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"ARE GENETICALLY MODIFIED FOODS BAD FOR MY HEALTH?" INDIVIDUALS' VALUATION AND THE CHOICE AMONG DIFFERENT INFORMATION SOURCES[♠]

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Abstract. We investigate the role of information on consumers' valuation for food products containing genetically modified organisms (GMOs), using data from a specifically designed survey. We provide three main results. First, we show that introducing mandatory labels to identify whether or not a food product contains GMOs, significantly reduces consumers' valuation. Second, adding to the label additional information on GMOs significantly affects valuation. Third, no matter the sign of the information previously received, consumers are more willing to trust General Practitioners (GPs), the information source they prefer most. Overall, these results indicate that the crucial issue is not the presence of the label *per se*, but the availability of the necessary information to make good use of the label content to assess potential health risks deriving from GM foods. In particular, our findings suggest that this can be achieved by properly informing (and convincing) GPs and other health professionals that risks for human health are minimal.

JEL Classification: C91, D82.

Keywords: Genetically modified foods, information, health risks, General practitioners, labelling.

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1. Introduction

Surveys designed to measure confidence in food products reveal that a significant fraction of European consumers believes that several aspects of foods (taste, farming methods, nutritional content, and – most importantly - safety) have indeed deteriorated in recent decades (e.g., Poppe and Kjærnes, 2003). Besides a clear role played by producers, also Public Authorities are held responsible for this trend. According to a Special Eurobarometer Issue, 47% of the EU citizens think that Public Authorities attach a higher importance to economic goals than to their well-being. The other side of the coin is that 42% of EU citizens consider it likely that the food they eat is risky for their health (European Commission, 2006): 50% of EU citizens would indeed like more information on the safety of food products (European Commission, 2008).

A particularly relevant and critical issue for public health emerges when modern biotechnology, and its impact on *food safety*, is considered. As it is well-known, biotechnology gives producers the possibility of modifying the genetic material of organisms to confer to products (mainly food and feed) some desirable characteristics (such as, for instance, resistance to insects, which should reduce the need for pesticides). Not surprisingly, as far as genetic manipulation is concerned, 25% of EU citizens declare to be "very worried" and 37% to be "fairly worried"; overall, 62% of EU citizens fell uneasy with genetically modified organisms (European Commission, 2006). However, about half of the European consumers would buy GM foods if it were proved they are healthier or more environmental friendly (European Commission, 2008).

Taking this situation as simply the result of some "green lobbies" successfully campaigning to influence public opinion and preferences is reasonably too simplistic. Consumers' diffidence is more likely to be rooted in a genuine *uncertainty* about the consequences upon both their health and the natural environment deriving from the production and consumption of food products containing genetically modified organisms, or GMOs (e.g., Nestle, 2003).

But how public opinion is influenced, and by whom? In this work we offer some evidence to provide an answer to these questions by investigating the role of information on consumers' valuation for food products containing GMOs, using data from a specifically designed survey involving a sample of undergraduate students at the Faculty of Economics of the University of Turin. Our aim is to study individuals' valuation for a specific product (which can possess either genetically modified content or not) as long as the nature and the source of the available information changes.

Confirming previous studies, our findings indicate that the genetically modified content of foods significantly alter consumers' valuation. Moreover, we also find evidence – consistent with European surveys (e.g., European Commission, 2006) - that individuals choose (and give sensibly more value to) the information received by General Practitioners (GPs). This suggests that consumers are basically interested to the consequences upon their health of the production and consumption of genetically modified foods. In this respect, the information received by GPs is exactly the information which is required to assess these consequences. In particular, when asked to choose among different sources (including "green lobbies" or business-oriented

newspapers), they prefer the information received within a long-term relationship characterized by personalized trust, revealing that they perceive this information as the most reliable and unbiased.[1] Hence, consumers' diffidence in GM foods probably reflects the *uncertainty* in the medical profession regarding GMOs and their consequences for public health and the environment.

