or sector can affect business in different ways. It can be configured by the interaction between a wide range of stakeholders, namely policy-makers, scientists and journalists, along the public and the industry/sector actors. As a new field of interest and investments, the liquid biofuels sector asks for a set of particular public policy to regulate it, to create incentives and/or to draw some limits or constraints to its activities. In such a case, the German government can be seen as a player with an important role in the liquid biofuels macro-environment configuration in Germany and in Europe as well (Balat, 2007; Talamini, Wubben, Padula, & Dewes, 2013). Scientists, on the one hand, by their knowledge itself and their contributions to the technological development, can influence the macro-environment configuration of a certain business by their interaction with policy-makers and journalists, suggesting a new set of concerns and technical aspects to be referred to in public policy or in mass media messages, according to their scientific findings (Sabatier, 1991; IPCC, 2004). On the other hand, mass media, in their way of spreading information, have a powerful influence on the public and on the policy-makers, and are able, as well, of changing the macro-environment configuration of an economic activity (Gamson & Modigliani, 1989; Strömberg, 2001).

The liquid biofuel production in Germany may be influenced by different forces, like environmental and cultural aspects. The European consumers are concerned with environmental matters and changing their consumption preferences in direction to more environmentally-correct products (Büttner and Grübler, 1995; Willer and Yussefi, 2005). Political and economic issues may also be pointed out. The *Renewable Energy Act*, passed in April 1<sup>st</sup> 2000, established the goal of increase the use of renewable energy from 12.5% by 2010 to 20% by 2020 (Germany, 2000); the new blend of biofuels to fossil fuels from 2% in 2005 to 5.75% by 2010 was defined in the Directive 2003/30/EC dated May 8<sup>th</sup> 2003 (EC, 2006); finally, the tax incentive by German government which is the highest in European Union according to Frondel and Peters (2006).

Taking into account that, firstly, the liquid biofuels industry in Germany has been attracting many investors and new opportunities for investments are latent; secondly, understanding that the macro-environment configuration is important for decision-makers; and, thirdly, scientists, journalists and policy-makers play an important role in configuring a business macro-environment, this paper aims to answer the following questions: under which dimensions the macro-environment for liquid biofuels has been structured during time, respectively by science, mass media, and government in Germany? Are there similarities in the macro-environment configuration expressed by German scientists, journalists and policy-makers? The purpose of this paper is to investigate under which dimensions the macro-environment for liquid biofuels has been structured along the time, respectively by German scientists, journalists, and policy-makers, and how these three stakeholders related to each other.

## **2. Interactions between Scientists, Journalists and Policy-Makers**

The relationship between mass media and government is a matter widely studied in communication sciences. Accordingly, there is a bi-directional relationship between these two stakeholders, and the level of influence on each other depends on the relative power in a specific situation. According to Mermin (1997), there is a relationship of influence and dependency between mass media and government. If mass media can drive the government attention to specific subjects, it can also have influence on the public policy carried out by government. On the other hand, government can also use its power to define the mass media agenda. Moreover, the government can be seen as a mass media sponsor (Gamson & Modigliani, 1989), while it influences the mass media agenda (Strömberg, 2001) and frames its policies through the mass media, as stated by Van Gorp (2007).

The relationship between mass media and government can be assumed as stronger than that between mass media and science, because journalists more often favor in covering politic events compared to scientific ones (Friedman, Dunwoody, & Rogers, 1986).

During some time scientists and policy-makers were not working closed each other. The interdependence between them was weak and unusual. As a result, the use of scientific knowledge for public policy purpose was just occasional. From 1960's the use of scientific knowledge in the public policy design became more frequent and scientists and policy-makers understood that there was an interdependency between each other (Sabatier, 1991). However, the relationship between them is still tense and somehow breakable.

The difficulties in the information flow between scientists and policy-makers may be dependent on the country priorities and government necessities. In the United States, for instance, the importance of scientific questions in the political agenda has changed significantly. In 1950's the most important issue addressed by government was the atomic bomb. As scientists had the technical knowledge about the atomic bomb, government starts to see scientists as advisors for definition of political issues related to that matter (Abelson, 1988).

As scientists and policy-makers have different strategic perspectives; their decision making is based on distinct utility principles; and, the applied research on politics and social have some degree of political 'morality',

eventual conflicts in the relationship between scientists and policy-makers may be seen as normal (Averch, 1987). Averch (1987) stated that, although the conflict can be not totally removed, it can be reduced by two means: science producing truth and useful information for policy-makers decisions and addressing more attention to quality control and the application possibilities of scientific results.

Other causes are highlighted as critical for the weak influence of science on government. Keren (1983) affirm that the communication between scientists and policy-makers is constrained by the competitive visions about the nature of knowledge. Abelson (1988) also points towards problems in the communication saying that many scientists show difficulties in separating technical knowledge from ideological convictions when called upon to assist governments. Besides that, the introspective culture of the scientific community can impose loss of credibility to those scientists, who got themselves involved in questions related to politics or public management (Steel, List, Lach, & Shindler, 2008).

