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ON THE IMPACT OF TRUST ON CONSUMER WILLINGNESS TO PURCHASE GM FOOD :

EVIDENCE FROM A EUROPEAN SURVEY

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On the Impact of Trust on Consumer Willingness to Purchase GM Food: Evidence from a European Survey

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Abstract

Many researches try to explain consumer's acceptance and opposition to GMO with focus on social factors. With a causal or an associationist theoretical model, different authors put forward the notion of trust as determining to define the position of individuals. Because as in the present case we could fear the simultaneity of decisions (trust, risk perceptions and acceptability), we have to take into account this endogeneity risk. With data from a European Survey (Eurobarometer 64.3 2005), multivariate probit was used to specify the importance of trust in the various organizations involved in the public debate on the acceptance of genetically modified foods on behalf of the "ordinary citizens". We discuss this portrait of European citizens that shows them to be increasingly optimistic about biotechnology, while being divided on this question.

Key words

Biotechnology; Consumer Attitudes towards Technology; European Survey Data; Genetically Modified Food; Multivariate Probit; Trust

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Introduction

The introduction of biotechnologies in production processes is widespread today in a number of sectors, such as pharmacy, agriculture, food-processing, chemistry, environment, the cosmetics industry, energy, etc. Moreover, since their emergence, and even with the introduction of the second generation of value-enhanced or nutritionally enhanced GM Food, agricultural biotechnologies have triggered off an intense debate concerning their innocuousness or lack of, in government circles of several industrialized countries, leading to a multiplicity of official initiatives on evaluation of this new technology and an important mobilization of public opinion associations (consumers' associations, environmental and animal protection associations) (Chaklatti & Rousselière 2006). Contrary to the environmental protection associations, which were leaders in the emergence of the debate about GMOs in Europe, consumers' associations can be considered as followers as they got involved quite late in the debate. The initial positioning of environmental protection associations such as Greenpeace France, one of the most important actors in the structuring of the debate in France, allowed them to gain credibility in the eyes of the public opinion (Todt 2003; Toke 2004). Similarly, whereas the opposition of the environmental protection associations appears as an opposition about principles, consumers' associations seem first to strike for the defense of consumers' interests, *i.e.* for the right of information.

More broadly, this context clearly fits in the frame of a *controversial or debated universe* (Godard 1998; Boisvert & Vivien 2005; Chaklatti & Rousselière 2006): environmental issues is constructed through an interplay involving scientific controversy, industrial interests, political stakes, groups lobbying and media effects. In a debated universe, it is crucial to answer the question about the formation of individual and collective preferences. In this frame, several researches show the diversity of consumers' approvals or refusals of biotechnological food-products. The determinants of the opposition or the

acceptance to the GMOs seem largely linked to individual attitudes and values (Pardo *et al.* 2002; Bredahl 2001), whereas the level of scientific knowledge about biotechnologies is of relative little importance for the formation of individual preferences (Priest *et al.* 2003; Sturgis *et al.* 2005; Gaskell *et al.* 2004; Barker & Burnham 2001). The notion of trust seems to be determining in a debated universe, characterized by uncertainty and a lack of common knowledge (Boisvert & Vivien 2005).

Therefore, this work aims to characterize the position of "ordinary citizens" who are legitimized neither by a specific expertise nor by a representative function (Joly & Marris 2003) and is based on their opinion about the information work of the different actors involved in this public and controversial debate about GMOs in Europe. After a literature review and a presentation of the survey data, we present our econometric strategy. For methodological and theoretical purposes, a multivariate probit was retained. In conclusion, we discuss this portrait of European citizens that shows them to be increasingly optimistic about biotechnology, while being divided on this question

On the social determining factors of the willingness to purchase GM Food

GMOs' marketing needs a real demand, which is linked to consumers' acceptance of them. The attitude of the public towards GMOs have been studied in surveys considering socio-demographic variables, knowledge level, trust in the information and/or the action of certain actors of the agricultural biotechnologies debate, social and political values, perception of risks and benefits linked to agricultural biotechnology, etc.

Table 1: The social factors of the acceptance of GM Food

	Authors	Data	Variables	Methodology	Results
Experimental Economics	Lusk *et al.* 2004	N=284 (USA, UK, France)	Information about potential benefits	Non parametric tests and censored regression	Information on environmental, health and World benefits significantly decreased the amount of money consumers demand to consume GM Food. Differences between French consumers (generally unaffected by positive information) and consumers from England and USA.
	Frewer *et al.* 2003	N = 1405 (Denmark, Germany, Italy, UK)	Trust in an information source	Simultaneous Equations, Maximum Likelihood	The results show that the availability of information had few effects on the individuals' attitude towards biotechnological products and that the perception of information sources characteristics scarcely contributed to the change of attitudes.
	Huffman *et al.* 2004a, 2004b	N = 318 (USA)	Personal Capital (PC) and Social Capital (SC)	Multinomial Logit model	The personal capital (PC) and the social capital (SC) of consumers have a significant impact on the trust in the information given by certain organizations. This trust has in turn an impact on the consumption level of biotechnological food products.
	Noussair *et al*. 2004	N = 97 (France)	Information in labels, price, socio-demographic variables	Comparison of averages and logit regressions	Impact of prices and labels in the acceptability or rejection of GMOs. Study of the propensity to purchase similar food products which differ only in their level of GMOs.
	House *et al*. 2004	N = 309 (USA, UK and France)	Objective and Subjective knowledge	Ordered logit models	Objective knowledge (partially an education outcome) is not linked to GMO acceptance. Subjective knowledge (also linked to education) is a significant variable for the consumer's disposition to purchase GM food products.
	Townsend & Campbell 2004	N=100 (UK)	Risk perception and GM Beliefs	Mixed ANOVA and logistic regression	Feelings of dread about GM food and the future risk of GM animals in food are important predictors of willingness to purchase GM food.
	Townsend *et al.* 2004	N=126 (UK)	Risk perception	Factorial Analysis	The results show that GM food is judged on key risk scales in the context of other current concerns, perceptions of GM food (in a largely student-based sample) are not as negative as other recent reports claim.
Eurobarometer Surveys	Pardo *et al*. 2002	Eurobarometer (1996)	Perceived benefits and risks of biotech applications, socio-demographic variables	Factorial Analysis et Structural equation models	The results show the importance of general values or worldviews in the formation of positive attitudes towards GMOs. For most of adults, optimism (or pessimism) towards technology or general beliefs in (or rejection of) biotechnological promises logically and chronologically precede attitudes towards a specific application of biotechnologies and can become a filter of the reception and processing of new information. The interests of an individual (and the related knowledge) play an important role in the perception of biotechnological applications' advantages.
	Priest *et al*. 2003	Eurobarometer (1999) and comparison USA (2000, N = 1002)	Knowledge, Trust in an actor and differences in trust	Regressions based on country averages	The difference of reaction *vis à vis* GMOs in Europe and the US are better explained by the trust in the actors involved in the GMO debate and the trust gap, than by the level of knowledge and education.
	Gaskell *et al*. 2004	Eurobarometer 52.1	Socio-demographic variables, perceived risks and benefits	Multiple Linear Regressions	The perception of risks and benefits linked to GMOs has an influence on the individual attitude towards the opposition to GMOs.

