Modeling controversies in the press: the case of the abnormal bees’ death

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Abstract

The controversy about the cause(s) of abnormal death of bee colonies in France is investigated through an extensive analysis of the french speaking press. A statistical analysis of textual data is first performed on the lexicon used by journalists to describe the facts and to present associated informations during the period 1998-2010. Three states are identified to explain the phenomenon. The first state asserts a unique cause, the second one focuses on multifactor causes and the third one states the absence of current proof. Assigning each article to one of the three states, we are able to follow the associated opinion dynamics among the journalists over 13 years. Then, we apply the Galam sequential probabilistic model of opinion dynamic to those data. Assuming journalists are either open mind or inflexible about their respective opinions, the results are reproduced precisely provided we account for a series of annual changes in the proportions of respective inflexibles. The results shed a new counter intuitive light on the various pressure supposed to apply on the journalists by either chemical industries or beekeepers and experts or politicians. The obtained dynamics of respective inflexibles shows the possible effect of

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lobbying, the inertia of the debate and the net advantage gained by the first whistleblowers.

Keywords: sociophysics, sociology, decision making, daily press, text-mining, renormalization group, bees colony collapse disorder, precautionary principle
1 Introduction

Public opinion is a key feature to determine which decisions should be taken by policy makers in modern democratic societies especially on subjects dealing with public and environmental risks. Therefore the understanding of its underlining mechanisms becomes at the top priority among current major challenges. In that context, the study case of the precautionary principle is a sensitive issue as it states that if a policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus, then the action or policy is harmful. But, since debates are driven by incomplete scientific data, the question becomes: how ”suspected” risks are translated [1] in the public debate?

Such issue of opinion dynamics has already been evaluated from a theoretical viewpoint, as a diffusing dynamics which leads to the success – or the disappearance – of one of the opinions in competition. In such case, the dynamics is understood as as selection process. But yet there remains the empirical challenge which aims to compare data descriptive analysis with theoretical modeling. Following this objective, this article first presents the context of the controversy that feeds a text-mining analysis on a press corpus in order to introduce a simulation framework dealing with opinion dynamics.

2 Setting the problem

The abnormal bees’ death\footnote{Called colony collapse disorder (CCD) in others country (like in US).} around the world appears as a complex issue that has been especially controversial in French daily press since 1998. This fact can be explained by many factors as it has been showed by scientific studies till 2012. Because of this complexity, the focus is made on the French public debate which has been analyzed with a mixed methodology.

After collecting all papers dealing with the ecological concern, a statistical analysis of textual data has been performed on the lexicon used by the authors to describe and report associated information. This step of the research aims to throw light on 3 points:

1. Define (in time and space) the particular social phenomenon;
2. Show the salient paradoxical dynamics that has to be reproduced with the model;
3. Select the relevant (and simplified) entities (especially between journals and authors level) that justify the use of a model.

The data are then reproduced with the Galam sequential probabilistic model of opinion dynamics. The proportions of inflexibles agents are finally confronted with the results of the text mining analysis.

2.1 About the social phenomenon

Two heuristics, depending on the definition of the issue, could guide our investigation. Only one way will be chosen for the modeling.

Bees’ death may appear as a tangible proof of the uncontrolled pesticides’ toxicity. In such heuristic axis, the focus is especially made on the pesticides’ case usually called ”Gaucho” affair or ”no Gaucho nor Regent” since Gaucho and Regent are the names of the chemicals accused by stakeholders from 1998 to 2004 years. Sociology of the controversy focused on pesticides in such way.

But the issue may have a different formulation for a new heuristic approach. The focus has not to be made only on the pesticides themselves but especially on the bees. The problem formulation becomes: ”how to explain the death of the bees?” We follow this acceptation since such description throws light on the consequences of abnormality that define the public problem (which evolves from a personal viewpoint to a public stake since, according to the whistleblowers, the bees’ death involves all publics). In such issue, the causality of the death’s bees is investigated by the actors (beekeepers in first) in order to unveil responsibilities for this hazard that becomes collective.