In Miller's (1999) opinion, the political decisions are more affected by the political game than by the technical and rational arguments. Additionally, the political concerns are not always in line with scientific findings. The use of scientific findings for public policy purpose depends on nature of the process of public policy development, the role of science and research in public policy design and how the relationship between research and politics is established (Booth, 1990). According to Bradshaw and Borchers (2000) the gap between science and government is the scientific uncertainty, which could be solved if scientific uncertainty is incorporated into a rigorous decision-theoretic framework as knowledge. In other words, science might be producing the necessary knowledge, which is sub-utilized for structural reasons of the political process and which leads to a distorted assessment of the importance of science.

The increasing importance addressed to the climate change and environmental matters has given a new opportunity for scientists and policy-makers to work closely. The assessment of Inter-governmental Panel on Climate Change is a clear example (IPCC, 2004). Around the globe many efforts can be seen in the sense to integrate scientists and other stakeholders (Falkenmark, Gottschalk, Lundqvist, & Wouters, 2004; Totlandsdal, Fudge, Sanderson, Van Bree, & Brunekreef, 2007; Holmes & Clark, 2008). The Copenhagen round table on climate change is another, recent example of this trend (Tollefson, 2009).

Regarding the liquid biofuels, there is apparently a closer dialogue between scientists and government. Searching for publications on the subject in the Science Magazine, one of the leader scientific journals worldwide, a hundred twenty-six references with the key-words "policy" and "biofuel" were found from 1975 to 2009, most of them published in the last five years. Evenmore, such journal offers the Policy Forum, a specific section designed to establish a communication between the scientific community and the political arena.

In the scientists-journalists relationship, a question to be addressed in understanding the science-mass media interaction is: why this relationship should be present? According to Dunwoody and Ryan (1985) and Friedman et al. (1986), the presence of this relationship can not be explained just by the necessity in transmitting the scientific knowledge to the lay public, but also for science obtaining popular support in getting public financing. In the same direction, Gehards and Schäfer (2009) suggest that this relationship is a way of legitimation of science to the public. Insofar, mass media acts as a mediator, not only between science and public, but also between science and government. On the mass media side, science is also an important source of information to compose the mass media daily news agenda (Friedman et al., 1986).

We have been looking at the way scientists, journalists, and policy-makers interact in configuring the macro-environment for liquid biofuels in those countries where this new industry is emerging. In Brazil, one of the leading countries in this field, we measured the similarities between the way Brazilian government and mass media configure the biofuel industry macro-environment, and between science and public policy (Talamini & Dewes, 2009, 2012). The results suggest that there are no significant similarities between them, although government and mass media are closer in similarity than science and government. Based on those results, it seems that, in Brazil, scientists, journalists and policy-makers describe the matters of liquid biofuels business from a different perspective. In United States was found that similarities between policy-makers and scientists are higher than policy-makers and journalists. Despite the mass media agenda to be gaining ground in the public policy agenda in comparison to science (Talamini, Caldarelli, Wubben, & Dewes, 2012).

Taking into account the aspects of scientists-journalists-policy maker's relationship, as described in the literature, the following hypotheses are stated:

*Hypothesis 1: there is similarity in the macro-environmental dimensions under which the liquid biofuels are framed by mass media and government in Germany;*

*Hypothesis 2: there is dissimilarity in the macro-environmental dimensions under which the liquid biofuels are framed by science and government in Germany;*

*Hypothesis 3: there is dissimilarity in the macro-environmental dimensions under which the liquid biofuels are framed by science and mass media in Germany.*

In the business environment, the strategic planning and decision taking are continuously developed by supporting of information gathered in different sources. For a long time the most common sources of information external to organization used by managers were those related to the mass media and governmental agencies. The scientific studies were not pointed out as a usual source of information by managers (Keegan, 1974, Ginter & Duncan, 1990; Ngamkroekjoti & Johri, 2000; Jogaratnam & Law, 2006). However, in the case of science being a driver for public policy, for instance, scientific information could be added as a source of information to be retrieved by decision-makers.

### 3. Methods and Procedures

In order to scan the macro-environment for liquid biofuels in Germany, a content analysis applied to scientific papers, mass media news, and government official documents was accomplished. The concept of Knowledge Discovery in Text and Text Mining techniques were used. The Text Mining procedures adopted in this study followed the steps proposed by Hippner and Rentzmann (2006).

The selection of scientific papers, mass media news and government documents was conducted by using a list of keywords related to the 'liquid biofuels' topic (see Figure 1). The list of keywords was composed by words in English and also German Languages because some sources the documents were available in both idioms. The stated keywords were used to search and trace mass media news, scientific papers and governmental documents in Germany, as presented in the Table 1. The searching for governmental documents starts from the main German government site in the World Wide Web, from which other sites of Ministries, Federal Secretariats, Departments and non-governmental institutions were visited. Using the search engines available in the related homepages, the documents were located and downloaded.

BIOFUEL, BIOFUELS, BIO-FUEL, BIO-FUELS, BIODIESEL, BIO-DIESEL, ETHANOL, BIO-ETHANOL, BIOETHANOL, BIO-OIL, ALCOHOL, BIOKRAFTSTOFF, BIO-KRAFTSTOFF, BIOTREIBSTOFF, BIO-TREIBSTOFF, BIOBRENNSTOFF, BIO-BRENNSTOFF, BIOFEUERING, BIO-FEUERING, ÄTHANOL, BIO-ÄTHANOL, BIOÄTHANOL, BIO-ÖL, BIOÖL

Figure 1. Keywords related to liquid biofuels

The information available in 'Press Room' was not included in our analysis because we tried to reduce the impact of eventual ordinary political and electoral discourse in the research findings, focusing only on German government official programs and public policy. Scientific papers were searched in the Web of Science database, selecting those papers pertaining to at least one author affiliated to German institutions. For representing the German mass media well known newspapers and tabloids were chosen. Search engine was used to retrieve the news from newspapers archive.