Even if our sample is not obviously representative of the whole Italian population, still our results deserve attention from a policy perspective, in that they emphasize two important facts often neglected by Public Authorities. The first of such facts is that health is the primary concern for consumers; the second is that to be *effective*, information about biotechnology should be given taking into account consumers' confidence that their health concerns are properly accounted for. In terms of policies, at least two suggestions stem from here. First, since identifying food as having genetically modified content reduces *ipso facto* individuals' valuation, it is likely that the biotech industry and the green lobby groups will keep on wrestling about the contentious issue of whether *mandatory* labeling should be enforced or not. It seems clear that as far as European consumers will perceive a potential danger to their health related to the use of GMOs, the biotech industry has a reasonable interest in contrasting

[1] On trust in GPs see, e.g., Pearson and Raeke (2000) and Tarrant et al. (2003). A recent anecdotal example of this confidence in GPs is offered by the H1N1 vaccine. During the 2009-2010 pandemic, most of the European population refused to take the vaccine, despite this was strongly recommended by the experts appointed by the World Health Organization (whose recommendations for the pandemic period are available on-line at http://www.who.int/csr/disease/swineflu/en/index.html). It was generally preferred to follow the suggestions not to take the vaccine coming from (most of the) GPs. It is noteworthy that in a well-known speech delivered to the Polish Parliament (on November 5, 2009), Poland's Health Minister Eva Kopacz, a former medical doctor who practised as a GP for many years before becoming Health Minister, argued against the H1N1 vaccine.

labeling. But denying labeling can be seen as in contrast with the article 153 of the EC Treaty, which affirms that: “in order to promote the interests of consumers and to ensure a high level of consumer protection, the Community shall contribute to protecting the health, safety and economic interests of consumers, *as well as to promoting their right to information*, education and to organize themselves in order to safeguard their interests” (emphasis added). Second, while it is obvious that information about GMOs is valuable to consumers, not all the information received by consumers can modify their beliefs towards biotechnology. It is extremely important that the information source is perceived as unbiased, i.e., it is crucial that whoever provides information is perceived as having no interest at stake. This means that GPs (or other health professional) can be empowered to provide a fair view of the current state of knowledge about GM foods, e.g., making available to their patients updated scientific information as soon as it becomes available. But this also means that health professionals need to be properly informed (and convinced) themselves about the effects on health deriving from both the production and consumption of GM foods.

The paper is organized as follows. In Section 2 we briefly review some previous results concerning consumers’ attitude towards GMOs in the presence of different information sources. In Section 3 we describe the survey. Section 4 illustrates the results. Section 5 provides some discussion and concludes.

2. Health at risk: Consumers' valuation and information about food characteristics

Since the XIX century two forces have reshaped the food production industry. On the one hand, technological advancements have made small scale productions economically inefficient and have allowed for long term food conservation (through refrigeration, packaging, and the use of chemical preservatives); on the other hand, improvements in both information transmission and transportation of goods have lowered the costs of separating consumers from producers, thus sharpening information asymmetries (e.g. Beraldo and Turati, 2011). The result of these processes has been a greater difficulty for consumers to assess food characteristics, which in turn has stimulated food adulteration with increasing health risks (e.g., Alsberg, 1931). The reaction of Public Authorities has traditionally been that of enforcing a stricter regulation for the production and marketability of food products. Nowadays, State regulation has however lost a large part of its power. The most obvious reason (but not the only one, as remarked below) is that a global economy would require global level regulation, something clearly difficult to achieve.

In such a situation, it is therefore not surprising that new information provided to consumers is able to substantially affect their valuation, especially when it concerns technologies surrounded by a high degree of uncertainty in terms of health risks. Indeed, a first well-established result in the literature is that positive (resp. negative) information about food production/processing technologies increases (resp. decreases)

willingness to pay (WTP) for a particular good in lab experiments designed to catch individuals' market preferences. For instance, Fox et al. (2002), who examine the effects of alternative descriptions of "food irradiation" on the WTP for a pork sandwich irradiated to control *Trichinella* by considering a sample of 87 primary food shoppers, find that whilst a "favorable" description of irradiation increases WTP, an "unfavorable" description decreases it[2]. However, when both the pro- and the anti-irradiation descriptions are provided, the negative description dominates, and WTP decreases. This result remains true even if either the negative information is identified as coming from a lobby group (e.g., a consumer advocacy group), or the information itself is provided in a clearly non-scientific way. A possible explanation for this outcome can be offered by (some version) of the Prospect Theory, which provides a sensible account of why individuals tend to give more value to negative information (e.g., Kahneman and Tversky, 1979).

These findings have been confirmed for the case of GM foods by Rousu et al. (2007). Their study analyses the behaviour of 172 individuals auctioning upon three items in the presence of information reflecting different perspectives: the biotech industry perspective, the environmental groups perspective, and a *third party* perspective characterized by having no interest at stake. Their findings are consistent with some of the results provided in our paper: first, bidders sensibly reduce their willingness to pay for a food item even if no other information, except the genetically

[2] Trichinella is a harmful parasite which causes severe infections (*Trichinellosis*). As recalled by, e.g., Nestle (2003), irradiation is a technique used to kill pathogens and other unwanted microbes using cobalt-60 and cesium-137 (i.e., radiation) to bombard foods, which – not surprisingly - induces dread and outrage; more importantly it cannot guarantee sterility.

modified content, is provided; second, bidders who receive only the biotech industry perspective are willing to pay a premium for GM food; finally, negative information has an higher impact than positive information on consumers' WTP for genetically modified foods.