	Authors	Data	Variables	Methodology	Results
	Chaklatti 2006; Chaklatti & Rousselière, 2006, 2007	Eurobarometer 58.0 (2002)	Socio-demographic variables, Knowledge, Trust	Data Analysis and Simultaneous regression models	The public debate on the GMOs is a controversial universe. Opposition and Trust in some organizations are strongly correlated: positively with environmental associations and negatively with governments, industrials and scientists.
Others National and Cross-National Surveys	Bredahl 2001	Denmark, Germany, Italy, UK N=2031	Perceived risks and benefits	Factorial Analysis and Structural equation models	The attitude *vis à vis* GM foods is determined by the perception of risks and benefits linked to the application of GMOs in food products. The perception of risks and benefits is linked to more general attitudes of consumers (notably towards nature and technology).
	Cook *et al.* 2002	N = 266 (New Zealand)	*Self identity* (SI), attitude, *subjective norm* (SN) and *perceived behavioral control* (PBC)	Ordered logit models and correlation analysis	The SI, attitude, SN and PBC have a positive influence on the purchase intention of GM food products.
	Fritz *et al.* 2003	N = 749 (USA)	Socio-demographic Variables	Comparison of averages	There is a positive relation between awareness and acceptance of biotechnologies. Young people are less aware of the impact of biotechnologies on food, health and environment than adults.
	Onyango *et al.* 2004	N =1201 (USA)	Benefits and potential risks of GM foods Socio-demographic Variables	Logit Regressions	Individuals giving information about both benefits and risks of GM food products are less inclined to consume them than individuals giving information only about the benefits of GM products. Individuals who take time to read product labeling are also less inclined to consume GM products. The difference of social or political values or the trust in private or public institutions does not affect the acceptance of GM food.
	Harrison *et al.* 2004	N = 459 (Italy) N = 509 (USA)	Socio-demographic Variables	Univariate probit regressions	In Italy, less educated people are more likely to buy GM food products. In contrast, in the US, a higher level of education is linked to a higher purchase intention.
	Sturgis *et al.* 2005	British Social Attitudes survey (2000) and Wellcome Consultative Panel Gene therapy (1999)	General knowledge in science and specialized knowledge in genetics	Univariate logit Regressions	General knowledge in sciences plays an important role in the determination of individual and group attitudes towards GM food products.
	Poortinga & Pidgeon 2004, 2006	N=396 (Norwich Population Survey, UK)	Trust, Beliefs and Acceptability	MANOVA, Principal Components Analysis and Discriminant Analysis	Most people are ambivalent about GM food. People with strong preconceived ideas may not easily change their existing attitudes and attributions of trust, as they largely interpret events in line with their prior attitudinal positions.
	Poortinga & Pidgeon 2005	N=296 (UK National Survey)	Trust, Risk, Acceptability	Zero-order and partial correlations	The results are supportive of the associationist view of Trust, Risk and Acceptably of GM Food, although the causal chain account of trust cannot be completely ruled out.
	Bukenya & Wright 2007	N=310 (USA)	Socio-demographic variables, risk perception, knowledge	Univariate logit regressions	Attitude toward the use of GM technology in food production and perceptions about the safety of GM foods are significant determinants of whether or not a consumer would purchase non-GM tomatoes at a price higher than that of GM tomatoes.

	Authors	Data	Variables	Methodology	Results
	Allum 2007	N=1273 (UK)	Risk perception, Trust, Competence and Social Values	Structural Equation Modeling	High levels of mistrust in scientists involved in the development of GM Food are accompanied by quite widespread concerns about the personal and generalized risk posed by such developments
	Barnett *et al.* 2007	British Social Attitudes survey (2003)	Socio-demographic variables, "attentiveness", trust and belief in public efficacy	Linear regressions	Trust in government rules, used as a control variable, was significantly associated with attitudes toward three genetic technologies (human cloning, gene therapy, genetic databases). No impact of trust in genetic scientists.
	Qin & Brown 2008	N=501 (USA)	Socio-demographic, variable, trust and social values	Linear regressions and structural equation modeling	Trust in government agencies is positively related to a positive general attitude toward GE Salmon. No impact of Trust in scientific organizations.
	Canavari & Nayga 2009	N=433 (Italy) (random stratified proportional probability sample)	Socio-demographic variable, Trust, knowledge	Univariate probit models	Knowledge of science and trust in scientists are positively related to willingness to buy nutritionally enhanced GM food (with less pesticide, less cholesterol or enhanced with vitamin E)