Table 1. German's sources of information

Stakeholder	Source of Information	World Wide Web link
Science	Web of Science	<a href="http://portal.isiknowledge.com">http://portal.isiknowledge.com</a>
Mass Media	Die Zeit	<a href="http://www.zeit.de">http://www.zeit.de</a>
	Welt Online	<a href="http://www.welt.de/archiv">http://www.welt.de/archiv</a>
	Berliner Zeitung	<a href="http://www.berlinonline.de/berliner-zeitung">http://www.berlinonline.de/berliner-zeitung</a>
	Sueddeutsche Zeitung	<a href="http://www.sueddeutsche.de">http://www.sueddeutsche.de</a>
	Frankfurter Rundschau	<a href="http://www.fr-online.de">http://www.fr-online.de</a>
	Der Tagesspiegel	<a href="http://www.tagesspiegel.de">http://www.tagesspiegel.de</a>
	Hamburger Morgenpost	<a href="http://www.mopo.de">http://www.mopo.de</a>
	Freitag	<a href="http://www.freitag.de">http://www.freitag.de</a>
Government	German Government official portal on the World Wide Web	<a href="http://www.bundesregierung.de">http://www.bundesregierung.de</a>

Documents from government, science and mass media were collected for a ten-year time frame (1997-2006). Considering the increasing frequency of scientific papers retrieved along the analyzed time it was clear how the liquid biofuels topic has expanded. The documents were filed in three specific folders: science, mass media and government, arranged by year of publication. When the process of gathering document was finished, the databases were composed by 149 scientific papers, 765 mass media news, and 170 governmental documents, totaling 1,084 documents.

In the next step, the textual content of the documents was transferred to a particular document-base built with the assistance of the QDA Miner®. This software prepares the textual content for later submission to Text Mining procedure. As QDA Miner® needs Rich Text Formats (\*.RTF) to construct the database and some documents were gathered in PDF with their content blocked, 11 scientific papers, 5 mass media news, and 2 government documents were lost. Therefore, the final composition of the database was made up of 138 scientific papers, 760 mass media news, and 168 governmental documents, totaling 1,066 documents.

To discover the knowledge present in textual documents an analytical structure was built. In general, in studies of content analysis is common the use a list of keywords, as can be seen in the Crawley's (2007) study. In our study we consider the macro-environmental dimensions under PESTEL acronym, known as Political, Economic, Sociocultural, Technological, Environmental and Legal (Johnson et al., 2008), rearranged and added by new dimensions as requested by the specificities of liquid biofuels subject. Thus, the final list of macro-environmental dimensions was composed by nine dimensions, as follow: Agronomical, Cultural, Economic, Environmental, Geopolitical, Legal, Political, Social and Technological.

After the definition of macro-environmental dimensions, the next efforts was directed to identify a list of words related to each dimension, which we call 'dimension-words' or just '*d-words*'. The set of '*d-words*' is made up of relevant terms that best discriminate a certain macro-environmental dimension. As we have selected nine dimensions, nine sets of '*d-words*' were required. Thus, the question was: how to identify the terms and to establish the number of '*d-words*' for each dimension? That is, how many and which are the '*d-words*' that would better discriminate the agronomic dimension?

To solve the problem, we tried to identify the words that occurred more frequently in scientific journals in the knowledge arena related to a specific macro-environmental dimension. A list of scientific journals with high impact factor was firstly nominated: *Agronomy Journal* (impact factor 1,272) *European Journal of Agronomy* (1,203), *Journal of Agronomy and Crop Science* (1,046), and *Journal of Agricultural Science* (0,861), were the selected journals for agronomic dimension, for instance. An issue of each journal was randomly selected for the following years: 1998, 2000, 2002, 2004 and 2006, because the time frame is similar to the data collected (1997-2006). The same procedures were applied for each dimension.

From all scientific papers published in the selected issues titles, abstracts and keywords were collected. The textual content of such elements was then moved to a database in QDA Miner® software. Then, the frequency of words was found with WordStat module of SIMStat®. A list of thousands of words was organized in descending order according their TF\*IDF (Note 1) rate, which shows the decreasing relevance of the words in the content of scientific documents (Aizawa, 2003).

Percentile measures was applied in order to define the number of '*d-words*' that best discriminated each dimension (see Table 2).

For each dimension an average of 14.2 '*d-words*' was selected. Rules were added always that a '*d-word*' became common to two or more dimensions. The rules may be seen in Table 2 by '*d-words*' beginning by '@'. The rules took into consideration the co-occurrence of terms within the same document. The rules were determined by using Jaccard's Coefficient (Chung & Lee, 2001). The '*d-word*' 'production', for instance, was counted into agronomic dimension each time that it co-occurred with words 'yield' or 'crop' in a same document.