To study this public problem, text-mining with descriptive statistics describe quantitatively the main textual features of our collection of data which is based on daily, weekly and monthly press. This corpus brings together all articles that deal with the death of the bees from 1998 to 2010 years in French language. Articles published during this period have been extracted from complementary databases – Lexis-Nexis and Factiva – in order to cover the event the best as we can. As a result, 1467 articles have been collected for the text mining analysis (Fig. 1).
Figure 1: Quantity of articles published each year by French daily, weekly and monthly press dealing with the bees’ death (N=1467).

3 The salient paradoxical dynamic

The first step on the study shows how judgement dynamics are connected to the claim of unusual death of bees through the evolution of explanatory factors reported in the media. Two periods are distinguished when scientific knowledge is translated in public debate. Firstly agents focus on unifactor cause. Secondly, agents focus on multifactor causes.

Indeed, we have first formulated the hypothesis that modeling the opinion dynamics can be tackled through the prism of factors written by journalists to report the controversy and to explain the death of the bees. During the public debate many factors have been identified [8], that is why all papers have been classified in 3 categories according to the factors reported in papers:

1. articles which mention only a unifactor explanation (caused by pesticides);
2. articles that assert there is no proof yet (that pesticides cause damages to bees);

3. articles that highlight on multifactor explanation of the phenomena (pesticides + one other factor at less).

85.3% articles of the corpus have been tagged with semi-automatic textual analysis tools and with human reading for validation. The chronology of these categories can be summarized by the Histogram 2.

Figure 2: Proportion of articles published each year by daily press dealing with unifactor, multifactor or "no proof" categories. 85.3% of the corpus (i.e. 1252 articles) has been tagged in that way.

The Figure 2 shows the proportions of categorized papers published per year. The causality reported in the articles is balanced between unifactor and multifactor explanations at time T1 (1998 year). Next, the unifactor thesis has been spreading at time T2 (1999-2000) whereas the no-proof assertion has been asserted at time T3 (2001). Then the unifactor cause has been
spreading again at time T4 (2002-2004 years). After the event of precaution principle application on pesticides in 2004, a multifactor explanation has been increasing at time T5 (2005-2007 years). At time T6 (2008), the unifactor thesis has been highlighted again. Finally, at time T7 (2009-2010), the multifactors papers have been mainly written. If “controversy” means a shift in the trend of meanings in the public debate, then this study consists in explaining such shift. How these proportions may change?

The key dates make it easier the understanding of the facts. Actually 2 large trends draw the main dynamics. The period from 1998 to 2004 represents the first trend of the controversy which tends to focuses on one cause: the chemicals. The second period, from the 2005 to 2010 years, deals with multi-factors such as environment, parasites, viruses or new insecticides.

Since 1998 beekeepers have assumed the role of whistleblowers focusing on one main factor, the neuro active insecticides called “neonicotinoids”. After controversial discussions on incomplete scientific data studies and a rough debate during the political elections, because of or thanks to the precautionary principle, in 2004 chemical products have been banned from sale by the ministry of agriculture in order to solve this disturbing fact. After this event, multifactor causes are highlighted in scientific field, and then in the press, showing a shift in the interpretation of the causes of the death. After 2005, multifactor causes are mentioned until 2010: the debate does not focus on the issue of the bees’ death any more (and its consequences for food economy, environment and humanity) but on the premisses of the reasoning that lead to the multifactor causes.

Before introducing the model, relevant social entities have to be selected. Even if actors involved in this debate are beekeepers, politics, experts/scientists and industrialists – who are selling chemicals, the journalists, as third party, are the agents writing the papers.

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2 This chronology explains why the segmentation by years has been used for the text mining analysis. Indeed this segmentation has effect on the dynamics detected. The event is long enough to analyze it by years since each (micro) event is ”automatically” indexed inside one year.

3 Chemicals are named Regent and Gaucho from 1998 to 2004 and after Cruiser from 2005 to 2010.
4 Selecting the relevant entities

To tackle this public issue in French daily press with the framework of opinion dynamics, it might be useful to provide a new light on agents who are implied in this phenomenon. In this case the agents are exclusively authors since the methodology described above can not take into account the opinion of the readers or the others agents. Behind the meta-categories defined previously (unifactor, multifactor, no-proof), what kind of social entities are implied to explain the dynamics? Focus is then made on journals and authors level to better describe the phenomenon.

4.1 The journal level

About 59 journals participated to the debate but only a few really “inflected” the opinion dynamics. Regional papers first published on unifactor causes and their opinion has been relayed by specific national papers.

