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## Votes and Lobbying in the European Decision-Making Process: Application to the European Regulation on GMO Release

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### Abstract

The paper presents a multi-agent model simulating a two-level public decision game in which politicians, voters and interest groups interact. The objective is to model the political market for influence at the domestic level and at the international level, and to assess how new consultation procedures affect the final decision. It is based on public choice theory as well as on political science findings. We consider in this paper that lobbying groups have different strategies for influencing voters and decision-makers, with long-term and short-term effects. Our computational model enables us to represent the situation as an iterative process, in which past decisions have an impact on the preferences and choices of agents in the following period. In the paper, the model is applied to the European decision-making procedure for authorizing the placing on the market of Genetically Modified Organisms (GMO). It illustrates the political links between public opinions, lobbying groups and elected representatives at the national scale in the 15 country members, and at the European scale. It compares the procedure which was defined by the European 90/220 Directive in 1990 with the new procedure, the 2001/18 Directive, which replaced it in 2001. The objective is to explore the impact of the new decision rules and the reinforced public participation procedures planned by the 2001/18 Directive on the lobbying efficiency of NGOs and biotechnology firms, and on the overall acceptability of the European decision concerning the release of new GMOs on the European territory.

### Keywords:

Lobbying, Europe, GMO, Multi-Agent Simulation, Public Choice, Politician, Voter, Group Contest

### Introduction

#### 1.1

European policies are shaped by a complex policy network involving not only elected representatives (in the European Parliament) and national decision-makers (in the European Council of Ministers), but also a broad range of non-state actors including nominated members of the various European committees, bureaucrats and experts of the European Commission, and lobby groups. There are numerous empirical social science studies describing how the multi-level European governance structure favours the intervention of non-state actors at different levels of the decision-making process, and affects the impact of lobbying actions on European decisions ([Biliouri 1999](#); [Pollack 1997](#), [Coen 2003](#)).

#### 1.2

The paper presents a simulation model designed to provide a better understanding of the political decision-making process at the European level, by exploring the interactions between the domestic

political markets and the European negotiation arena. It is based on a public choice model and includes simultaneously votes and lobbying.

### 1.3

Public choice theory relaxes the traditional assumption of public economics, which describes the government as a benevolent dictator maximizing social welfare: assuming on the contrary, that elected decision-makers seek political support in order to maximize their chances to be re-elected, and that they choose public policies accordingly. Therefore, there is a political market between politicians and voters and lobby groups, where votes and financial support are exchanged for promises of favourable regulation ([Downs 1957](#); [Buchanan, Tollison and Tullock 1980](#); [Stigler 1971](#); [Becker 1983](#)).

### 1.4

In the public choice literature, there are two broad categories of models which are of interest: (i) voter-politician models focus on the electoral market between voters and election candidates. It is demonstrated that for choices in which voters have uni-dimensional and single-peaked preferences<sup>[1]</sup>, the politician (or political party) aligning his decision with the preference of the median voter<sup>[2]</sup> wins the election ([Black 1948](#)); and (ii) group contest models ([Tullock 1980](#)) describe the government as a neutral arena in which interest groups compete through lobbying expenditure. The government then defends the interests of the winning group. The two forms of influence are important in the European context. Moreover, the political game is played at two levels, the European level and the domestic level. The latter constrains the position defended by the national representative in negotiations at the European level by restricting his set of politically acceptable actions. This type of situation has been modelled by Putnam ([1988](#)) in the domestic-international context, in his famous two-level game which describes how sovereign states seek to negotiate international treaties that best maximise their own ability to satisfy domestic pressures. Putnam's model focuses therefore on the range of agreements (international set) that are acceptable to a majority at the domestic level. Our model builds upon this analysis: it shows how the interactions between political domestic constraints and the structure of international negotiations shape the political game and the positions defended in the international arena<sup>[3]</sup>.

### 1.5

Although we define a generic model to formalize political interactions within the European Union, we have chosen to apply it to a specific case study, the European procedure for authorizing new genetically modified organisms (GMO). In the European legislation, this procedure is called, the "placing on the market" or the "deliberate release of GMOs into the environment". The main environmental concerns associated with GMOs are the risks of dissemination, cross breeding, invasion and losses of biodiversity. Since pollen ignores borders, the decision to authorize new GMOs must be taken at the European level, not at the member state level. The European procedure concerning the introduction of new GMOs was thus defined by a European Directive, the 90/220 Directive, enacted in 1990. It was based on a straightforward procedure of qualified majority voting by the European Council of environment ministers. However, this Directive soon became the subject of virulent opposition by civil society groups, who criticised the way decisions could be imposed on member states. It took several years of discussions and debates before the 90/220 Directive was replaced by a new Directive in 2001. The Directive EC 2001/18 has institutionalised a more complex decision process, imposing several phases of public consultation, conciliation meetings and requiring final unanimity voting by the Council of Ministers. The objective of this new Directive was to improve the participation of the public in the decision process and to achieve a more stable consensus among European countries on the level of GMO regulation.

### 1.6

We developed a multi-agent model, based on the assumptions of lobbying theories, to conduct simulations with three purposes: (i) to explore different scenarios of lobbying strategies by two competing interest groups, comparing their relative efficiency in influencing the results; (ii) to evaluate whether the 2001 procedure leads to final collective decisions which better reflect the diversity of public opinions in country members; (iii) to assess to what extent the 2001 Directive could be more successful than the 1990 procedure in inducing changes in public opinion and in reducing the preference gap between national opinions.

### 1.7

The second section of the paper presents the public choice models of vote and lobbying that we have developed to capture the specifications of the European decision-making process<sup>[4]</sup>. The third section describes the European regulation for the release of GM-products. The fourth section explains the

multi-agent model structure and describes the artificial societies the model created through simulations. The fifth section provides simulation results and conclusions. Our model shows that the main effect of the switch from the 1990 Directive to the 2001 Directive is to increase the influence by non-governmental organizations (NGOs) in the European decision-making. As a consequence, the 2001/18 Directive enhances the coherence between national public opinions and the final European decision. However the 2001 procedure does not improve homogeneity among European public opinions. Our model is — to our knowledge — the only agent-based simulation which seeks to model the political market between voters, elected representatives and lobbying groups as a dynamic process with feedback loops. It proves to be helpful for the analysis of lobbying strategies within a complex political environment when analytical results are intractable.



## The European decision-making process: political markets and multi-level decision

### Tullock's group contest model

#### 2.1

Our model draws from the public choice literature. It combines votes and lobbying, and incorporates the interactions between the national level and the European level. We develop below an enriched version of a group contest model. It provides the underlying theory of the multi-agent model described in section 4. However, the formal structure of the two models differ.

#### 2.2

Following Tullock (1980), the political market is assumed to be structured as a contest between interest groups. Without loss of generality, we assume that what is at stake is a new environmental regulation. There are two opposing lobby groups: a green lobby E (for environment), which wants stricter rules; and an industrial lobby F (for firm), which wants less regulation. They can both influence the government's decisions by investing in lobbying actions.

#### 2.3

The contest is modelled as follows: the two groups compete to win a price, the price ( $x$ ) being the choice of decision-maker to defend at the European level a position in favour ( $x=1$ ) or against ( $x=0$ ) a new environmental regulation.

#### 2.4

Each lobby group invests in lobbying efforts, with costs  $X_E$  for the green lobby and cost  $X_F$  for the industrial lobby respectively. These expenses are the costs of organizing and financing lobbying campaigns.

#### 2.5

The probability  $\pi$  for the decision-maker to make a choice in favour of one of the two groups is then a function of:

- the relative efforts of the two groups ( $X_E / X_F$ )
- their capacity to influence the decision-maker, independently of their efforts (due to historical and institutional reasons). Here we define  $\lambda_E$  and  $\lambda_F$  the relative sensitivity of decision-makers to the lobbying actions of groups E and F respectively (with  $\lambda_E + \lambda_F = 1$ )

#### 2.6

In the Tullock's model, the decision is probabilistic. The probability  $\pi(x=1)$  for the decision-maker to vote in favour of the environmental regulation is a logit *contest success function* written as follows:

$$\pi(x=1) = \frac{(\lambda_E X_E)}{(\lambda_E X_E + \lambda_F X_F)} \quad (1)$$

#### 2.7

Tullock shows that by identifying the benefits and costs of a decision in favour of the regulation for groups E and F, it is then possible to calculate the Nash equilibrium strategies of the two groups in terms of lobbying efforts.