Using the combination of database of textual content and the knowledge extraction structure, Text Mining procedures were applied by means of WordStat module of SIMStat®. As a result, it was possible to determine the frequency with which each '*d-word*' and macro-environmental dimension occurred in scientific papers, mass media news, and governmental documents. Thereafter the frequency was determined by the times of each macro-environmental dimensions was called upon in the selected documents indicating how the macro-environment of liquid biofuels was configured by German scientists, journalists and policy-makers.

The frequencies of the occurrence of the macro-environmental dimensions were used for the final analysis of the results. Based on the frequencies, tables and figures were built. To analyze the co-occurrence and the linking process between dimensions a cluster and network analysis was carried out. To verify the similarities or

dissimilarities regarding the frequency of use of the nine dimensions for the macro-environment configuration for liquid biofuels between science, mass media and government, adherence and homogeneity tests were carried out.

Table 2. Set of “*d-words*” for the agronomic dimension

List of “d-words” – English Language	List of “d-words” – German Language
<ul style="list-style-type: none"> <li>• @PRODUCTION_AGRO [PRODUCTION AND YIELD   PRODUCTION AND CROP /C] (1)</li> <li>• @WATER_AGRO [WATER AND SOIL   WATER AND FIELD /C] (1)</li> <li>• APPLICATION (1)</li> <li>• APPLICATIONS (1)</li> <li>• CROP (1)</li> <li>• CROPPING (1)</li> <li>• CROPS (1)</li> <li>• CULTIVARS (1)</li> <li>• GROWTH (1)</li> <li>• HA (1)</li> <li>• IRRIGATION (1)</li> <li>• PLANT (1)</li> <li>• PLANTING (1)</li> <li>• PLANTS (1)</li> <li>• QUALITY (1)</li> <li>• RICE (1)</li> <li>• SEED (1)</li> <li>• SEEDING (1)</li> <li>• SEEDLING (1)</li> <li>• SEEDS (1)</li> <li>• SOIL (1)</li> <li>• SOILS (1)</li> <li>• SOYBEAN (1)</li> <li>• TILLAGE (1)</li> <li>• YIELD (1)</li> <li>• YIELDS (1)</li> </ul>	<ul style="list-style-type: none"> <li>• @KULTUREN_AGRO [KULTUREN AND BODEN   KULTUREN AND ERTRAG /C] (1)</li> <li>• @KULTUR_AGRO [KULTUR AND BODEN   KULTUR AND ERTRAG /C] (1)</li> <li>• @PRODUKTION_AGRO [PRODUKTION AND ERTRAG   PRODUKTION AND KULTUR /C] (1)</li> <li>• @WASSER_AGRO [WASSER AND BODEN   WASSER AND FELD /C] (1)</li> <li>• ANTRAG (1)</li> <li>• ANTRÄGE (1)</li> <li>• BEWÄSSERUNG (1)</li> <li>• BODEN (1)</li> <li>• BÖDEN (1)</li> <li>• ERNTE (1)</li> <li>• ERTRAG (1)</li> <li>• ERTRÄGEN (1)</li> <li>• HEKTAR (1)</li> <li>• JUNGPFANZEN (1)</li> <li>• PFLANZE (1)</li> <li>• PFLANZEN (1)</li> <li>• PFLANZENBAU (1)</li> <li>• PFLANZENZÜCHTUNG (1)</li> <li>• QUALITÄT (1)</li> <li>• REIS (1)</li> <li>• SAMEN (1)</li> <li>• SÄEN (1)</li> <li>• VIELFALT (1)</li> <li>• WACHSTUM (1)</li> </ul>

#### 4. Results and Discussions

In this section the results will be presented, comparing the nine macro-environmental dimensions under which the liquid biofuels have been configured by German scientists, journalists and policy-makers. The first set of results is presented on tables which show the absolute and relative frequencies of each macro-environmental dimension according its occurrence in the science, mass media and government publications along the analyzed periods. After it, a comparison between science, mass media and government is presented taking into account the total frequency accumulated over time.

At start, as shown in the Table 3, German science configured the macro-environment for liquid biofuels mostly under the environmental dimension, followed by the technological and legal ones. In the following years three dimensions appear as the most frequent: environmental, technological and agronomic. In 1998 the agronomic dimension rose up to the first position in frequency and the same occurred in 2004. From 1999 to 2003 and later, in 2005 and 2006, the environmental dimension was the most frequent in the German science. The importance of such dimensions in the German science can be observed by the average of its relative frequency over time. The environmental dimension obtained an average of 37% per year, followed by the agronomic with 24% and 19% for technological dimension, totaling 80% of relative frequency of all dimensions. This means that, although the other macro-environmental dimensions were present in the German science agenda, they were just slightly frequent in the science content, so with cultural, legal and social ones.

German mass media towards the liquid biofuels sector has been prioritising other dimension in its discourse. In general, in the German mass media there is no well defined pattern in using dimensions to configure the macro-environmental for liquid biofuels as observed in German science (see Table 3). At the beginning, most

attention was addressed to the economic and geopolitical dimensions, followed by the technological one. In 1998 just three dimensions marked the mass media news: environmental, economic and agronomic. In 1999 and 2000 the agronomic aspects related to the liquid biofuel dominated the mass media news, decreasing its relative importance the following periods. A similar performance was observed regarding the environmental and economic dimensions, although the relative frequency of economics aspects increased again in the last periods. The most important matter in the mass media content, regarding the liquid biofuels, was attributed to the geopolitical dimension. The importance of geopolitical discussion, measured by its relative frequency, has an increasing tendency since 1999. In the last 6 periods it was the most frequent in 5, with the highest values observed in 2001, 2002 and 2003, maybe because the events of September 11, 2001 in the United States and the related facts, like the Iraq War.