Figure 3: Quantity of unifactor papers per journal through time
Focus is first made on journals asserting unifactor causes (Fig. 3). The regional journal called "Sud Ouest" is the first journal to mainly publish articles on unifactor cause. Sud Ouest is quickly followed by the national journal "Le Monde" during the 2002-2003 years. Sud Ouest appears as an "inflexible" agent who has been mainly supporting the same thesis along the first period. The journal "Le Monde" appears more flexible, as "open minded agent", because proportion of multifactor papers gradually decrease whereas unifactor cause is gradually reported (from 1998 to 2002). If we focus on journals assuming multifactor causes (Fig. 4), during all the public debate, Le Figaro is almost the main journal defending the industrialists since its papers has been supporting the idea that others factors must be taken into account. But such granularity of social entity does not detect if there is an editorial opinion or individual opinion that could explain the dynamics.

Figure 4: Quantity of multifactor papers per journal through time

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Sud Ouest is followed by Ouest-France, which published unifactor papers in the same proportions.
4.2 The individuals or authors’ level

Each newspaper has more than one author writing papers dealing with the bees’ death. Hence, if we consider author’s profiles, we have to detect the main author in order to compare his writings with the papers written by others journalists inside the same newspaper obviously. We call ”main author”, the journalist who has published more articles than all the others individually supposing all the other agents do not change during the considered period (in such case it would be a change of population and not a change of the agents themselves). According to this methodology, we can throw light on 3 profiles which seem to be 3 ideal types:

1. The main author has constantly published unifactor papers in the same way as all others journalists during the same period (Fig. 5). This is the case of Sud Ouest. Hence an inflexible and editorial position can be assumed.

2. The main author has increasingly published unifactor papers during the first period whereas others journalists have published unifactor papers during the first period and multifactor papers during the second period (Fig. 6). This is the case of Le Monde. Hence the main author appears as an inflexible unifactor author whereas the others authors appear more flexible.

3. The main author has published mainly multifactor papers whereas others journalists, in the same newspaper but only during the first period, have written unifactor papers (Fig. 7). Hence the main author appears as an inflexible multifactor author whereas the others authors appear more flexible as an ”open minded agents”.

According to these results, simulation of the public debate can be done with inflexible or flexible agents who are composing the authors of the articles.

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5 To simplify we suppose that author and journalist is almost the same.
6 According to Max Weber definition.
Three hypotheses to justify the model

We do not need to suppose neither meta nor social categories a priori – such as network, interest, education, skills or habitus – to explain the dynamics observed since only 3 minimal hypothesis are needed to justify the model in this paper.

First hypothesis states that agents can distinguish the hierarchy of factors they have mentioned during the debate. Suppose $F_1, \ldots, F_p, F_{p+1}, \ldots, F_n$ factors could cause the death of the bees (in fact more than 40 factors are implied [8]). In such cognitive rationality [9] during the first period only some factors $F_p$ or $F_{p+1}$ or $F_{p+2}$ are involved according to the agents. Moreover actors infer a hierarchy between them: $F_p < F_{p+1} < F_{p+2}$. For example, beekeepers’ assertions reported by the journalists mainly focused on one cause, the chemicals, according to their own inquiry. If beekeepers focused exclusively on one factor, the industrialists tried to highlight the fact the level of
toxicity is not high enough to kill the bees; then they have focused on others factors. At the individual level, each third party – the journalist in that case – have "good reasons enough" [9] to report the social fact as an inflexible (i.e. to publish mainly unifactor articles) or as an more flexible agent with open minded behaviour (changing the proportion of unifactor and multifactor articles). We do not explain their reasons but the way how they translate the public debate and the consequences for the dynamics of the public problem.

To understand the social fact, we also assume a second hypothesis which supposes that the proportion of inflexible agents in a public debate may explain the shift in the bees’ death explanation along the corpus. Denoting inflexibles and flexibles agents leads to evoke the Galam Sequential Probabilistic Model of opinion dynamics [10] [11] [12] [13]. It considers the social field as a composite of heterogeneous agents with inflexibles and flexibles agents in order to simplify and mimic the reality. Using a one-person-one-argument principle, the model implements an opinion shift via small group
discussions monitored by local majority rules. Why does this model could be adapted to this fact?