This literature review presents some of the social factors, which, according to different studies, determine the acceptability of GMOs (cf. Table 1). In this frame, several surveys in experimental economics (Cook *et al*. 2002; Frewer *et al.* 2003; Huffman *et al.* 2004a, 2004b; Lang *et al.* 2003; Lusk *et al.* 2004; Noussair *et al.* 2004; Townsend & Campbell 2004; Townsend et al. 2004.) or based in national and transnational survey (Bredahl 2001; Gaskell e*t al.* 2004; Priest *et al.*, 2003; Pardo *et al*. 2002; Chaklatti & Rousselière 2006, 2007; Poortinga & Pidgeon 2004, 2005, 2006; Allum 2007; Barnet et al. 2007; Qin & Brown 2008; Canavari & Nyaga 2009) show the diversity of consumers' approvals or refusals of biotechnological food-products. These different methodologies are coupled with a diversity of theoretical models (human capital, conventionalist economics, behavioral economics, and social psychology). A huge variety of econometric methods were used for measuring the relation between social values and acceptability (linear and logistic regressions, factorial analysis, ANOVA and MANOVA, structural or simultaneous equations modeling). As it is very difficult to summarize all these approaches, we will focus on three social factors: risk perception, knowledge and trust. While the results are mitigated about the impact of knowledge and risk perception, trust had been unanimously considered as a key factor.

Some results of surveys made in Europe (Bredahl 2001; Gaskell *et al.* 2004; Pardo *et al*. 2002) and in the US (Onyango *et al*. 2004) about **the importance of the perceived risks and benefits** allow us to notice that consumers are very skeptical about the use of GMOs in food products. They consider that the new technology entails an important risk[1]. These consumers link the risk with the intended benefit of GMOs and they are aware that the *zero risk* concerning the impact of GMOs does not exist. Attitudes towards GMO use in food products are explained by risks as well as benefits associated with the technology. As Gaskell *et al*. (2004: 191) underlines it: "*It is notable that in the context of GM foods there are a*

[1] For only two studies (Townsend & Campbell 2004, Townsend *et al.* 2004), GM Food was not rated on a scale of key risk as "dreaded". Because of the methodology (a very small sample), this finding must be replicated in a larger sample of individuals.

sizeable number of respondents in the group labeled "skeptical". Fully 60% of the sample believes that GM foods offer no benefits and carry risks". A minority of the European population are classified in two other groups of interest were labeled 'trade-off' – perceiving both risk and benefit – and 'relaxed' – perceiving benefits and no risk. According to this survey, there is no direct relation between risk perception and opposition, but rather a plurality of possible attitudes, differing in respect of key social and cognitive resources that may inform consumers' views of GM food.

House *et al.* (2004) distinguish between objective (tested) and subjective (self-rated, also known as perceived) **knowledge.** Their results show that people holding a college degree or more are the one more likely to accept GM food. They specify that objective knowledge (partially an outcome of education) is not linked to the acceptance, whereas subjective knowledge (also partially linked to education) is an important variable of the acceptance of GM food. Sturgis *et al*. (2005) isolate two variables of knowledge as determining factors in the attitude towards GMOs: knowledge in general sciences and in genetics. The results show that the knowledge in general sciences play an important role in determining individual and group attitudes towards GM food. Sturgis & Allum (2001) specify that knowledge and attitude towards biotechnological food products are related (the higher the knowledge, the higher the acceptance) but that this relation is usually not important. In general, the level of scientific knowledge in biotechnologies is hence of relative little importance for the formation of individual preferences (Priest *et al*. 2003; Sturgis *et al.* 2005; Gaskell *et al*. 2004; Bukenya & Wright 2007; Chaklatti & Rousselière 2006, 2007). On this last point, (according to Marris 2001; Gaskell *et al*. 2004), the usual argument (which states that a higher level of knowledge would entail a better acceptance of biotechnologies) would reveal a misunderstanding about the way the consumers take decisions, as they take into account other parameters. Moreover, there is a huge disagreement on the link between knowledge and scientific attitudes towards

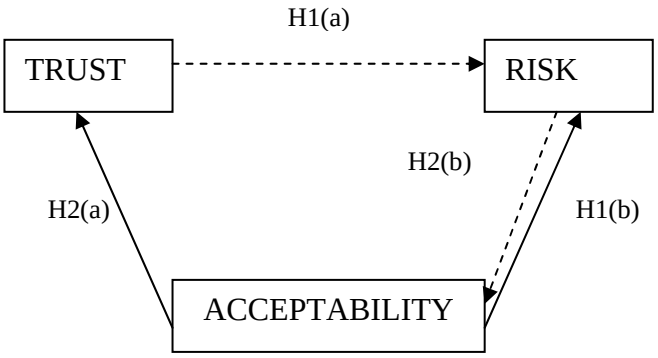
science (Gaskell *et al.* 2001). This suggests, as noted by Barker and Burnham (2001), that consumer behavior is determined less by how much consumers know, and more by what they believe.

Trust has been increasingly identified as the key issue that managers involved in the management of risks have to solve. Indeed different authors put forward the notion of trust (Todt 2003; Priest *et al.* 2003, Cook *et al*. 2002; Huffman *et al*. 2004a, 2004b; Lusk *et al.* 2004; Poortinga & Pidgeon 2004, 2005, 2006; Allum 2007; Barnett et al. 2007; Qin & Brown 2008; Canavari & Nyaga 2009) as a determining factor to define the position of individuals concerning GMOs applied to agriculture, in a context of uncertainty. According to Todt (2003) and Priest *et al.* (2003), the controversy over the use of certain technologies is first a sign of the trust gap in the actors. The usual arguments of scholars and political parties are such that if citizens trusted scientists and public authorities, they would have little reasons to oppose to technological developments such as GM food (Gaskell *et al*. 2004). To analyze the relation between the trust in the information coming from different sources and the consumption level of GM products, Huffman *et al*. (2004a) developed a model inspired by Becker (1996). The latter suggests a formal model of individual preferences or tastes, which takes into account the "social capital" (acquired through relatives and participation in social networks) and the 'personal capital' (acquired by the individual through education and experience) (Becker 1996: 7-18). Trust, seen as a function of these two capitals, has then an influence on the choice between different types of goods (for instance GM and regular food). The same individual holds at the same time different levels of trust towards different actors and it's the relation between them that determines the final decision. If an individual increases his trust in the information coming from environmental protection associations or loses trust in the information coming from agbiotech business, this contributes to lower his marginal utility of GM product (by hypothesis). The marginal rate of substitution of the consumer