The importance of such dimensions in the German mass media can be observed by the average of its relative frequency over time. The geopolitical dimension obtained an average of 21% per year, followed by the agronomical with 19%, environmental with 18%, and economic with 17%, totaling 75% of relative frequency of all dimensions. Other macro-environmental dimensions were also present in the German mass media agenda, but with a weak importance in the newspapers content, mainly legal, cultural, social and political. Technological aspects occupied an intermediary level of importance in the mass media liquid biofuels context. Results from German government are shown in the Table 5.

As there were not found any documents in the German government domains from 1997 to 2000, the frequencies in the table were reduced to zero. From 2001 to 2003 the document contents in the German government were addressed to three main macro-environmental dimensions: environmental, technological and agronomic, highlighting the higher relative frequency of environmental dimension in 2002. From 2004 to 2006 was observed a remarkable change in the set of the main dimensions under which German governmental has structured the macro-environment for liquid biofuel with an increasing importance attributed to the geopolitical aspects, besides technological and environmental dimensions. The geopolitical dimension was the most frequent found in 2004.

Table 3. Macro-environmental dimensions frequency in the German science<sup>a,b</sup>

Macro-environmental Dimensions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agronomic	13 (7.0)	249 (37.1)	410 (20.9)	442 (33.9)	186 (10.0)	513 (31.8)	539 (23.0)	416 (31.2)	722 (26.5)	1217 (21.8)
Cultural	4 (2.2)	6 (0.9)	42 (2.1)	13 (1.0)	21 (1.1)	25 (1.5)	26 (1.1)	20 (1.5)	38 (1.4)	84 (1.5)
Economic	27 (14.5)	58 (8.6)	175 (8.9)	36 (2.8)	41 (2.2)	41 (2.5)	273 (11.7)	53 (4.0)	288 (10.6)	416 (7.5)
Environmental	66 (35.5)	205 (30.5)	655 (33.4)	542 (41.6)	1078 (58.1)	601 (37.2)	938 (40.1)	370 (27.8)	781 (28.7)	1833 (32.8)
Geopolitical	20 (10.8)	31 (4.6)	82 (4.2)	82 (6.3)	86 (4.6)	38 (2.4)	105 (4.5)	60 (4.5)	310 (11.4)	384 (6.9)
Legal	7 (3.8)	11 (1.6)	13 (0.7)	6 (0.5)	26 (1.4)	15 (0.9)	28 (1.2)	12 (0.9)	45 (1.7)	64 (1.1)
Political	15 (8.1)	11 (1.6)	62 (3.2)	6 (0.5)	38 (2.0)	4 (0.2)	65 (2.8)	35 (2.6)	127 (4.7)	161 (2.9)
Social	0 (0.0)	17 (2.5)	44 (2.2)	11 (0.8)	37 (2.0)	12 (0.7)	10 (0.4)	1 (0.1)	12 (0.4)	41 (0.7)
Technological	34 (18.3)	84 (12.5)	479 (24.4)	165 (12.7)	342 (18.4)	365 (22.6)	355 (15.2)	365 (27.4)	398 (14.6)	1383 (24.8)
Total	186 (100.0)	672 (100.0)	1962 (100.0)	1303 (100.0)	1855 (100.0)	1614 (100.0)	2339 (100.0)	1332 (100.0)	2721 (100.0)	5583 (100.0)

<sup>a</sup>Absolute Frequency and <sup>b</sup>(Relative Frequency). Source: research data

Table 4. Macro-environmental dimensions frequency in the German mass media<sup>a,b</sup>

Macro-environmental Dimensions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agronomic	1 (3.4)	1 (14.3)	38 (41.3)	49 (26.2)	75 (22.2)	31 (13.8)	32 (13.9)	86 (26.5)	114 (10.6)	390 (14.3)
Cultural	2 (6.9)	0 (0.0)	2 (2.2)	9 (4.8)	16 (4.7)	2 (0.9)	8 (3.5)	7 (2.2)	22 (2.0)	65 (2.4)
Economic	8 (27.6)	2 (28.6)	14 (15.2)	30 (16.0)	29 (8.6)	20 (8.9)	24 (10.4)	41 (12.7)	227 (21.1)	516 (18.9)
Environmental	2 (6.9)	4 (57.1)	8 (8.7)	30 (16.0)	29 (8.6)	45 (20.1)	15 (6.5)	52 (16.0)	150 (13.9)	306 (11.2)
Geopolitical	8 (27.6)	0 (0.0)	19 (20.7)	28 (15.0)	95 (28.1)	57 (25.4)	75 (32.5)	70 (21.6)	264 (24.5)	690 (25.3)
Legal	0 (0.0)	0 (0.0)	1 (1.1)	4 (2.1)	0 (0.0)	4 (1.8)	4 (1.7)	6 (1.9)	23 (2.1)	86 (3.1)
Political	2 (6.9)	0 (0.0)	3 (3.3)	6 (3.2)	27 (8.0)	18 (8.0)	14 (6.1)	11 (3.4)	81 (7.5)	223 (8.2)
Social	1 (3.4)	0 (0.0)	2 (2.2)	16 (8.6)	16 (4.7)	9 (4.0)	16 (6.9)	13 (4.0)	49 (4.5)	127 (4.6)
Technological	5 (17.2)	0 (0.0)	5 (5.4)	15 (8.0)	51 (15.1)	38 (17.0)	43 (18.6)	38 (11.7)	148 (13.7)	329 (12.0)
Total	29 (100.0)	7 (100.0)	92 (100.0)	187 (100.0)	338 (100.0)	224 (100.0)	231 (100.0)	324 (100.0)	1078 (100.0)	2732 (100.0)