A third – and also minimal – hypothesis is then supposed: the cost of defending a thesis may depend on the cost of its falsification [14]. A man of science (and therefore a journalist in this peculiar case) continues to believe in a theory if the accumulation of objections makes it too "expansive" the fact of falsificating it [14]. In such epistemological way, the cost-benefit analysis [15] or in others words, the fact to defend a thesis depends on his difficulty to defend it. The problem of this empirical "base" is an investment problem: whether or not to invest time and effort into processing a particular basic statement into a falsifying hypothesis for the theory we wish to test. Then, the valuation of the costs of rejecting or, as the case may be, of defending a basic statement, are objective. With respect to this approach, in basic public and scientific issue, the issue is not one of acceptance or rejection of a single theory, but rather of theory preference. Both the rational response
to a falsification and rational theory preference may be governed by cost-
benefits-analysis-considerations for the purpose of this model.

6 Modeling the controversy with the mixed inflexible-flexible agents model

At this stage to try to understand the origin of the empirical data of Figure 2 one could use a model of opinion dynamics. However the problem is that most models of opinion dynamics yields threshold dynamics with attractors which means the dynamics either spread an opinion or shrink it \[16\] \[17\]. Given some initial conditions with some fixed parameters, the respective proportions of the various opinions are considered as internal parameters which evolve till reaching the corresponding attractor. At odd, Figure 2 exhibits a series of brutal reversal of trends. Focusing on the unifactor curve reversal points appear at respectively the years 2000, 2001, 2003, 2007, 2008 with a quasi-plateau between 2005 and 2006.

To implement such breaking in the dynamical trends the values of the external parameters must be changed. Indeed, we interpret them as a signature of a redistribution of the respective proportions of inflexibles in favor of either the unifactor state or the combination of multifactor and no proof states. Then, using the Galam sequential model with groups of size 3, we are able to fit the exactly data given some values of inflexibles. Accordingly, Figure 2 shows the year evolutions of the various proportions of inflexibles making the model heuristic to identify among the various journalists the respective proportions lobbied for a cause.

We start from the data shown in Figure 2 for the unifactor proportions. We denote them \( P_{A,T} \) with \( T = 0, 1, ..., 12 \) for year 1998 (\( T = 0 \)) till 2010 (\( T = 12 \)). The values are \( P_{A,0} = 0.500, P_{A,1} = 0.722, P_{A,2} = 0.839, P_{A,3} = 0.564, P_{A,4} = 0.712, P_{A,5} = 0.903, P_{A,6} = 0.803, P_{A,7} = 0.576, P_{A,8} = 0.590, P_{A,9} = 0.437, P_{A,10} = 0.568, P_{A,11} = 0.419, P_{A,12} = 0.283 \).

Given some values \( p_{A,t} \) and \( p_{B,t} = 1 - p_{A,t} \) at time \( t \) the Galam model of opinion dynamics \[17\] determines the value \( p_{A,t+1} \) and \( p_{B,t+1} \) at time \( t + 1 \) associated with one update, which corresponds to the evolution of individual opinions driven by local groups discussions during one period of time. From the data it happens to be reasonable to choose 5 consecutive updates to span a full year. Such a choice is not unique. However, once the choice is done we
apply five consecutive updates to go from each year to the next one to span the full period of time from year 1998 till year 2010.

We include the possible existence of inflexibles on both sides whose proportions are denoted respectively $a$ and $b$. It means that given a proportion $p_{A,t}$ of supporters of the unifactor cause, only the fraction $p_{A,t} - a$ is flexible, i.e., able to shift opinion under convincing arguments with a proportion $a$ of A supporters which never changes opinion whatever may happen. The same holds for opinion B.