between GM and plain-labeled food decreases. At given relative prices, the consumer will purchase more traditional products and lower his consumption of GM food products. The authors quoted above analyzed the importance of trust in sources of information, on the basis of a sample of 318 people participating in biotechnologies-related experiments. They show that in the American context the most trusted sources are scientists and the government, whereas there are doubts raised about environmental groups and consumers' defense groups (only 3% of individuals quote them as the first trustworthy source of information, whereas 30% quote scientists for this place). In general, studies show that trusting scientists (Allum 2007; Chaklatti 2006; Canavari & Nyaga 2009) government authorities (Barnett et al. 2007; Chaklatti 2006; Qin & Brown 2008) or industry (Huffman et al. 2004a) have a positive impact on the willingness to purchase GM Food. On the contrary, trusting environmental associations (Chaklatti & Rousselière 2007; Huffman *et al.* 2004a) leads to a lower acceptability of GM Food.

If there is empirical evidence that trust and GM Food acceptability are closely correlated, there are two alternative views in competition (Eiser *et al.* 2002; Poortinga & Pidgeon 2005): the associationist and the causal view. The causal model of trust is the most common interpretation of the generally strong relationships between trust and GM Food acceptability. Therefore researchers use standard linear or logistic regression with trust as dependent variable to predict the level of the willingness to purchase or accept GM Food in general or some special GM varieties (*e.g.* Onyango *et al.* 2004; Canavari & Nyaga 2009). Trust determines Risk Perception (H1a) which determines Acceptability (H1b). The associationist model views the acceptability of a risk as the determinant of trust. Both Trust and Risk Perception could well be indicators or expressions of a more general attitude toward a technology (H2a & H2b) (Poortinga & Pidgeon 2005: 200).

Figure 1: Associationist and causal views of trust



Drawing on the results of this literature review, this paper will consider trust in actors involved in the public debate on GMOs as a determining factor in the acceptability, and we will pay attention to have a methodology that allows us to test simultaneously the two models of Trust, while controlling for trust in the various organizations involved in the public debate.

Presentation of the survey data

The data used are taken from the special European survey "Eurobarometer 64.3" dealing with Foreign Languages, Biotechnology, Organized Crime, and Health Items (Gaskell *et al.* 2006). The special Eurobarometer reports are based on advanced thematic study carried out for the account of the services of the European Commission or other European institutions, and integrated into the waves of the survey of the standard Eurobarometer. Carried out in November and December 2005, Eurobarometer 64.3 covers the population—having the nationality of one of the member countries of the EU—15 years and older, residing in each member state of the European Union. 25000 individuals from 25 countries were thus questioned. Our study is based on the sample of 12320 individuals who had to answer the biotechnology module.

In our analysis, in order to compare our results with the literature, we have paid attention the variables usually retained: socio-demographic ones (age, age at the end of formal

education, gender, professional status, place of residence…), individual values (political and religious stance, interest in science and politics) and concerning the debate on biotechnology (trust, knowledge, information). For "Trust", the question posed is "do you trust the information on modern biotechnology coming from the following sources". Each time we thus obtain a qualitative dichotomous variable with the modalities "trust" (mentioned) and "no trust" (not mentioned). The list of variables obtained is relative to the confidence in some organizations[2]. A possibility to answer "do not know" is thus offered as well as the possibility to spontaneously answer "none of these". A scale based on these various trusts has a weak Cronbach's Alpha (0,401), which allows us to suppose that very different social dynamics are at stake. According to Gaskell *et al.* (2006), the 2005 survey data do not support the claim that there is a crisis of trust in actors involved in biotechnology in Europe: trust in every source of information show substantial improvements since the first Eurobarometer on biotechnology in 1999.

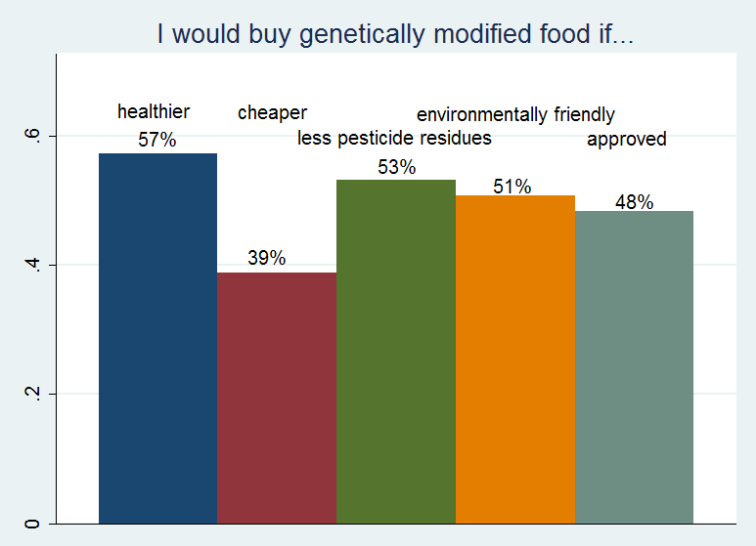
We also created variables concerning the willingness to the purchase of GM Food and knowledge of biotechnologies. We thus established a scale of acceptance of the food use of GMOs and a dichotomous variable BUY "buying GM Food for at least one reason". Six questions were asked about the reason to purchase GM food (with three possible modes of response: "yes", "no", "do not know")[3]. Based on the negative responses to these six questions we thus constructed a scale of acceptance going from 0 ("total opposition") to 6 ("total acceptance"). Cronbach's Alpha for this scale is 0,917, which allows us to suppose a greater reliability. By isolating the last modality, we thus obtain the new variable BUY. According to Gaskell *et al*. (2004, 2006), this division is one that discriminates most between

[2] "consumer organizations", "environmental organizations", "animal welfare organizations", "the medical profession", "farmer organizations", "religious organizations", "national government bodies", "international institutions (not companies)", "a industry", "universities", "political parties", "television and newspapers".