### A model with two sources of influence

2.8

The Tullock model overlooks the influence of voters on the decision of the policy-maker. In our model, we have chosen to combine two influence games: direct influence on politicians (described above); and indirect influence through changes in public opinion.

2.9

We make the assumption here that lobbying is before all an expert and media battle rather than funds allocated to parties for their political campaigns. Lobby groups provide political support to decision-makers in exchange for favourable regulation, but they also try to influence citizens by producing and transmitting information and by bringing environmental issues to the forefront of public opinion. Therefore, voters are also influenced by lobby groups: the median voter's position in favour or against the environmental regulation shifts according to the respective efforts and capacity of influence of the two competing groups.

2.10

Let's assume that the position of the median voter  $P_m$  can be located on a normalized continuous scale between -1 and +1,  $P_m \in [-1, +1]$ , with  $P_m=0$  indicating a neutral position with respect to the environmental regulation,  $P_m=-1$  indicating a position against the environmental regulation (aligned with the firm) and  $P_m=+1$  indicating a strong preference for the environmental regulation (aligned with the green lobby).

2.11

The policy maker takes into account the preference of the median voter. Equation (1) is altered to introduce this new assumption.

- If  $P_m \geq 0$  then:

$$\pi(x=1) = R_m + (1 - R_m) \times \frac{(\lambda_E X_E)}{(\lambda_E X_E + \lambda_F X_F)} \tag{2}$$

and

$$\pi(x=0) = (1 - R_m) \times \frac{(\lambda_F X_F)}{(\lambda_E X_E + \lambda_F X_F)} \tag{2'}$$

- If  $P_m \leq 0$  then:

$$\pi(x=1) = (1 + R_m) \times \frac{(\lambda_E X_E)}{(\lambda_E X_E + \lambda_F X_F)} \tag{3}$$

and

$$\pi(x=0) = -R_m + (1 + R_m) \times \frac{(\lambda_F X_F)}{(\lambda_E X_E + \lambda_F X_F)} \tag{3'}$$

Note that for  $P_m = 0$ , equations (2) and (3) and equations (2') and (3') are the same and equivalent to the simpler Tullock's model described in equation (1). The median voter, in such case, does not influence the decision.

2.12

Similarly to the way we have modelled  $\pi$ , we can define  $P_m$  as a function of  $Y_E$  and  $Y_F$ , the expenses of the green lobby and the industrial lobby respectively, directed towards public opinion. The sensitivity of public opinion to green lobbying and to industrial lobbying can be defined as  $\gamma_E$  and  $\gamma_F$  respectively, with  $\gamma_E + \gamma_F = 1$ . These sensitivities are also taken as exogenous parameters depending on cultural and social factors.

$$R_m = \frac{(\gamma_E Y_E - \gamma_F Y_F)}{(\gamma_E Y_E + \gamma_F Y_F)} \tag{4}$$

2.13

Equation (4) assumes that the median voter's opinion increases towards 1 when the weighted lobbying efforts of the green lobby are greater than those of the firm and decreases towards -1 when the weighted lobbying efforts of green lobbies are lower than those of the firm.

2.14

Lobbying groups therefore have to choose the optimal allocation of their budget:  $B_E = X_E + Y_E$  for the environmental lobby and  $B_F = X_F + Y_F$  for the industrial lobby.

2.15

Their Nash strategies can be calculated by inserting (3) into (2) and calculating the first order conditions with respect to  $Y_E, Y_F, X_E, X_F$ , as well as the benefits for the two groups ( $< 0$  for the industrial lobby) of a decision ( $x = 1$ ).

**A two-level game with feedback**

2.16

Our computational model borrows from this theoretical approach but two layers of complexity are added. We assume first that there are several sovereign countries, needing to adopt a common regulation on the environment. Such a collective decision is taken by an intergovernmental vote. One elected representative from each country  $i$  participates in the vote, with probability  $\pi_i$  to vote in favour of the regulation and probability  $(1 - \pi_i)$  to vote against it. According to the collective decision rule (unanimity or majority), we can then calculate the aggregate probability that the collective environmental regulation will be adopted or not.

2.17

Our second assumption is that such votes are not one-shot games. In many cases, there can be several succeeding decisions concerning environmental regulations. Previous decisions and previous lobbying activities influence public opinions. Therefore, the median voter's preference  $P_m$  is not only based on the outcome of the relative lobbying efforts of interest groups at time  $t$ . It also depends on both preferences at time  $(t - 1)$  and on past choices. Figure 1 summarises this complex lobbying system by indexing decisions by  $t$ . Decision in time  $t$  is influenced by past decisions.

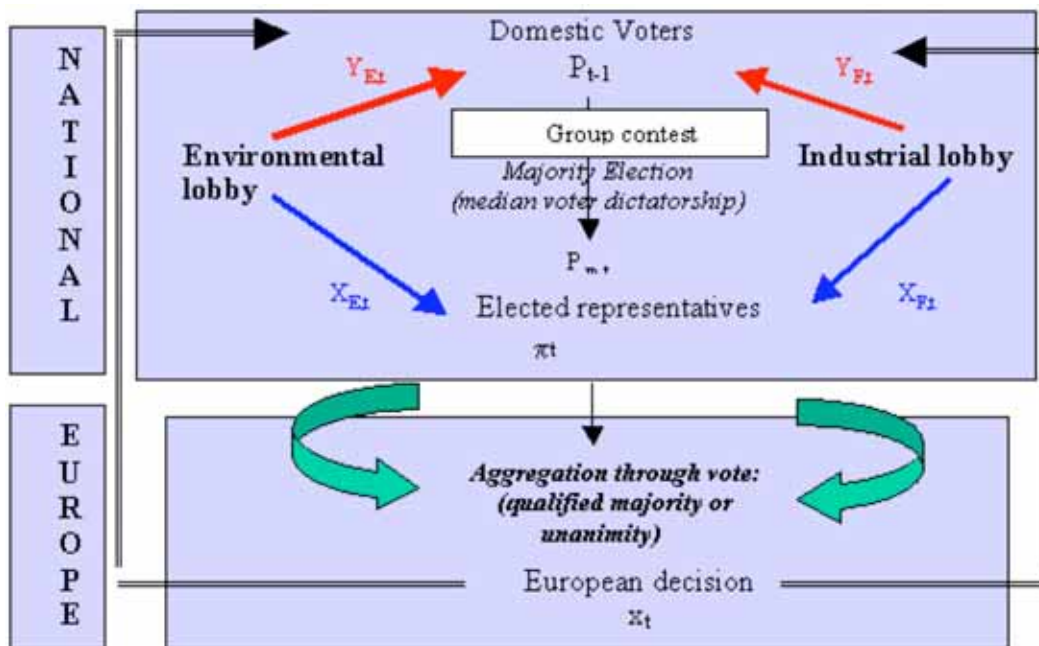


Figure 1. Lobbying interactions at domestic and European level (round t)

2.18

Aggregation of votes and feedback effects make the analytical model less tractable. We therefore chose to build a computational model, representing the European decision procedure concerning environmental issues, based on a structure inspired by the political market described above. We have

also made different assumptions concerning an agent's rationality in order to be able to compare various lobbying strategies. The use of multi-agent systems for modelling political markets is not widespread, although they provide an interesting modelling environment for public choice analysis by allowing to integrate different levels of decision-making and various influence loops ([Kollman and Page 2006](#)).



## European collective decision-making to regulate the placing on the market (release in the environment) of genetically modified organisms

### 3.1

In order to illustrate our model, we chose the case example of the European biotechnology regulatory framework. The GMO issue has stirred considerable scientific and social controversy. It is therefore an interesting case study which has been analysed extensively by social scientists and political economists. Most studies compare European and US policies, and try to analyse why they seem to diverge so drastically on the definition and implementation of the precautionary principle. It is emphasized in most papers that culture, history and institutions have shaped two different societal attitudes towards risk ([Bernauer and Meins 2003](#); [Echols 1998](#); [Lewidow 1999](#)). It is also stressed that the nature of the political markets between voters, pressure groups, and elected representatives, both at the national level and at the federal/European levels is instrumental in explaining such differences. Bernauer and Meins ([2003](#)), for example, explain that European biotech-critical NGOs were capable to increase their collective action capacity and to overpower the biotechnology coalition by creating a strong sense of "public outrage" and by taking advantage of the multi-level European governance system to lobby at different levels of the decision process. However, notwithstanding the quality of these studies, no framework model is available to analyse in more depth the interactions between interest groups, evolving public opinion, and decision-makers both at national and European levels.