<sup>a</sup>Absolute Frequency and <sup>b</sup>(Relative Frequency). Source: research data

Table 5. Macro-environmental dimensions frequency in the German government<sup>a,b</sup>

Macro-environmental Dimensions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agronomic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	49 (8.9)	213 (7.6)	748 (18.3)	919 (6.5)	694 (8.0)	6666 (11.7)
Cultural	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.4)	17 (0.6)	80 (2.0)	519 (3.7)	341 (3.9)	2288 (4.0)
Economic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.5)	24 (0.9)	413 (10.1)	1254 (8.9)	750 (8.6)	6491 (11.3)
Environmental	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	177 (32.2)	1976 (70.2)	898 (22.0)	2335 (16.5)	1859 (21.4)	8899 (15.6)
Geopolitical	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	31 (5.6)	21 (0.7)	372 (9.1)	3639 (25.8)	1809 (20.8)	11069 (19.3)
Legal	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	75 (13.7)	63 (2.2)	196 (4.8)	1197 (8.5)	392 (4.5)	3487 (6.1)
Political	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	24 (4.4)	41 (1.5)	308 (7.5)	1755 (12.4)	741 (8.5)	4989 (8.7)
Social	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	9 (1.6)	36 (1.3)	74 (1.8)	524 (3.7)	225 (2.6)	1755 (3.1)
Technological	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	179 (32.6)	424 (15.1)	992 (24.3)	1983 (14.0)	1866 (21.5)	11570 (20.2)
Total	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	549 (100.0)	2815 (100.0)	4081 (100.0)	14125 (100.0)	8677 (100.0)	57214 (100.0)

<sup>a</sup>Absolute Frequency and <sup>b</sup>(Relative Frequency).

Source: research data

The significance of such dimensions in the German government can be estimated by the average of its relative frequency over time. The environmental dimension was the first with an average of 30% per year, followed by technological which average was 21% and geopolitical with 14%, totaling 65% of relative frequency of all

dimensions. Of course that others macro-environmental dimensions were also present in the German government agenda, but with a less comparative importance. As a medium average group we found agronomic, economic, legal and political dimensions and with low average cultural and social dimensions.

As stated above, a comparison between science, mass media and government use of macro-environmental dimensions can be done. Such analysis was carried out from the total frequency of each dimension along the time and the findings are presented at the Figure 2. The results confirm the presence of some similarities and differences among the three stakeholders. As previously stated, the dimensions environmental (36.1%), agronomic (24.1%) and technological (20.3%) were mainly addressed by the German scientists in scientific papers, while geopolitical (24.7%) and economic (17.4%) were most frequently used by German journalists. Technological (19.5%), geopolitical (19.4%) and environmental (18.5%) were most frequently used by German government.

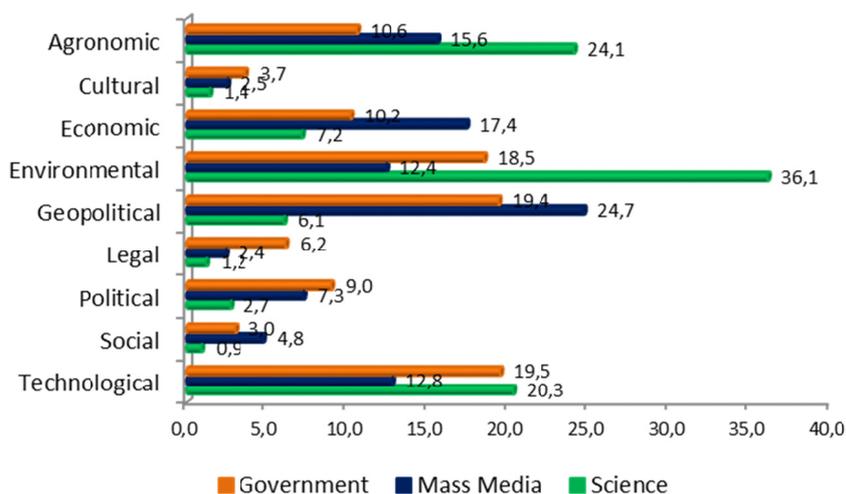


Figure 2. Relative frequency of the macro-environmental dimensions under which the liquid biofuels were categorized by the German science, mass media and government in a ten-year period

Source: Research data

As similarities between science, mass media and government we can point out the low frequency in the macro-environment configuration under political, legal, social and cultural dimensions. Science and government present a similarity because environmental and technological are among the three main dimensions used in the macro-environment configuration. The presence of technological among the three main dimensions is a similarity between science and mass media. On the other hand, there is a similarity between mass media and government in the use of the geopolitical dimension as one most frequently used.