[3] "I would buy GM food if it were healthier.", "I would buy GM food if it contained less pesticide residues than other food.", "I would buy GM food if it were grown in a more environmentally friendly way than other foods.", "I would buy GM food if it were approved by the relevant authorities.", "I would buy GM food if it were cheaper than other foods.".

the two groups thus created. In effect, across all the countries, the mean for the purchase scale amongst the potential buyers is 3.6. This relatively high value indicates that the public is split on this issue: "The non-buyers operate a total veto, but once a threshold of minimal acceptability is reached, then people are inclined to find a number of the reasons acceptable for buying GM Foods" (Gaskell *et al.* 2006: 24).

Figure 2.

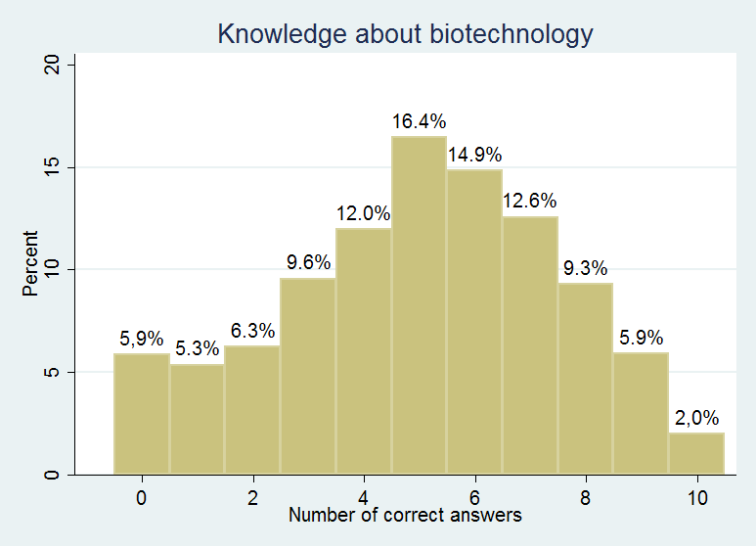


Note: A least one reason to buy GM food: 64%. Cronbach's alpha = 0,917 (high reliability).

The health and environmental related reasons for buying GM food seem to be the elements influencing the more in the pro-GMO choice: 57%, 53% and 51% of Europeans would buy GM Food if it were respectively healthier, contained less pesticides residues and more environmental friendly. While environmental benefits attract more potential purchasers than non-purchasers, European opinion is clearly split on this. Neither approval by the relevant authorities nor lower prices appear to be persuasive reasons in people's choice intentions: "While economics tells us that price is a key determinant of people's actual choices, in this hypothetical situation some may be responding as citizens rather than as consumers" (Gaskell *et al.* 2006: 13).

A variable was created concerning knowledge of biotechnologies. Questions concerning the use of biotechnologies had the goal of measuring the real knowledge of individuals. A scale taking up the 10 questions can thus be constituted[4]. We thus obtain a reliable scale (Cronbach's alpha = 0,711) providing the number of right answers (Figure 3). Only 2% of the European population respond correctly to all question and 45,5% to more than 5 question. But since 1996, there has been a constant increase in the proportion of Europeans' knowledge of genetics and biotechnology. Gaskell *et al.* (2006) propose two different explanations: a generation effect (young people may have been taught these topics at school) or a period effect (the population as a whole is learning more about these emerging areas).

Figure 3.



Note: Cronbach's alpha = 0,711 (good reliability).

[4] "It is possible to find out in the first few months of pregnancy whether a child will have Down's Syndrome.", "It is not possible to transfer animal genes into plants.", "Human cells and human genes function differently from those in animals and plants.", "Ordinary tomatoes do not contain genes, while genetically modified tomatoes do.", "Genetically modified animals are always bigger than ordinary ones.", "Embryonic stem cells have the potential to develop into normal humans.", "By eating a genetically modified fruit, a person's genes could also become modified.", "More than half of human genes are identical to those of a chimpanzee.", "Yeast for brewing beer or making wine consists of living organisms.", "The cloning of living things produces genetically identical copies.".

We also find small but significant correlations between willingness to purchase GM Food and various sources of information, suggesting that these items relate to each other[5]: people with a willingness to purchase GM Food are more likely to trust medical professions ($r=0,10$; $p<0,01$), national and international governments and institutions (respectively $r=0,08$ and $0,07$; $p<0,01$), European Union ($r=0,11$; $p<0,01$), Industry ($r=0,04$; $p<0,01$) and Universities ($r=0,05$; $p<0,01$); they are less trust in consumer, environmental and animal welfare associations (respectively $r=-0,03$, $-0,05$ and $-0,04$; $p<0,01$); knowledge in biotechnology and willingness to purchase GM Food are also positively correlated ($r=0,05$; $p<0,01$).

The econometric strategy

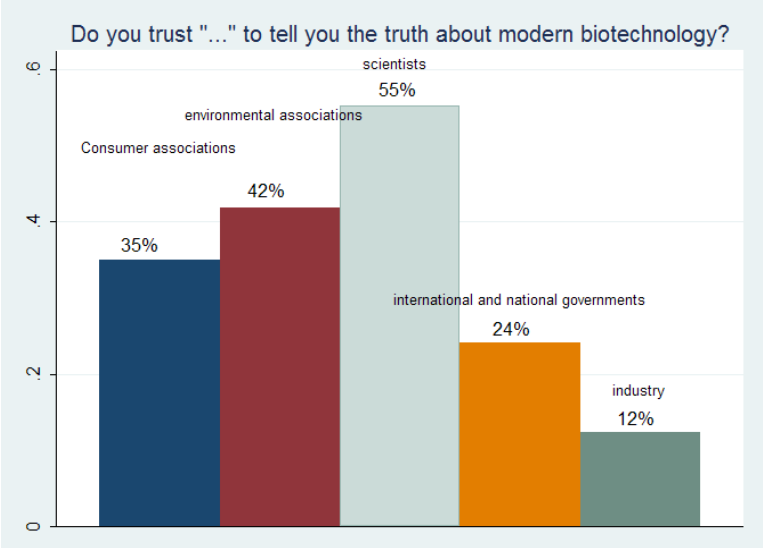
The relationship between consumer characteristics and consumer willingness to purchase GM Food is examined through an institutionalist econometric model of consumption that is compatible with the various theories reviewed previously. As Hendry (2000) suggests it, our econometric model must take into account that the data used here cannot be treated as if they were generated in conditions of experimental control and that we have to consider the existence of structural breaks and the intrinsically dynamic nature of social reality (Prattern 2005). Fixed effects and endogeneity are therefore two issues that our econometric model must deal with. Finally, as in the majority of cases, it is not possible to preview how each individual will exactly behave; it is more reliable to estimate a probability, through a logistic model, that an individual with some attributes will choose a given alternative.