### European decision procedures for the release of GMO

### 3.2

The aim of the 90/220 Directive of 23 April 1990 was to harmonize national procedures and criteria for biosafety assessment under the concept of the European single market. The Directive (transposed in all EU member states since 1995) set a number of constraints and a strict procedure for requests by companies intending to manufacture, import or grow a new GMO in a European country.

### 3.3

Within the framework of the 90/220 Directive, the procedure for obtaining the authorization to place a new GMO on the European market (or to release it into the environment) implied the following steps:

1. a notification by the company wishing to sell or import a new GMO must be submitted to the national competent authority of the member state where such a GMO is to be placed on the market for the first time. The competent authority produces an assessment report which indicates whether the demand is accepted or rejected. If the authority rejects the notification, the company is free to submit a notification in another country member.
2. If the notification is assessed favourably by the competent authority of the member state concerned, the information is transmitted to the competent authorities of the other member states (through the European Commission). In the absence of any reasoned objection from a member state or from the Commission, consent is given to the notifier.
3. In the case where an objection is raised and maintained, the European procedure is the following: the Commission seeks the opinion of a European regulation committee, made up of representatives of all member states, in order to find a conciliation solution on the basis of qualified majority voting. If a qualified majority<sup>[5]</sup> is obtained, the authorization is granted within three months by the Council of Environment ministers and applies to all member states: member countries are theoretically not allowed to forbid this GMO on their own territory, even if they voted against it. If the authorization demand is rejected, then no authorization for this GMO is provided in any EU countries.

### 3.4

All authorization demands since 1990 have given rise to sharp debates, in which both anti-GMO associations and biotech firms tried to push forward their position. In the last fifteen years, overall public opinion in the European Union has become increasingly suspicious of GMOs ([Eurobarometer 1999](#)). Such reluctance has been partially shaped by powerful non-governmental organizations (NGOs), such as environmental protection groups, consumers unions, and even farmers' unions. Such groups



have been very vocal, financing anti-GMO campaigns, lobbying actively in Brussels and even taking direct anti-GMO actions (demonstrations, destruction of genetically modified maize fields etc.). The environmental organizations Greenpeace and Friends of the Earth-Europe have made GMOs one of their top priorities for their actions in Europe since the end of the 80's. They have formed solid alliances with consumer groups (such as the European Bureau of Consumers' Unions) and with farmers unions (such as the *Confederation Paysanne* in France). They were successful in transforming the GMO issue "into one of high saliency and — in the eyes of the wider public- of low complexity", therefore "increasing the public distrust in regulatory authority" (Billiouri 1999). The biotech sector is concentrated and organized ([Clerc 2003](#)). It has also invested in intensive lobbying, to obtain softer regulations on the GMO sector. US and European biotechnology firms have based their advertising campaigns towards the general public on the arguments that GMOs can improve productivity, can contribute in preserving the environment, and can help cure diseases. They have also defended their positions by lobbying at a more political level, reminding governments that they contribute to create value added and that they are a powerful economic sector, whose competitive capacity should not be jeopardised by unjustified and unneeded controls and regulations.

### 3.5

Despite the lobbying of biotech firms, a number of European governments have responded to the mounting pressure of public opinion and have chosen to put themselves at odd with European regulation by restricting unilaterally the release of certain GMO [\[6\]](#). Since April 1998, these countries imposed a *de facto* moratorium on new approvals, on grounds of potential hazards to human health and the environment. By then, only 18 GMOs had been approved by the EU. The biotech industry claimed that it was a "victim of bio politics" ([Morris and Adlery 2000](#)), and that "the public perceptions of modern biotechnology were having an effect on the public policy process which in turn was causing changes in the regulatory guidelines".

### 3.6

New discussions were launched from 1998 for a revision of the Directive 90/220 in order to extend and clarify its scope and to tighten GMO control. The stated objectives were threefold: "(i) to improve the administrative procedures; (ii) to harmonize decision-making between member states on the basis of common principles of risk assessment; (iii) to improve the flexibility of directive 90/220/EEC while maintaining a high level of protection for human health and the environment" (ref COD/1998/OO72).

### 3.7

The 2001/18 /EC Directive, repealing the 90/220/EC Directive was finally voted in March 2001 [\[7\]](#): it includes the gradual elimination of antibiotic resistance markers in GMOs; tighter risk assessment carried out prior to authorization; and tighter time-limited consent [\[8\]](#). It also involves changes in the decision-making process based on renewed voting procedures and consultation of the public. The new collective decision procedure for granting (or rejecting) authorization for a new GMO is comparable to the 1990 procedure except for the following points:

1. The Commission must *make available to the public* the information concerning the GMO before any authorization is granted.
2. In case when an objection is raised and maintained, the Commission must seek the opinion of its Scientific Committee. If unfavourable, the notification is rejected. If favourable, then a European regulation committee is set up with representatives of Member States. They either grant the authorization with a qualified majority or, if no qualified majority is obtained in favour of the GMO, the decision is taken by the Council of Ministers after consultation of the public. Authorization requires unanimity in the Council of Minister. It has to be underlined that this last point can be controversial. In fact, the official texts (Decision 1998/468) state that the Commission makes a proposal to the Council which can reject it with a qualified majority. The Commission can then resubmit an amended proposal which can only be rejected with the unanimous vote of the Council. Depending on the way the Commission formulates its proposal, it can in fact impose unanimity for granting authorization of a new GMO. We retained this second interpretation in our model.

### 3.8

Within such a controversial context, it was interesting to examine two aspects of the European political market. First of all, we are interested in analysing the complex dynamics of competing lobby groups, acting at national and European levels, and seeking to influence median voters and decision-makers. Second, we want to assess the impact on public choice of the decision-making procedure. In particular, it is important to analyse whether the 2001 procedure leads to final collective decisions which reflect

better the diversity of public opinions in country members.

## Structure of the multi-agent based model

### 4.1

We have simplified the true decision-making process in order to make our simulation results tractable. The general structure of the model is described below.

### 4.2

The model simulates the decision-making process followed at the European level to reject or to accept a notification for the releasing of a new genetically modified organism into the environment. Each decision has a feedback effect on the action of lobby groups and on public opinions, which in turn will affect the votes of decision-makers in the following round, when another notification is examined. We thus consider a representation of successive interacting loops, each of them corresponding to a new notification process and therefore to a decision to reject or to authorize a new GMO. Two voting processes are compared, named *Vote1990* and *Vote2001*, corresponding to the decision-making procedures of Directive 90/220 and 2001/18 respectively.

### 4.3

Thus we model the collective decision of the 15 EU member states. Agents are:

- i. 15 *Public-Opinion* (equivalent to the opinion of the median voter in each country) reflecting the intensity of each country's preference for GMOs, which is assumed to be gradable on a common index, from 1 to 5. It is assumed that domestic decision-makers can measure this opinion without costs.
- ii. 15 *Decision-Makers*, one in each country member. In practice and in our model, there are two types of votes by state representatives: votes in the European regulatory committees (in which state representatives are sent with vote instructions from their ministries) and votes in the Council of Environment Ministers, gathering the environment ministers of the 15 member states. In the model, we simplify the notion of state representatives by assuming that there is only one Decision-maker per country.
- iii. 2 *Lobby Groups*: Firm (the biotechnology firm, assumed to be in favour of GMO release) and NGO (the environmental organization, assumed to be against GMO release).

### 4.4

Our model does not include the European Commission as an agent. We made this choice by considering that the influence of the Commission is important only in the case when the Council cannot reach a decision. In our model, however, we focus only on decisions which have been taken by political agents, not by administrative or scientific procedures. In other words, we do not include in our model neither the decisions which are ultimately taken by the European Commission (this happens when no qualified majority is obtained in the previous votes or when there is no unanimous vote for rejection), nor the decisions which are taken by scientific authorities, when there is little scientific controversy concerning the GMO at stake (and when therefore there is no need for a political decision). We therefore focus on decisions concerning GMOs for which there is not enough scientific consensus concerning their potential threat for the environment or health. When scientists cannot reach any conclusion, then the decision is passed on to elected representatives, who have to decide collectively on the level of risks that society is prepared to accept.