We thus have $p_{A,t} \geq a$ and $1 - p_{A,t} \geq b \iff p_{A,t} \leq 1 - b$, which combine to

$$a \leq p_{A,t} \leq 1 - b, \quad (1)$$

to which we add the constraints

$$0 \leq a \leq 1 \quad \text{and} \quad 0 \leq b \leq 1 \quad \text{with} \quad 0 \leq a + b \leq 1. \quad (2)$$
From [17] the update equation writes for update groups of size 3,

\[ p_{A,t+1} = -2p_{A,t}^3 + (3 + a + b)p_{A,t}^2 - 2ap_{A,t} + a. \]  \[ (3) \]

Then, starting from \( p_{A,0} = P_{A,0} = 0.500 \) and iterating Eq. (3) five times we want to determine the minimum values of \((a_0, b_0)\) which yields the best realization of the equality \( p_{A,5} = P_{A,1} \) after five iterations. Indeed we aim at the exact equality within 3 digits. Next we repeat the scheme finding the values \((a_1, b_1)\) which leads the equality \( p_{A,10} = P_{A,2} \) still within a 3 digit precision starting from \( p_{A,5} \) and so on till \((a_{12}, b_{12})\) to the realization of the equality \( p_{A,60} = P_{A,12} \). The respective values obtained are exhibited in Table 1.

Table 1: inflexible proportions at each year

| t, T  | \( a_t \) | \( b_t \) | \( p_{A,t} \) | \( P_{A,t} \) |
|-------|-----------|-----------|--------------|--------------|
| 0, 1  | 0.080     | 0         | 0.500        | 0.722        |
| 5, 2  | 0         | 0.117     | 0.722        | 0.839        |
| 10, 3 | 0         | 0.261     | 0.839        | 0.564        |
| 15, 4 | 0         | 0.055     | 0.564        | 0.712        |
| 20, 5 | 0         | 0.077     | 0.712        | 0.903        |
| 25, 6 | 0         | 0.154     | 0.903        | 0.803        |
| 30, 7 | 0         | 0.251     | 0.803        | 0.576        |
| 35, 8 | 0         | 0.108     | 0.576        | 0.590        |
| 40, 9 | 0         | 0.176     | 0.590        | 0.437        |
| 45, 10| 0.1397    | 0         | 0.437        | 0.568        |
| 50, 11| 0         | 0.152     | 0.568        | 0.419        |
| 55, 12| 0.0746    | 0         | 0.419        | 0.283        |

It is worth to stress that once we start from \( p_{A,0} = P_{A,0} = 0.500 \) we repeat Eq. (3) 60 times in a row changing only the values \((a, b)\) every five updates. Those values are exhibited in Figure 9.

The overall picture drawn from our fit sheds an interesting light which is contrary to what would have been \( a \) \( priori \) expected: the proportions of multi/uni-factor categorized papers are not the same as multi/uni-factor-inflexible agents. Most of the ”lobbying” effort has been performed by the multifactor side and not by the unifactor one. Looking at the data, it is worth to notice that the first point is located at exactly fifty percent \( p_0 = 0.50 \)
Figure 9: Proportions of inflexible agents at each year

which shows a balanced distribution of the journalist opinions at the starting point of the controversy.

It seems that the unifactor side was "lucky enough" to have by chance a few inflexibles on its side (8%) while none were on the other side. That has lead the unifactor side to jump to $p_1 = 0.72$ the next year. Worried by the situation the other side has been supported by a few inflexibles on its sides (12%) with a reduction by half of the unifactor inflexibles (4%). But it was not enough to curb the spreading of the unifactor side which reached $p_2 = 0.84$. It is worth to emphasize that we are using 5 cycles of update per year. At this desperate level the industrial side made a huge investment in a huge lobbying getting up to 27% of inflexibles on its side against the still 4% of unifactor inflexibles. The expected result was indeed achieved with a falling down to 56% from 88% of the proportion of articles supporting the unifactor side. Perhaps satisfied with such a success the industrial side has reduced its lobbying pressure keeping only 8% of inflexibles against 6% for the unifactor side. However, not aware of the threshold nature of the dynamics,
since 56% is lower than 50% the next two years brought the unifactor side back to high values at $p_4 = 0.71$ and at the top value $p_5 = 0.90$.

7 From the model, back to the data

Each period of the controversy has to be analyzed since each phase of the debate has its own dynamics which depends also on the terms used by actors for their argumentation. The first trend (1998-2004) shows a shift from hypothesis of factors to the certitude of the proof, from a personal concern to a public hazard, from the interrogation to the assertion: "the facts have proven that only pesticides kill the bees". The second trend (2005-2010) shows an investigation on the others causes since one cause has been banned. If the first shift gradually focuses on the issue of the death’s bees, the second one focuses on the premisses, i.e. all the causes which could explain the death of the bees.