To study the relationship between trust and acceptability, we concentrated on five categories that are the most important in this debate on GMOs (Figure 3): trust in the information on biotechnologies furnished by environmental associations, by consumer

[5] When measuring associations between dichotomic variables, one must pay attention to the fact that Pearson correlations are by nature limited to a range largely smaller than -1 to 1.

associations, by the agbiotech industry, by the scientists, and finally by public authorities. As showing by a hierarchical cluster analysis[6], scientific and medical professions have a tendency to converge. Grouped together under the label of "scientists", this category is the must trusted by the Europeans (55%). National government and international institutions ("public authorities") on the one hand and industrial and farmers' organizations on the other hand ("industry") follow the same tendency, while being clearly distrusted (respectively 24% and 12% of the European citizens trust them to tell the truth about modern biotechnology).

Figure 4.



To analyze further these data, different methods of logistic regression could be used. However, there is a risk here to get biased coefficients, as in the present case we could fear the simultaneity of decisions (trust and acceptability); the responses to the different questions are not independent to one another. Unfortunately, this issue was not correctly taking into account by previous researches (*e.g.* Huffman et al. 2004a; Townsend & Campbell 2004; Canavari & Nayga 2009; Onyango *et al.* 2004), which were only based on the causal model of trust. For example, Onyango *et al.* 2004 estimated the impact of trust in scientists, industrials

[6] The hierarchical cluster analysis, using Wards method, is not reported here. The results are strictly comparable to Chaklatti & Rousselière (2006, 2006). This analysis is available upon request.

or medical profession with a dummy independent variable and claimed to report no effect. In contrast to these previous studies, it is reasonable to suppose that the determining factors, both observable and unobservable, of a trust type and willingness to purchase are variables that could potentially explain the other types of trust. A simultaneous discrete choice model may have a better fit to the real consumer behavior. To take into account this *simultaneity*, which induces *endogeneity* risks that lead to biased coefficients (Wooldridge 2002), we estimate a multivariate probit model with six independent variables (rather than six independent probit models) (Cappellari & Jenkins 2003, 2006). Furthermore, this correlative model gives us an indication, the coefficient *rho* of correlation between residuals, of the force of association of the different variables (once controlled by a set of other variables). And finally, we can estimate the impact of a given trust on willingness to purchase GM Food with the conditional probabilities provided by multivariate probit models. This econometric strategy clearly fits not only with methodological issues but also with our theoretical framework presented in the first part of this article. We are indeed able to test simultaneously Associationnist and Causal models of Trust.

We thus select the six variables y_1 (acceptance – labeled BUY), y_2 (trust in the information on biotechnologies given by environmental protection agencies – labeled TRUSTENVI), y_3 (trust in the information given by consumers' associations – labeled TRUSTCONSO), y_4 (trust in the information on biotechnologies given by the agbiotech business – labeled TRUSTINDUSTR), y_5 (trust in the information on biotechnologies given by scientists – labeled TRUSTSCIENCE) and y_6 (trust in the information on biotechnologies given by public authorities – labeled TRUSTPUBLIC).

Let the following hold for the given six latent variables $y_1^*,\ y_2^*,\ y_3^*, y_4^*, y_5^*, y_6^*$ $\left(i.e.\ y_j = 1\ si\ y_j^* > 0;\ \ 0\ otherwise\right)$, the system of equations to estimate is then given by:

$$\begin{cases} y_1^* = \alpha_1 + \beta_1 X + \gamma_1 V + \lambda_1 C + \varepsilon_1 \\ y_2^* = \alpha_2 + \beta_2 X + \gamma_2 V + \lambda_2 C + \varepsilon_2 \\ y_3^* = \alpha_3 + \beta_3 X + \gamma_3 V + \lambda_3 C + \varepsilon_3 \\ y_4^* = \alpha_4 + \beta_4 X + \gamma_4 V + \lambda_4 C + \varepsilon_4 \\ y_5^* = \alpha_5 + \beta_5 X + \gamma_5 V + \lambda_5 C + \varepsilon_5 \\ y_6^* = \alpha_6 + \beta_6 X + \gamma_6 V + \lambda_6 C + \varepsilon_6 \end{cases}$$

with

X a vector of socio-demographic variables, V a vector of variables of social values and attitudes and C a vector of Country dummies variables. These vectors are identical in each equation.

$\alpha_i, \beta_i, \gamma_i, \lambda_i$ with *i = 1,…6,* the vector of parameters to be estimated, $\varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4, \varepsilon_5, \varepsilon_6$ six error terms distributed according to law of multivariate normal distribution, with mean equal to 0 for each variable and a variance-covariance matrix W, such that W has the value 1 on the principal diagonal and the correlation terms $\rho_{jk} = \rho_{kj}$ as the off-diagonal terms.[7].

We choose X, V and C vector according to previous studies: the different sociodemographic variables (age, gender, education, current socioprofessional status, marital status, residence location), variables of values (political scale, religion, variables in relation to GMO debate), as well as dichotomous variables of countries as a control on country effect.

The log-maximum likelihood function to maximize then becomes $L = \sum_{i=1}^{n} \log \varphi_3(\mu_i; \Omega)$, with $\varphi_3(\mu_i; \Omega)$ the cumulative multivariate normal distribution.