### 4.5

Both *Lobby Groups* influence voters (*Public-Opinion* in our model) and governments (*Decision-Maker* in our model), by investing in lobbying campaigns in different EU countries. The NGO and the Firm are given a lobbying capacity (equivalent to  $B_E$  and  $B_F$  in section 2 model) reflecting the effort they are able — or willing — to put on the GMO issue. In practice, this effort could be measured by the financial and human means they allocate to lobbying. It is represented in our artificial system by an index, from 1 to 30, and it is interpreted as the number of lobbying campaigns (*Firm-Lobbying* and *NGO-Lobbying*) which the lobby group is willing to finance at each time-step. The maximum lobbying capacity of the pressure groups is assumed to be exogenous. In a more complex version of this model, it would be useful to endogenize the lobbying means of pressure groups. It could for example be assumed that if the median voter's position moves in favour of the environment, then the membership of the NGO increases, therefore increasing membership fees collected. By the same token, if past decisions are favourable to the firm, then it makes greater profits and it can allocate a larger budget share to lobbying activities. We also



assume in our model a linear effect of lobbying effort on opinion change. In a more realistic setting, we could have considered a decreasing marginal effect: the higher the number of campaigns, the lower the impact of each additional campaign.

#### 4.6

*Lobby Groups* also have to choose a strategy to target their lobbying efforts. Here, we depart from the Tullock's model: we do not have an optimising strategy as we could have under the assumption of hyper rationality and perfect information. We assume in fact that both lobby groups are boundedly rational. Lobbying strategies of biotech firms and civil society groups are not well documented, although a number of authors have tried to characterize them. The European political market is in fact characterized by numerous biotech-critical associations and numerous pro-GMO firms, located in different European countries. It is actually very difficult to know how those groups organise their lobbying activities. Following the findings of the empirical literature ([Vogel 2001](#), [Clerc 2003](#)), we make two assumptions.

1. the priority of NGOs is to influence *Public-Opinion* (organizing demonstrations, publicizing events in the media etc), whereas the Firm's priority is to influence *Decision-Makers* first (lobbying in the Ministries and at the Parliament, for example).
2. we identified two "archetypical" strategies for lobbying groups: they can decide to influence in priority those (*Public opinion* or *Decision-makers*) who are on their side — in order to reinforce their support - or they can decide to influence those who have opposite opinions — in order to mitigate their counter-balancing effects in the political game or even in order to bring them back on their side. These two types of strategies are named "Pro" or "Anti" respectively. The "Anti" strategy represents schematically a situation where the most active anti-GMO (resp. pro-GMO) lobbies would tend to be created in countries whose public opinion is sympathetic to (resp. against) GMOs. The "Pro" strategy models the situation where anti-GMO (resp. pro-GMO) lobbying activities are created in countries whose public opinion is suspicious of (resp. sympathetic to) GMOs.

#### Programming choices

#### 4.7

*Public Opinion* is an agent with an opinion value ranging from 1 to 5 (1 for very strong anti-GMO opinions, 5 for GMO-supportive opinions, 3 is considered a neutral value) [\[9\]](#). Public Opinion changes under the influence of lobby groups, weighted by a sensitivity to Firm's lobbying (Sens-Firm), and sensitivity to NGO's lobbying (Sens-NGO), such that

$$\text{Sens-NGO} + \text{Sens-Firm} = 1$$

This sensitivity parameters are equivalent to  $\gamma_E$  and  $\gamma_F$  of section [2](#).

#### 4.8

After a lobbying campaign, *Public Opinion* is increased or reduced as follows:

$$\text{Change in Public-Opinion} = (\text{Firm-Lobbying} * \text{Sens-Firm}) - (\text{NGO-Lobbying} \times \text{Sens-NGO}) \quad (5)$$

#### 4.9

The sensitivity to *Firm Lobbying* versus NGO lobbying is an exogenous parameter of our model. It is of course very difficult to evaluate. Most of our simulations are therefore based on a random draw of this parameter (except simulations replicating the European situation).

#### 4.10

The initial values of *Public-Opinion* are equal for all countries (a series of previous simulations has shown that the final outcomes are not sensitive to initial opinion values, see appendix [2](#)) but evolve in time independently.

#### 4.11

*Decision-Maker* is an agent who knows his *Public-Opinion*. He has a specific weight in the European vote, which is his true voting weight in the European Council (see appendix [1](#)). His vote reflects both his *Public-Opinion* and Lobbying efforts (*Firm-Lobbying* and *NGO-Lobbying*) to which he is submitted. In the absence of lobbying, the Decision-Maker's opinion is the same as his *Public-Opinion*. When there is lobbying, his opinion in the vote (Val-Vote) includes this influence. We assume here that the *Decision-*

*Maker's* sensitivities to the firm's lobbying and to the NGO's lobbying are the same as the *Public Opinion's* sensitivity.

$$\text{Influence} = (\text{Firm Lobbying} \times \text{Sens-Firm}) - (\text{NGO Lobbying} \times \text{Sens-NGO}) \quad (6)$$

$$\begin{aligned} \text{If influence} > 0 \text{ then } \text{Val-Vote} &= \max(\text{Public Opinion} - 0.5; 1) \\ \text{If influence} < 0 \text{ then } \text{Val-Vote} &= \min(\text{Public Opinion} + 0.5; 5) \end{aligned} \quad (7)$$

Then the Decision-Maker votes at the European level:

$$\begin{aligned} \text{If } \text{Val-Vote} > 3, \text{ then he votes in favour of the GM-product (YES)} \\ \text{If } \text{Val-Vote} \leq 3, \text{ then he votes against the GM-product (NO).} \end{aligned} \quad (8)$$

#### 4.12

It has to be underlined here that the modelling choices introduce a fundamental difference between targeting *Public-Opinions* and targeting *Decision-Makers*: changes in *Public-Opinion* are more long-lived than changes in the vote position taken by *Decision-Makers*, because they carry over from one simulation round (one notification) to another. On the other hand, the influence on decision-makers is only valid for the vote under consideration. It does not change the preference of decision-makers in the long run which align on *Public-Opinions*. Therefore in our model, *NGO*, whose priority is to target *Public-Opinions*, has a longer-lasting impact than *Firm*.

#### 4.13

*NGO* and *Firm* are the two Lobby-Groups. Each has a lobbying capacity (from 1 to 30 units). They choose to allocate their lobbying capacities across the 15 *Decision-Makers* and 15 *Public-Opinions* according to two strategies (Pro and Anti). In both strategies, their priority is to target first those whose opinion is closest to the neutral value. Let's underline that four combinations of lobbying strategies can therefore be observed: "*Pro-Pro*" when *Firm* and *NGO* both choose to target *Public-Opinions* and *Decision-Makers* whose preferences are similar to theirs; "*Anti-Anti*" when *Firm* and *NGO* both choose to target *Public-Opinions* and *Decision-Makers* whose preferences are opposed to theirs; and two mixed situations where *Firm* and *NGO* adopt two different strategies: "*Anti-Pro*" (resp. "*Pro-Anti*") when *Firm* and *NGO* both choose to target Pro-GMO (resp. Anti-GMO) agents.

#### 4.14

In the model, two different decision-making processes can be used, "*Vote 90*" (see Figure A1 in appendix 2) and "*Vote 2001*" (see Figure A2 in appendix 2), both inspired from the two deliberative processes that are defined in the Directive 90/220 and 2001/18 respectively. They are organised in iterative steps which involve two decision procedures: unanimity (or veto power) for the first step; qualified majority for the following steps. The main differences between *Vote 90* and *Vote 2001* are the following:

1. the 1990 procedure involves a qualified majority voting in the final vote whereas the 2001 procedure imposes unanimity in the last voting phase to reject a notification.
2. the 2001 procedure includes mandatory consultation with the public during the decision-making process. We have modelled it by adding an additional phase of lobbying.



## Simulations results and interpretation

### Simulation protocol and observation protocol

#### 5.1

The simulation protocol involves testing the sensitivity of the model's results to initial conditions (in particular to initial *Public-Opinion*, and to lobbying capacity), and to lobbying strategies<sup>[10]</sup>. These parameters are not easily measured or described empirically and we therefore need to assess their impact on the global dynamics of the system.

#### 5.2

The simulations are run for different values of the parameters, with 100 time-steps repetitions. Average results are presented.

- lobbying capacity (identical for *Firm* and *NGOs* and stable along the whole simulation) takes the following values: 5, 10, 15, 20, 25, 30.