During the first period 1998-2004, it becomes even harder to falsify unifactor explanation of abnormal bees’ death not only because it is scientifically right but also because it is right in the morality field. Indeed, the public debate progressively focused on the consequences of negative externality of pollution since the precautionary principle has been reversing the burden of the proof: industrialists must prove the safety of their products since then can hardly make profit with negative external effects. In the context of European and Regional political elections in 2004 year, the death of the bees has been interpreted as a hazard for the environment and for humanity; using an argument authority with the name of Einstein who would have said ”when bees disappear, humanity has 4 years left". Evolution of lexical textual data shows a semantic shift from scientific field to moral accusation, from analytic verity to moral justice [18]. That is why the proportion of multifactor-inflexible agents increases during the first phase to counter the framing argumentation firstly launched by the whistleblowers.

During the second period, 2005-2010, pesticides have been banned from sale but bees are still dying. New factors have been investigated [8]. Therefore, it becomes even harder to falsify multifactor explanation of abnormal bees’s death. The number of unifactor-inflexible agents has been increasing to cope with this trend. Our corpus arbitrary stops the investigation at the end of 2010 to throw light on the second trend of the multifactor dynamics but new scientific studies appeared in 2012 focusing on the pesticides and
reviving the affair.

8 Conclusion and discussion

From the above results, this study case shows how empirical data and theoretical modeling can stimulate each others to tackle the dynamics of a controversy. Four main results can be discussed.

First result has consequences on the methodology to study a controversy. The particular social phenomenon has been defined with this research question: how agents do explain the bees’ death in their publications? Then the salient paradoxical dynamics has been highlighted with the causal factors explaining the abnormal collapse of the bees. Usually opinion A and B are axiomatically asserted. But the empirical results have shown that if we consider opinion A ”bees are dying because of chemicals”, then opinion B is not ”not A”. Indeed, the dynamics described by the ”no proof” assertion can hardly explain all the shift in the opinion dynamics of the whole debate. In reality, opinion B appears to be ”the multifactor explanation of the bees’ death”.

Second result has heuristic consequences. With the modelling, we have discovered that most of the ”lobbying” effort may have been performed by the multifactor side and not by the unifactor one (mainly during the 1998-2004 years). Authors of papers have been selected as relevant entities to reproduce the phenomenon with a dynamical model as a possible explanation of the dynamics of the collective judgment: the Galam sequential probabilistic model of opinion dynamics. According to this model, proportions of inflexible and flexible agents describe the shifts observed in the dynamics opinion. The counter-intuitive results show the necessary minimal proportions to maintain or to break the dynamics. Finally, the key result of this study stresses that without supposing any social meta-category, the proportions of multi/uni-factor categorized papers are not the same as multi/uni-factor-inflexible agents.

Third result has sociological implications. If the debate starts with a rather neutral position of opinion, the debate seems to get a strong coloration with the first assertions. Results show that inside one phase (1998-2004 or 2005-2010), it appears very difficult to fight against inertia of the no falsification process because of the evolution of the thematization, as text mining analysis already suggested [18]: it becomes too ”expansive” the fact of
falsifying it. This fact depends on the problem formulation which oriented the controversy in one exclusive way [7]. Here is the main difference between two definitions of the public problem: ”Do pesticides kill the bees?” or ”what do kill the bees?”. The first assertion of the whistleblowers oriented the debate focusing on the pesticides, reversing the burden of the proof. Moreover the evolution of the framing argumentation during the first period of the debate has implied its no-falsifiability from the scientific and analytic field to the moral and synthetic judgement. This paper finally concludes the agents not only select or calculate, but prioritize and above all translate the causal factors explaining the issue: ”simple agents” become ”symbolic actors” in a drama.

Fourth result deals with the parameters of the model itself. One may postulate the data could be reproduced with groups of size 4 (or more) since journalists can meet (or study) more than 3 opinions. Besides, number of iterations (5 in this paper) can be modified according to the tendencies observed with the text mining methodology. This parameters will be changed preserving the dynamics observed. But, in fact, we found the minimal conditions to reproduce the states. However a change in the proportions of inflexible agents can create redundancies and heavy investments. Finally, such modeling completed with an ethnographic and sociological investigation could focus on the shape of the networks of inflexible agents from both side and find how it is correlated to the structure of debates’ dynamics.

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