This system of six simultaneous equations is estimated according to the method of simulation of maximum likelihood (as the estimation implies the calculation of a triple integral with the likelihood function). The GHK simulator (Geweke-Hajivassiliou-Keane) can be used (Hajivassiliou 2000). It corresponds to the *mvprobit* procedure of *Stata* developed and

[7] The usual assumption that e is independently and identically distributed is clearly violated here, as the observations are clustered in countries. But with a small number of clusters (lower than 50 and very unbalanced cluster sizes, the cluster-robust standard error can be more biased than the usual standard error.

by Cappellari & Jenkins (2003) and updated with antithetic acceleration in 2006. The use of the GHK simulator implies that results depend on a number of random draws used to calculate the simulated likelihood function. Cappellari & Jenkins (2003) recommend choosing a number of draws equal to at least the square root the sample size. Consequently, the choice of 150 draws allows us to be relatively confident in the estimated parameters.

Results

The LR test of p (positive) allows us to justify the estimation of this multivariable probit and not of six independent probits: the hypothesis H0 of conjoined nullity of 15 p_y can be rejected (p-value <0.0001). Moreover, the coefficients p_y (the correlation between the terms of errors in each one of the equations) are significant in some case: the unobserved variables influencing the willingness to purchase GM Food are positively correlated to the unobserved variables influencing the trust in public authorities, industry and science. Trust and acceptability may be caused by a third variable or a more general attitude toward biotechnology. The cases where p is not significant are the two linking the acceptability to trust in consumer associations and environmental associations. The model with countries fixed effects has a BIC (Bayesian Information Criterion) and AIC (Aikake Information Criterion) largely lower than the model without fixed effects, suggesting the former is preferable[8]. From the explication of these results, we can particularly highlight the fact that it is not exactly the same variables that significantly influence the different dependant variables.

Concerning socio-demographics variables, the willingness to purchase is positively influenced by age: this relation can be modeled in the form of a quadratic equation. The acceptability decreases strongly in relation to age but in a successively slower way. Being a woman increases the marginal propensity to trust the information provided by environmental

[8] For the model with countries fixed effects, AIC=80562.52 and BIC=80755.42; the model without countries fixed effects AIC=83037.36 and BIC=83230.26.

associations, and lowers the marginal propensity to trust public authorities, while it has no influence on the acceptability. The educational level has no impact on the level of acceptance at one notable exception: being a student increase the probability to accept GM Food and trust shown towards scientists. The level of knowledge influences positively all the depend variables (with the exception of the trust in the information provided by the industry). The variables concerning the political scale influence the different dependant variables. Indeed, in relation to the people situated to left, those more to the right or not situated on the political scale at all, tend to be less confident in the information provided by environmental associations. The estimation doesn't underscore the "left" opposition to GMOs usually characterized (see Chaklatti & Rousselière 2006, 2007). But another type of opposition to GMOs can be identified. The people who oppose while they do not trust any of the diverse organizations are people who do not feel themselves concerned. In other words, there is a form of opposition based on the absence of looking for information: Having interest in politics or science increases the willingness to purchase GM Food, and for the last the trust in environmental associations. One of the main results of this multivariate probit is that acceptability of GM Food and trust in the information provided by environmental associations are two behaviors or dispositions that became more connected.

Table 2: Results of the multivariate probit model

	BUY	TRUSTCONSO	TRUSTENVI	TRUSTSCIENCE	TRUSTPUBLIC	TRUSTINDUSTR
AGE	-0.026***	0.025**	0.000	-0.012*	-0.008	-0.023**
AGE2	0.017*	-0.026**	-0.005	0.012	0.007	0.020
WOMAN	-0.037	0.039	0.149***	0.077	-0.086**	0.012
MARIED	-0.018	-0.012	-0.028	-0.017	0.103**	-0.021
EDUC16-19	0.019	0.130*	0.035	-0.101	0.028	-0.146*
EDUC20+	-0.077	0.121	0.067	-0.055	0.122	-0.157
EDUCSTILL	0.247*	0.127	0.047	0.266***	0.266*	-0.417**
SCALEKNOWLEDGE	0.057***	0.040***	0.025***	0.060***	0.051***	-0.008
TALKEDBIOTECH	-0.020	0.042	0.049	0.084**	0.182***	-0.016
OFTENINTPOLITICS	0.106	0.243**	0.182**	0.102	0.182*	-0.045
SOMEINTPOLITICS	0.141*	0.148**	0.021	0.136*	0.113	-0.090*
RARELYINTPOLITICS	0.228***	0.059	-0.015	0.122	0.130	-0.029
OFTENINTSCIENCE	0.353***	0.171*	0.374***	0.267***	0.178*	0.297**
SOMEINTSIENCE	0.271***	0.190***	0.465***	0.186**	0.050	0.221**
RARELYINTSCIENCE	0.118	0.160*	0.309***	0.164*	0.007	0.122
NORELIGION	-0.035	-0.108*	-0.039	-0.001	-0.080*	-0.103
POLITICALCENTER	0.111**	-0.080	-0.095	0.052	0.018	0.110
POLITICALRIGHT	0.083	-0.159**	-0.213***	0.130*	-0.058	0.229***
POLITICALREFUSAL	-0.073	-0.045	-0.172***	-0.051	-0.013	0.020
POLITICALDK	-0.083	-0.174*	-0.251***	-0.017	-0.199*	0.081
INTERCEPT	0.461**	-0.861***	-0.492**	-0.343*	-1.366***	-0.494
Log pseudo-likelihood	-40255.26					
LRtest of ρ_{ij} (15)	1116.72***					
ρ	BUY	TRUSTCONSO	TRUSTENVI	TRUSTSCIENCE	TRUSTPUBLIC	TRUSTINDUSTR
BUY	-	0.027	-0.015	0.219***	0.189***	0.161***
TRUSTCONSO		-	0.368***	0.082***	0.054*	0.096
TRUSTENVI			-	0.066**	0.021	0.251***
TRUSTSCIENCE				-	0.207***	0.206***
TRUSTPUBLIC					-	0.167***
TRUSTINDUSTR						-

*Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels. Countries, Communities and professional categories fixed effects not reported.*

More precisely, to underscore the way in which the different dependant variables are linked to one another, we can calculate the different conditional probabilities: $\left(i.e,\ p\left(y_i = 1 \middle/ y_j = 1 \right) \ \forall i, j = 1,2,3,4,5,6 \right)$. With the *unconditional* probability $\left(p(y_i = 1), \forall i = 1,2,3,4,5,6 \right)$ of willingness to purchase GM Food, we can calculate the impact of trust on acceptability[9]. We can compare the 2005 table of impact with 2002 previously calculated in Chaklatti (2006) and Chaklatti & Rousselière (2007)[10].