- the initial value of Public-Opinion (identical for all 15 agents) takes the following values: 1, 2, 3, 4, 5.
- the decision-making procedure: Vote 1990 or Vote2001,
- lobbying strategies: Pro or Anti

### 5.3

There are therefore 240 different combinations of simulations. We compare their outcomes in terms of the impact on decisions and opinions of lobbying strategies and decision-making procedures. We observe the following indicators for each notification round:

- the final decision: authorization or rejection
- the average Public-Opinion at the European level (arithmetic mean of the 15 Public-Opinions)
- the number of "dissatisfied" countries: countries whose Public-Opinion is not in accordance with the decision [\[11\]](#).

### 5.4

Based on these indicators we identify three schematic patterns of artificial societies generated by our model: "cyclical acceptance", "no acceptance", "permanent acceptance". For each of these situations, there can be several distribution patterns of Public-Opinions and hence different numbers of satisfied countries. We never focus on initial time-steps, since they are highly influenced by the initial value of opinion.

### 5.5

Once the patterns are known, the regularity of the results implies that three simple indicators can enable us to define the type of society we generate: number of notifications accepted in the last 10 time-steps, number of countries that are pro-GMO, number of satisfied countries.

## Specific Patterns of Our Artificial Societies

### 5.6

Frequencies of patterns described below are summarized in table 1. More details are provided in appendix [3](#).

#### No authorization

### 5.7

The case of "no authorization" is the most frequently observed. Two distributions of Public-Opinions are observed: either all Public-Opinions are against GMO (value below 3), or they are split into two opposing groups. Hence two sub-configuration are found:

- *With satisfied majority*: 9 to 15 Public-Opinions are anti-GMO. The resulting vote is therefore also against GMOs. In such case, Public-Opinions do not vary much. Stability is due to the fact that lobbying groups direct their efforts towards the same targets. Their action does not cancel-out though because NGO has a longer-lasting influence.
- *With unsatisfied majority*: 5 to 6 Public-Opinions are anti-GMO. This situation happens when the lobbying capacity of lobby groups is large. Therefore, the potential to induce Decision-makers to vote "against" their Public-Opinion is greater.

#### Cyclical authorization.

### 5.8

This pattern occurs only under Vote90 with an "Anti" lobbying strategy of Firms . We then observe 1 or 2 acceptations every 10 time-steps. The cyclical property is also noticeable in the Public-Opinion changes: average Public-Opinion oscillates between 2 and 4. Acceptations are usually obtained with dissatisfied majority.

#### Permanent authorization.

### 5.9

We also observe — with low frequencies — cases when the notification is always accepted.

---

**Table 1:** Frequency of observed patterns

Procedure	2001	1990
Permanent authorization	4 cases	5 cases
Cyclical authorization	No cases	37 cases
No authorization with majority satisfied (average Public-Opinion < 3)	83 cases	39 cases
No authorization with minority satisfied (average Public-Opinion > 3)	33 cases	39 cases

Note: Numbers calculated out of 120 different simulations: 6 lobbying capacities, 5 initial value of Public-Opinions, 4 combinations of Lobbying strategies.

### 5.10

As shown by table 2, the values of initial opinions do not have any impact on the final decision after a few rounds. However the initial sensitivity to Firm/NGO lobbying is important: we observe a positive correlation coefficient between the weighted average sensitivity<sup>[12]</sup> to firm and the level of European average final opinion (Table 3).

**Table 2:** Correlation coefficients between initial opinion and average final opinion

Voting procedure	Correlation
1990	-0.105
2001	-0.064

Note: Result of 50 random choice of initial sensitivity and opinion. For each set of initial parameters, 10 simulations are run and calculations are made on the average value.

**Table 3:** Correlation coefficients between weighted average sensitivity to firm lobbying and average final opinion

Voting procedure	Correlation
1990	0.627
2001	0.774

Note: simulations are the same as in table 2.

## Consistency with Real Facts

### 5.11

In a second series of simulation we used the estimated values for the sensitivity<sup>[13]</sup> to firm lobbying of the European countries to run simulations with the 1990 voting procedure. We therefore made a rough estimation of these values, based on several criteria: (i) the cultural and historical background of different European countries concerning risk ([Eurobarometer 1999](#); [2001](#); [2006](#)), (ii) the relative weight of NGOs and biotech firms in different European countries (iii) the institutional set-up to take into account public opinion. In the simulations presented here, we identify qualitatively three groups to which ad-hoc values for sensitivity were associated: "very sensitive" to anti-GMO lobbying ( $Sens-Firm=0.15$  and  $Sens-NGO=0.85$ ); "fairly sensitive" to anti-GMO lobbying ( $Sens-Firm=0.35$  and  $Sens-NGO=0.65$ ); or "rather indifferent" to anti-GMO lobbying ( $Sens-Firm=0.65$  and  $Sens-NGO=0.35$ ) — see appendix [1](#).

### 5.12

The outcome is striking. In most simulations, whatever the level of initial Public-Opinion, we observe the "No authorization" decision pattern. The only exceptions are a few cases of cyclical authorizations with

the 1990 vote procedure. It only happens when the strategies of lobby groups are different (combination anti-pro or pro-anti). When lobby groups adopt the same strategy (Pro-Pro or Anti-Anti), it is extremely rare to observe acceptations except when average initial Public-Opinion is 5. When authorizations are obtained, countries with a low sensitivity to firms' lobbying are dissatisfied. These are precisely the countries which decided to systematically reject new demands for GMO release, therefore imposing a moratorium on GMOs in Europe. Our simulations therefore reflect quite well the situation between 1990 and 1998.

## Comparison Between the 1990 and the 2001 Voting Procedures

### 5.13

The following statistical analysis is a comparison of the 1990 and 2001 Directives. The objective is to assess whether the implementation of the 2001 Directive does achieve its underlying objectives: (i) to ensure that European decisions concerning the authorization or rejection are closer to the average European public opinion on GMOs (ii) and to secure more homogenous opinions across European countries through more collective deliberation and multi-level voting procedures.

### 5.14

Within this perspective, we used the model to explore two questions:

- - Is the number of "satisfied" countries greater with the 2001 procedure as compared with the 1990 procedure?
- - Does the 2001 procedure contribute to smooth out public opinion heterogeneity between countries?

### 5.15

The following simulations were conducted using the same initial parameters (initial public opinions and sensitivity to firm/NGO lobbying) both in the 1990 and in the 2001 voting procedure. At each time-step, societies are different, but they emerge due to similar rules and similar initial conditions. Hence such simulations allow us to compare the final outcomes — when the society patterns have stabilized — in the two procedures. We run 100 simulations: for each simulation, initial opinions and sensitivities to lobbying of each of the 15 member states are drawn randomly. Each simulation is therefore characterized by a weighted average of initial opinions and a weighted average of sensitivities to lobbying.

### 5.16

It was shown that the 1990 procedure is such that a GM-product can be authorized although the average opinion within Europe is actually against it (inferior to 3). The 2001 procedure was set up in order to reduce the gap between decisions and public opinions. Figures 2 and 3 demonstrate that, whatever the initial level of average public opinion and the average level of sensitivity to firm/NGO lobbying, the number of "satisfied" countries (countries for which the final European decision to authorize or reject a GM-product is in conformity with its opinion) is statistically higher in the 2001 procedure than in the 1990 procedure.