Looking for similarities and dissimilarities between the three German stakeholders of the liquid biofuels sector, adherence and homogeneity tests were carried out. The results for adherence test between science, mass media and government can be seen at Table 6. According to Siegel and Castellan Jr. (2006) an adherence test is used to check whether there is a significant difference or not between the expected frequency of a category and the observed frequency. In this case, we check for adherence between the expected and observed values for each dimension taking into account the accumulated frequency. Then, we check for adherence between 'government to mass media' relation, for instance, using the mass media frequency as expected values and government frequency as observed values. The same procedure was accomplished in each relation presented on the Table 6.

Table 6. Adherence Test between German liquid biofuels stakeholders – Total dimensions frequency

Stakeholder's Relations	$\chi^2$
Government to Mass Media	16910.33
Mass Media to Government	891.57
Government to Science	79465.9
Science to Government	10805.1
Mass Media to Science	15886.20
Science to Mass Media	6174.83

df = 8;  $\alpha = 0.01$ ; Critical  $\chi^2$  value = 20.090; \*p < 0.01

The results for adherence test suggest that there is no significant adherence between science, mass media and government in Germany regarding the use of dimensions to configure the macro-environment for liquid biofuels. The lowest chi-square value, although without statistic significance, was that one observed between mass media and government ( $\chi^2 = 891.57$ ), suggesting that the relative frequencies of which each dimensions occur in the mass media were closer than those ones verified elsewhere.

As adherence tests don't reveal any significant similarity between science, mass media and government, homogeneity tests were carried out. In the homogeneity test we were looking whether two fields of social expression were using or not macro-environmental dimensions in a similar frequency taking the accumulated frequency over time. The results for homogeneity test are presented on the Table 7.

Table 7. Homogeneity Test between German liquid biofuels stakeholders – Total dimensions frequency

Relations	$\chi^2$
Mass Media and Government	833.9
Science and Government	8410.5
Science and Mass Media	3547.3

df = 8;  $\alpha = 0.01$ ; Critical  $\chi^2$  value = 20.090; \*p < 0.01

The results for homogeneity test suggest also that there is no significant similarity between science, mass media and government in Germany regarding the use of dimensions to configure the macro-environment for liquid biofuels. The closer homogeneity was verified between German mass media and government with the lowest chi-square value ( $\chi^2 = 833.9$ ). The second lower chi-square value ( $\chi^2 = 3547.3$ ) occurred between science and mass media. Finally, when comparing science and government results in the highest chi-square value ( $\chi^2 = 8410.5$ ), suggesting a weak similarity between those two stakeholders in the use of dimensions to configure the macro-environment for liquid biofuels in Germany, although any chi-square value have been significant at p<0.01.

After looking for similarities between science, mass media and government through the adherence and the homogeneity tests, a cluster and network analysis was accomplished. The clusters of macro-environmental dimensions were grouped by similarity index, according to Jaccard's coefficient by occurrence of each dimension. The network of dimensions was designed from its co-occurrence frequency at the same document. The thickest lines mean a strong relation between two dimensions. As thicker as a line is, stronger is the relation, that is, the more frequently two dimensions were found in the same document. The results are shown in the Figures 5, 6 and 7.

The top four dimensions cluster in the German government could be divided into two other clusters, one grouping the technological and environmental dimensions and other with geopolitical and economic dimension (Figure 3). The next stronger relations occur with agronomic dimension. Those findings suggest that, when discussing about the liquid biofuels, the technological and environmental aspects are more closely related in the policy-makers discourse, followed by the geopolitical and economic ones.

German science, on the other hand, has a well defined dominating cluster, which is composed by agronomic and technological first, linking with environmental thereafter (Figure 4). This cluster presents strong relations between the three dimensions and is so far from other macro-environmental dimensions, meaning that, when researching and working on liquid biofuels, German scientists have been investigating the relations between agronomic, technological and environmental aspects of liquid biofuels production and consumption.

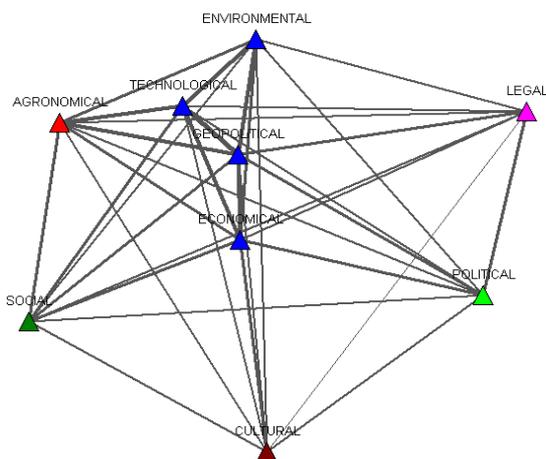


Figure 3. Macro-environmental dimensions cluster and network for German government