We deduce that trusting environmental association leads to a lowering of 0,9% in the probability of purchasing GM Food (comparing to a lowering of 7,9% in 2002). More precisely, our conclusions don't confirm those of Huffman (2003) on the important impact of trust in environmental associations. On the other hand, trusting the industrialists, scientists or the public institutions leads to a rise of the probability of purchasing GM Food (by 14,0%, 8,6% and 13,4% respectively) (Table 3). An important change is that trusting consumer association leads to a rise of 1,4% (in 2002 the impact was a lowering of 0,9%). It is notable that the probability of trusting a certain actor in the debate is always positively influenced by the trust shown to another party (with more or less important factors).

Table 3: Table of impact

Change in the probability of row term given column term with respect to unconditional probability	BUY	TRUST-ENVI	TRUST-CONSO	TRUST-INDUS	TRUST-SCIENCE	TRUST-PUBLIC
BUY		-0,9% (2002: -7,9%)	+1,4% (2002: -0,9%)	+14,0% (2002: +14,6%)	+8,6% (2002: +6,4%)	+13,4% (2002: +17%)
TRUSTENVI	-0,8%		+37,0%	+39,0%	+4,2%	+2,7%
TRUSTCONSO	+1,3%	+32,8%		+16,8%	+5,3%	+6,9%
TRUSTINDUS	+14,1%	+40,4%	+19,5%		+24,2%	+41,2%
TRUSTSCIENCE	+8,6%	+4,2%	+6,1%	+23,5%		+18,9%
TRUSTPUBLIC	+11,8%	+2,3%	+7,0%	+37,6%	+16,9%	

Lecture: The fact having trust in consumer associations increases the probability of willingness to purchase GM Food by 1.4%

[9] Unconditional probabilities are estimated with the multivariate probit model; conditional probabilities are estimated with bivariate probit models (using the same vector of independent variables).

[10] One must pay attention to the fact that the econometric models, while being largely comparable, are not exactly the same. Because of changes in the survey questionnaire, our econometric model cannot include all the social values variables that were available in previous Eurobarometer waves.

Discussion and conclusion

This article reported results from a European survey that finds an increasing optimism in the development of GM Food. The main aim of the article was to evaluate two different perspectives on the relation between trust and acceptability. As Eiser *et al.* (2002), we find support to a complex view of trust that can reconcile two apparently contradictory viewpoints.

Understanding the basis of public trust is essential for explaining variation in public perception of technological risk. Trust in the information given by certain actors (such as environmental organizations, scientists, industrialists and governments) is therefore a determining factor to explain the differences of attitudes concerning GM Food consumption. Our econometric model is also supportive to an associationist view that considers trust as a consequence of acceptability. The multivariate probit is justified if we consider a complex view of trust: Trust and acceptability may be caused by a more general attitude toward biotechnology. This leads to important theoretical propositions in terms of economic analysis. It is necessary to take into account values and perceptions in the economic theory of the consumer, as both proposed by the human capital or the conventionalist approaches. Our empirical analysis can then be understood as a corroboration of such theoretical analysis. Thus far trust has rightly assumed enormous prominence as an explanatory concept in relation to dissent and conflict over the development trajectory of a wide range of technologies. Consideration of the importance of a belief in public efficacy would potentially seem a valuable complement to this, and in particular to the recent work on critical trust (Barnett *et al.* 2007).

Our work confirms the results of different studies, using the same type of data (transnational surveys including the last Eurobarometer) or other methodologies, on the importance of individual values and attitudes and of the participation in certain social networks, or “the importance of general value orientations or worldviews” (Pardo *et al*. 2002:

9). However then comparing with the European situation in 2002, there a slightly changes in the “associations trust effects”. The strong negative impact of trust in environmental associations on willingness to purchase GM Food disappears. Furthermore we find a small but positive impact of trust in consumer associations.

One of the reasons why the “environmental associations trust effect” is not truly underscore by our multivariate probit can be caused by the European Union heterogeneity. According to Gaskell *et al.* (2006), the New EU10 are somewhat different to the EU15 countries in 2005: science has not achieved much penetration in public awareness in the new Accession States; the publics in these countries are relatively more optimistic about the contribution of technology to society, and are just as supportive of medical, industrial and agricultural biotechnologies; and finally they also have greater trust in actors and institutions involved in science and technology. The next steps of this research are to taking into account both endogeneity and institutional effect. Because of the increasing heterogeneity of European Union, impact of trust may vary according to institutional variables (reject of hypotheses of identical coefficients). By the way, fixed effects models must be replaced by random effects models estimated according to multilevel multiprocess modeling (combining multilevel analysis and simultaneous equations modeling) (Goldstein 2003; Steele *et al.* 2007). To go further on this point and be able to really confirm this result, it would be necessary to have subjective scales of trust in one actor of the debate (which would then provide a scale of 'trust gap' at the individual level).

Based on the Eurobarometer, which is a face-to-face survey, our works may undermine some economics factors and underestimate some social factors of the acceptability of GM Food. We may suspect that the hostility of the “citizen” become attenuated when he is placed in the role of a “consumer” (Noussair *et al.* 2002). It is quite possible that their valuations of the GM products would change if prices were different. Therefore experimental

economics, which focus on prices variations for a small non-representative sample, and cross-national surveys, which focus on values and socio-demographic variables for large sample, are clearly two complementary methods that help us understand the main factors of the willingness to purchase GM Food. Microsimulation, based on behavioral hypotheses confirmed by experimental economics and applied to a representative sample of the population, may be a very fruitful direction for future researches.

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