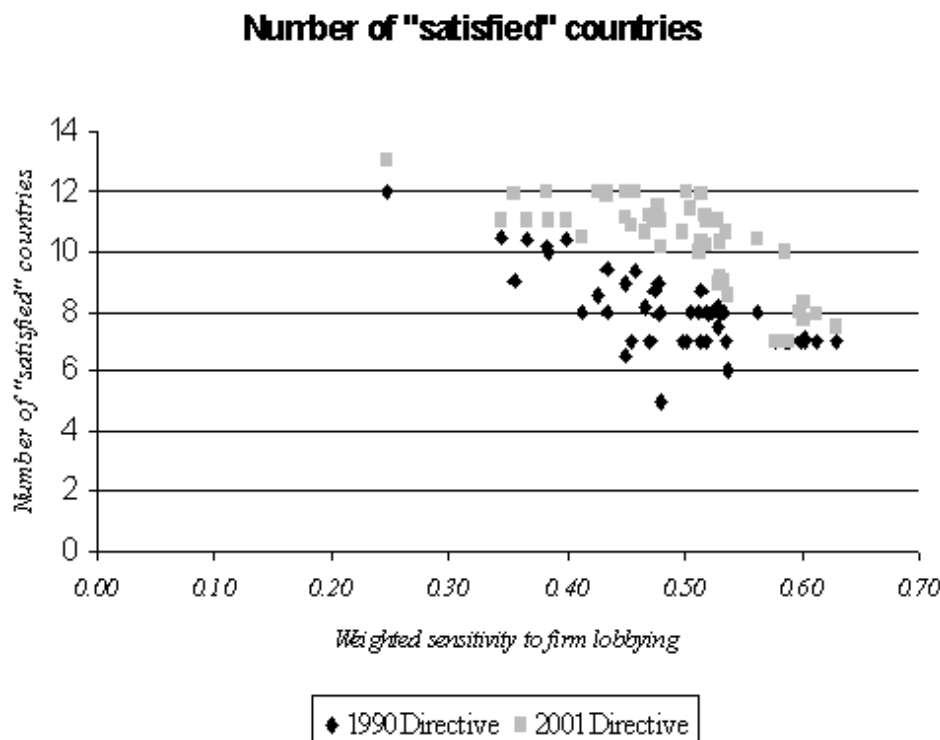


Figure 2. Number of satisfied countries in the 1990 and 2001 Directives for different levels of weighted average sensitivity to firm's lobbying

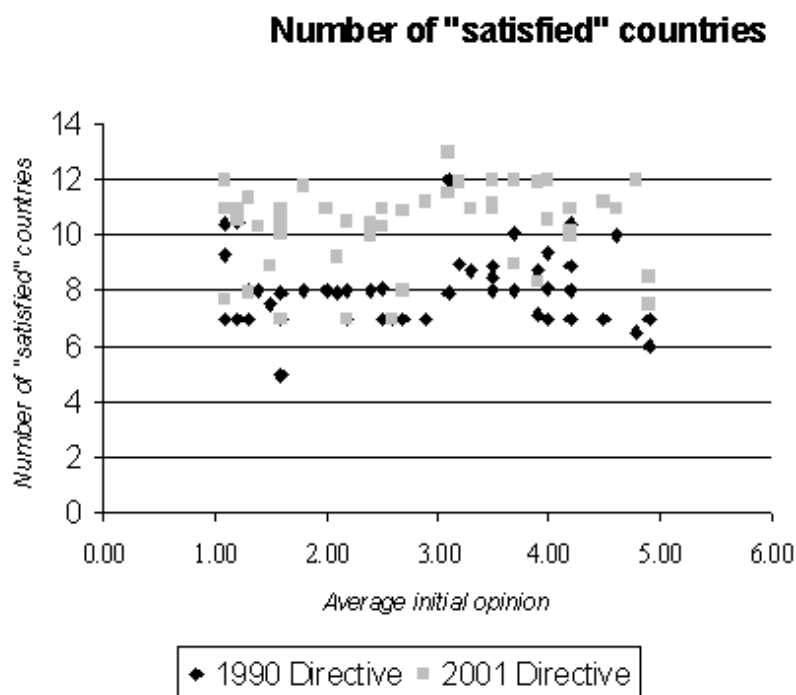


Figure 3. Number of satisfied countries in the 1990 and 2001 Directives for different levels of weighted average initial public opinion

5.17

Table 4 shows that, whatever the NGO's strategy in the 1990 and in the 2001 voting procedures, the average final public opinion under the 1990 voting procedure is higher (less opposed to GMOs) than under the 2001 procedure. The only exception is when the NGO adopts a Pro strategy under the 1990 procedure and an Anti strategy under the 2001 procedure. Our simulations also reveal that the difference between 1900 and 2001 public opinions declines when sensitivity to firm's lobbying increases. It therefore shows that the 2001 procedure gives the NGO more capacity to lobby and to induce a long-term shift of public opinion against GM-products: in effect, the 2001 procedure, which includes a phase of consultation of the public and therefore gives the opportunity to lobby groups to indirectly influence the decision, is more advantageous for NGO's lobbying since it has longer term effects than Firm lobbying.

## 5.18

However, the comparison of different combinations of lobbying strategies also shows that, for the NGO, the Anti strategy is more efficient than the Pro strategy since the NGO, by switching from a Pro strategy to an Anti strategy (comparison of columns 1 and 3 in table 4) succeeds in increasing the opinion gap between 1990 and 2001. The negative value in column 4 row 1 indicates that the NGO's lobbying strategies have actually more effects on average European opinion than the change in voting procedure. This seems to indicate that NGOs should maybe spend more time rethinking their strategies (especially in terms of better targeting).

## 5.19

Table 4 shows that the heterogeneity of opinion increases under the 2001 procedure and is even higher when the NGO adopts a Pro strategy. This result is at odd with the implicit objectives of the new directive, which is to smoothen out differences in opinions. However, it is consistent with our earlier findings: by allowing lobby groups to be more active and to intervene more regularly, the 2001 procedure does in fact gives more opportunities for increasing discrepancies between public opinion.

## 5.20

Therefore, it can be concluded that the 2001 procedure is effective in increasing the consistency between the final decision to reject or authorize a new GM-product and the average European opinion. But it does not succeed in reducing heterogeneity between European countries. It can therefore be concluded that the innovations of the 2001 Directive (unanimity in the rejection vote and increased consultation of the public) work in both directions: it does improve the feeling that people's opinions are more genuinely reflected in European collective decisions — but at the expenses of more inaction (since the heterogeneity in public opinions reduces the chances of obtaining a unanimous decision).

**Table 4:** The efficiency of NGO lobbying strategies under the 1990 and the 2001 procedures - when the Firm's lobbying strategy is Pro

	NGO lobbying strategy			
	1990 and 2001: Pro	1990 and 2001: Anti	1990: Pro 2001: Anti	1990: Anti 2001: Pro
Differences in final average public opinion (vote90 - vote2001) <sup>(1)</sup>	0.45**	0.21*	0.75**	-0.09
Differences in standard deviation of final public opinion (vote90 - Vote2001) <sup>(2)</sup>	-0.25 <sup>††</sup>	-0.10	-0.17 <sup>†</sup>	-0.18 <sup>†</sup>

\*\* > 0 with 99% confidence level - one tail t-test df = 198

\* > 0 with 95% confidence level - one tail t-test, df = 198

†† < 0 with 99% confidence level - one tail F-test with df = ( 99, 99)

† < 0 with 95% confidence level - one tail F-test with df = ( 99, 99)

<sup>(1)</sup>A positive sign indicates that the European public opinion obtained after several decision rounds under the 1990 procedure is greater than the European public opinion obtained under the 2001 procedure.

<sup>(2)</sup>A negative sign indicates that the standard deviation of public opinions in the 15 member states is lower under the 1990 procedure than under the 2001 procedure

## Conclusion

### 6.1

The European decision process is characterized by a political market activated both at the domestic level (within each member state) and at the supranational level (between member states). Lobbying groups need therefore to adjust their targeting strategies in order to be efficient: should they seek to influence voter's opinions or decision-makers' decisions? Should they act at the domestic level or also at the

European level? Should they try to convince opponents to change their position or should they seek to reinforce the position of their supporters? This article develops a two-level public choice model in which both the politician-voter relation and the lobbying groups competition are taken into account. The objectives are twofold: (i) to analyse the impact of different European decision processes on the efficiency of lobbying strategies and; (ii) to measure the impact of the change in European decision procedures on the heterogeneity of public opinions in Europe and on the acceptability of the decision. The Directive 2001 was enacted to reduce the strong opposition of some member states to a collective procedure which ended up too often in decisions which were unacceptable for their constituencies. It was also expected that public consultations would improve the convergence of public opinions across member states, therefore facilitating the collective decision. The model is applied to the European procedure for authorizing new GMOs. It is based on the public choice theory of interest group contests and of the median voter's dictatorship.

## 6.2

Computational simulations show that the new procedure adopted since 2001 for the authorization of new GMOs (involving more consultation and a unanimity voting rule) reduces the discrepancy between national preferences and the European decision but does not succeed in reducing heterogeneity in public opinions across member states. Therefore our results demonstrate that only the first objective of the 2001 Directive was attained. The fact that public opinions remain dispersed has a very negative impact on the European decision since it increases the number of cases where no qualified majority nor unanimity can be attained, and when therefore the European Commission decides in place of the European Council of Ministers. This result is confirmed by what has happened since 2004 when the Directive was enforced: only 5 new GMO crops (3 maize and 2 rapeseed) were authorized. They were all submitted to the final decision of the European Commission because member states did not succeed in reaching a qualified majority.