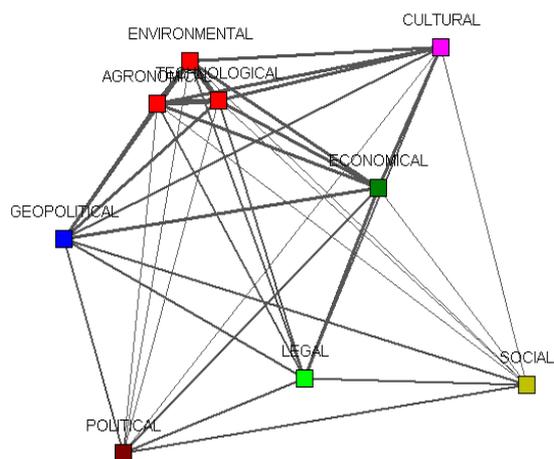


Figure 4. Macro-environmental dimensions cluster and network for German science

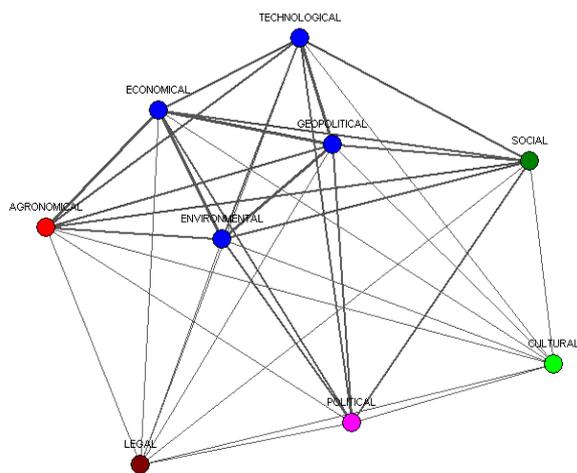


Figure 5. Macro-environmental dimensions cluster and network for German mass media

Finally, German mass media presents a cluster of top four dimension co-occurrence similar to that seen in the German government, almost in the list of macro-environmental dimensions that compose the top cluster: geopolitical, economic, technological and environmental (Figure 5). The strongest link occurs between economic and geopolitical dimensions, then linking with technological and after with environmental dimension.

The results suggest that, when informing the public (policy-makers, scientists, consumers, producers, managers, investors, and so on) about the liquid biofuels, the German journalists prioritize and relate geopolitical and economic aspects with each other more frequently, linking with technological and environmental matters as secondary in their discourse.

### **5. Concluding Remarks**

The primary conclusion of this study is that there is a set of macro-environmental dimension most frequently used in German science, mass media and government. Such dimensions are: agronomic, environmental, economic, geopolitical and technological. Although present in the stakeholders discourse, other dimensions (cultural, legal, political and social) were less frequently noticed on the document's content. Despite their same set of most frequently used dimensions, it does not mean that there is a high level of similarity between science, mass media and government because the frequency that each dimension had occurred varied from each stakeholder and over time. Therefore, the main conclusion is that, when scanning the macro-environment for liquid biofuels, the decision-makers will probably find out different configurations according to the source of information used. On following question is to identify which of them have more influence on the liquid biofuels players' decisions. In future studies we hope to explore such influences.

Derived from a literature overview, a set of hypotheses regarding the similarity in the macro-environment configuration was declared. Retrieving such hypothesis after the results and data analysis, we may conclude that hypothesis 1 was not confirmed, while hypotheses 2 and 3 were confirmed. That is, based on the results of adherence and homogeneity tests we should reject the hypothesis that German mass media and government configures the macro-environment for liquid biofuels under the same dimensions, at least at a chi-square statistical significance level. On the other hand, we can accept the hypothesis that there is difference in the macro-environmental dimension under which the liquid biofuels are framed by German science and government and also by science and mass media.

Considering the fact that German science, mass media and government stress different macro-environmental dimensions, it implies that investment decisions and the expansion in the production and use of liquid biofuels may be more or less affected by (changes in) the prevalent configuration of the national macro-environment. For example, changes in the environmental dimension may have a larger impact on the German scientific knowledge regarding biofuels than in other stakeholders. As well as changes in the economical dimension may have a larger impact on the German mass media than in other stakeholders. This stakeholder-by-stakeholder analysis of macro-environment configuration may help to safeguard private biofuel activities in Germany, by deploying a stakeholder-specific strategy on macro-environmental scanning.

In spite of statistical results have shown that there are no similarities between German science, mass media and government, the additional analysis of frequencies on which dimensions have joined occurred at the same documents suggest a closer relationship between mass media and government, followed by the relationship between mass media and science and, finally, by science and government. What should it mean? In our opinion, such findings take us to wonder about the influence of journalists on the policy-makers. In other words, it could mean that German public policy regarding the liquid biofuels is more mass media-based than science-based. Therefore, it may reflect disarrangement between the scientific knowledge produced by German scientists and the knowledge required by policy-makers to propose public policy. On the other hand, the policy-makers may be disinterested or disregarding the scientific knowledge.

We conclude that there are almost two implications on those findings. First, for academic audience, is that there is an opportunity for scientists and policy-makers working closer to each other. Second, for decision-makers, is that whether one wants to know the public policy direction in Germany he/she should look out on the mass media discourse instead of scanning the macro-environment in German science. Such conclusion may be helpful for business managers and decision-makers in the liquid biofuels sector once the macro-environment may be properly scanned by using the most relevant sources of information. A clear perspective of liquid biofuel macro-environment will certainly lead the decision-makers to better strategic planning and management of this industry, helping them to better structures and add value their business.

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**Note**

Note 1. TF\*IDF = Term Frequency multiplied by Inverted Document Frequency.