## 6.3

The simulations also show that targeting opponents rather than supporters is a more efficient strategy, especially when lobbying efforts are directed at changing the median voter's position. It is also striking to find out that the choice of NGO's lobbying strategy has more impact on opinion changes and on final European decisions than the change in voting procedure. This seems to indicate that NGOs should maybe spend more time rethinking their strategies (especially in terms of better targeting).

## 6.4

Although our model does not capture all subtleties of an international decision-making process, it is an attempt to represent in a unified framework the interrelations between vote and lobbying, in a multi-stage process. Simulations helped us to clarify the indicators and criteria for assessing the performance of the voting procedures and lobbying strategies. The next step is to develop a better understanding of the interlinked decision-making processes, but also to improve our representation of the lobbying activity and its influence on the public opinion. Another development of this model is to simulate the impact on the collective decision of the newly adopted voting rules adopted, following the enlargement to the ten new member states.

## Notes

<sup>1</sup> Voters are of course interested in many different issues but we can make the assumption that on politically sensitive issues (security, health, irreversible environmental damages), a national election could be used as a mean of political sanction by voters who would not agree with the position defended by the decision-maker. We can make the assumption that such issues are dominant in the vote and that voters have single-peaked preferences on such issues.

<sup>2</sup> The median voter is the voter whose preference is such that there are as many voters whose preferences are lower as voters whose preferences are higher.

<sup>3</sup> In this paper, the international level is the European level.

<sup>4</sup> This paper was written before the EU enlargement: the European model is therefore based on 15 country members, each having a fixed voting weight (see appendix [1](#)).

<sup>5</sup> One can note that there are two main procedures for voting at the European Council: qualified

majority voting or the veto system (ie, unanimity). The qualified majority requires a minimum of 62 votes out of 83 votes in total.

<sup>6</sup> The dispute was triggered by the approval in 1996 by the EU of a variety of Bt-corn produced by Novartis and of the Monsanto's Roundup Ready soybean (1996), for which scientists had expressed serious doubts concerning their health and environment immunity. In June 1999, Denmark, France, Greece Italy and Luxembourg issued a declaration that they would effectively block new GMO approvals until the European Commission proposed legislation for traceability and labeling of GMOs and products derived therefrom.

<sup>7</sup> In 2004, after all regulations on product signaling have been organized, the moratorium was eventually lifted

<sup>8</sup> The first-time consent for a release of GMOs is limited to a maximum of ten years.

<sup>9</sup> Here, we depart from the theoretical presentation where opinion value ranged from -1 to +1

<sup>10</sup> Sensitivities to lobbying are drawn randomly

<sup>11</sup> for example a country with a Public-Opinion value inferior to 3 (therefore against GMO), and a European decision in favour of authorization; or vice versa, a country with a Public-Opinion value superior to 3 (therefore in favour of GMO), and a European decision rejecting the notification.

<sup>12</sup> Weighted average sensitivity is the sensitivity coefficients ( *sens-NGO* and *sens-Firm*) averaged across the 15 European countries, weighted by their voting power.

<sup>13</sup> It is not interesting to run simulations for estimated values of Public Opinions in the 15 European countries since we have shown that the simulation results are independent of initial opinions after a few runs.



## Acknowledgements

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## Appendix 1: country-specific parameters

**Table A1:** Vote weights and Sens-Firm. Analogy with "real-world" situation — figures given by the authors after literature review and expert interviews

Country	Voting weight	Firm sensitivity
France	10	0.15
Germany	10	0.15
Italy	10	0.65
UK	10	0.65
Spain	8	0.35
Belgium	5	0.35
Netherlands	5	0.35
Greece	5	0.65
Portugal	5	0.65
Austria	4	0.15
Sweden	4	0.35
Ireland	3	0.65
Denmark	3	0.15
Finland	3	0.35
Luxembourg	2	0.35



 Appendix 2: Voting procedures

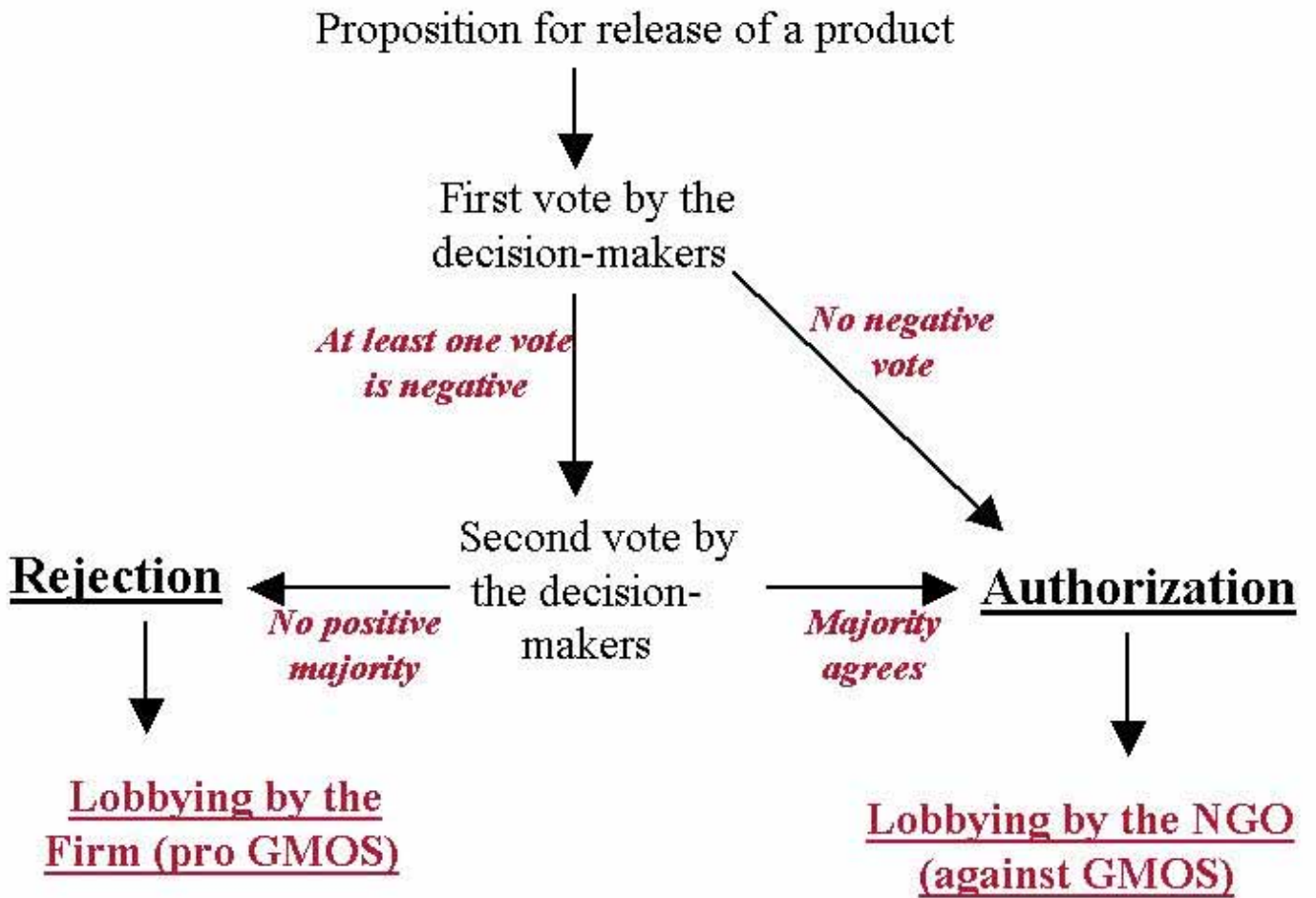


Figure A1. The Vote90 procedure in the multi-agent model

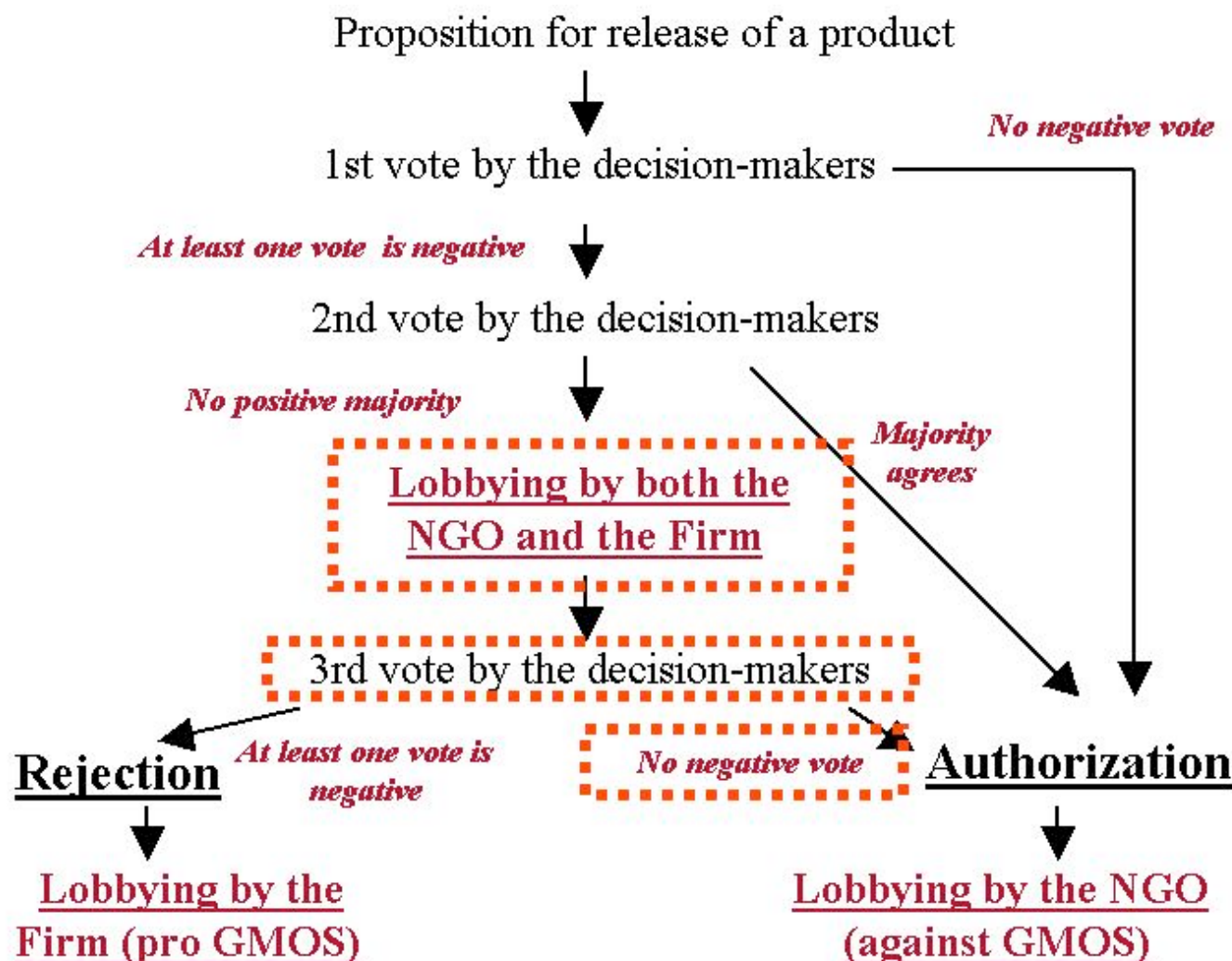


Figure A2. The Vote2001 procedure in the multi-agent model

Dotted lines indicate the main differences between Vote90 and Vote2001

### Appendix 3: Sensitivity analysis on initial parameters

#### A3.1

It happens that the final decision (to authorize or reject the notification) goes against the satisfaction of 50% of the countries. In other words, the decision does not conform to the average Public-Opinion. Such situation is observed when either a minority of high weight Public-Opinions decide against the others, or when the Decision-Maker votes against his own opinion. This is mostly the case when Public-Opinions are close to neutral and can therefore be pushed above or under 3 by the influence of lobby groups.

#### A3.2

Tables A-2 to A-7 describe the outcomes for different levels of lobbying capacities (from 5 to 30 units) and for different levels of initial Public-Opinions and for different strategy combinations in Vote90 and Vote2001 respectively. Permanent acceptance are only observed when lobbying capacities are low (5 or 10 units). Moreover, the initial value of Public-Opinions must be high.

Table A2: Frequency of decision patterns for different levels of lobbying capacity - Vote 90

Lobbying capacity (number of campaigns)	5	10	15	20	25	30
Permanent authorization	20%	5%	0%	0%	0%	0%
Cyclical authorization	0%	5%	30%	50%	50%	0%
No authorization with majority satisfied	60%	60%	40%	35%	0%	0%
No authorization with minority satisfied	20%	30%	30%	15%	50%	100%

Total 100% 100% 100% 100% 100% 100%

Note: Out of 20 different initial settings (initial value of Public-Opinion from 1 to 5, 4 combinations of lobbying strategies).

**Table A3:** Frequency of decision patterns for different levels of lobbying capacity — Vote 2001

Number of Campaigns	5	10	15	20	25	30
Permanent authorization	20%	0%	0%	0%	0%	0%
No authorization with majority satisfied	80%	80%	80%	95%	70%	0%
No authorization with minority satisfied	0%	10%	10%	5%	30%	100%
Total	100%	100%	100%	100%	100%	100%

Note: Out of 20 different initial settings (initial value of Public-Opinion from 1 to 5, 4 combinations of lobbying strategies).

**Table A4:** Frequency of decision patterns for different levels of initial Public-Opinions- Vote90

Initial Opinion	1	2	3	4	5
Permanent authorization	0%	0%	4%	8%	8%
Cyclical authorization	33%	33%	42%	42%	46%
No authorization with majority satisfied	59%	59%	29%	12.5%	4%
No authorization with minority satisfied	8%	8%	25%	37.5%	42%
Total	100%	100%	100%	100%	100%

Note: Out of 24 different settings (lobbying capacity: 5,10, 15, 20, 25, 30; 4 combinations of lobbying strategies).

**Table A5:** Frequency of decision patterns for different levels of initial Public-Opinions — Vote2001

Initial Opinion	1	2	3	4	5
Permanent authorization	0%	0%	0%	8%	8%
Cyclical authorization	0%	0%	0%	0%	0%
No authorization with majority satisfied	83%	79%	79%	54%	50%
No authorization with minority satisfied	17%	21%	21%	38%	42%
Total	100%	100%	100%	100%	100%

Note: Out of 24 different initial settings (lobbying capacity: 5,10, 15, 20, 25, 30; 4 combinations of lobbying strategies).

### A3.3

With a high lobbying capacity (30 units), we can observe permanent rejection even with an average public opinion which would be favourable to GMOs (4.1 in Vote90 and 3.7 in Vote2001). This situation is independent of the initial value of Public-Opinions and lobbying strategies. The reason why we observe such a high average Public-Opinion in the last rounds is that Firm gets more opportunities to lobby through the European voting system.

**Table A6:** Frequency of decision patterns for different lobbying strategies — Vote90

Lobbying (Firm - NGO)	Anti-anti	Anti-pro	Pro-anti	Pro-pro
Permanent authorization	10%	0%	7%	0%
Cyclical authorization	70%	0%	17%	17%
No authorization with majority satisfied	20%	23%	33%	37%

No authorization with minority satisfied	0%	77%	43%	46%
Majority satisfied	80%	60%	57%	83%
Majority dissatisfied	20%	40%	43%	17%

Note: Out 30 different initial settings (number of campaigns: 5,10, 15, 20, 25, 30; initial values of opinion: 1 to 5)

**Table A7:** Frequency of decision patterns for different lobbying strategies — Vote2001

Lobbying (Firm - NGO)	Anti-anti	Anti-pro	Pro-anti	Pro-pro
Permanent authorization	7%	0%	7%	0%
No authorization with majority satisfied	70%	83%	43%	73%
No authorization with minority satisfied	23%	17%	40%	27%
Majority satisfied	77%	83%	57%	77%
Majority dissatisfied	23%	17%	43%	23%

Note: Out of 30 different initial settings (number of campaigns: 5,10, 15, 20, 25, 30; initial values of opinion: 1 to 5)

## Appendix 4

### A4.1

The source code of the model and an explanation about how to use it can be found at: <http://www.vcharite.univ-mrs.fr/PP/rouchier/jasss/jasss.htm>.

### A4.2

For more information on the multi-agent model, please write to [juliette.rouchier@univmed.fr](mailto:juliette.rouchier@univmed.fr).

[Return to Contents of this issue](#)

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