If the "sign" of new information is important in affecting consumers' valuation, it is also natural to expect that the *credibility* of the information source significantly affects individuals' reactions. According to Frewer et al. (1998), credibility is however strongly influenced by individuals' prior attitudes: individuals who hold extreme views might choose not to trust an information source rather than change their attitudes. Lusk et al. (2004) also find that initial attitudes have a significant effect on how individuals respond to new information.

Focusing on modern biotechnology, the issue of what information source individuals have more confidence in to tell the truth is tackled by Bucchi and Neresini (2004) in a two-wave survey (a representative sample of 1,022 Italian citizens aged over 18 responded to a phone survey in September 2000; another representative sample of 1,017 citizens were interviewed in November 2001). Their results confirm that individuals have more confidence in an information source when they perceive that the information it offers is not strategically provided: over one third of the sampled individuals declare to trust universities and scientists (36%); consumer organizations (28%), environmental organizations (18%), Public Authorities (6%) and industry and entrepreneurs (2%) follow. There is one aspect of this study which is worth being emphasized: as far as modern biotechnology is concerned, the percentage of

individuals who trust Public Authorities is very low, a finding consistent with the results provided by the studies commissioned by the European Authorities (e.g., European Commission, 2006). A possible explanation is that European consumers believe that the biotech industry is highly capable at influencing public regulation.

A related question is whether the aversion that consumers display in surveys about GM foods really reflects their actual market behaviour. For example, Noussair et al. (2004) find that in laboratory experiments an high percentage of consumers (42%) is willing to purchase GM foods provided it is sufficiently inexpensive. This is in line with the recent findings by Aoki et al. (2010), whose study investigates consumers' reaction to a food additive (sodium nitrite) present in ham sandwiches in both real and hypothetical situations. Consumers' WTP (valuation) for ham sandwiches without sodium nitrite are estimated to be lower in the experiment and higher in the survey, after negative and positive information is provided, implying that the effect of information differs: the information related to flavour seems to have more influence on the consumers' choice behaviour in a real situation, while the information associated with health risk plays a relatively more important role in a hypothetical situation. Overall, lab experiments seem then to catch some aspects of individuals' preferences which differ from those aspects caught in surveys. In particular, differently from lab experiments, individuals involved in surveys may be induced to see themselves as placed in the role of *citizens* rather than in that of *consumers*, and may therefore be stimulated to make judgments from the society's point of view (e.g., Noussair et al., 2004). This seems especially true whenever individuals are confronted with ethically

difficult issues (Nyborg, 2000). As the central question in the European debate about GMOs concerns the role of information in conditioning the support of citizens/voters to policies favoring the production and consumption of GM foods, we consider here survey analysis as the most valuable tool to elicit (social) preferences.

3. The survey

3.1. Design and Procedure

The survey on which this study is based was conducted at the University of Turin, Faculty of Economics, on November 18th, 2009. 108 undergraduate students, randomly recruited, were involved. After taking a seat, participants were asked to both switch off their mobiles and stop talking to their colleagues. Since the beginning they were informed that the survey consisted of different stages and that they would have received the instructions – read loudly by a tutor – stage by stage.[3] In each stage, a tutor delivered to any participant a paper displaying: 1) the picture of a one liter unbranded orange juice box[4]; 2) the basic information about the product (net weight and content); 3) some stage-dependent information about the product. The task subjects had to perform in each stage was to state their valuation of the product and to report it on an anonymous card. Subjects were informed that, in each stage, their

[3] We used what experimentalists call a within-subject design in order to observe if and how consumers' choices may change across the treatments as new information becomes available.
[4] The picture was slightly manipulated in order to get rid of the brand and to avoid noise in the data due to subjects' opinion on that particular brand.

valuation could not have exceeded their endowment, set to 5 euro[5]. At the end of each stage, subjects' valuation was collected.

The survey consisted of four stages. In stage 1 (S1), subjects were provided only with some basic information about the product. In particular, participants received a card with the picture of the product and a label with some basic information (Fig. B1). In stage 2 (S2), they were notified that the orange juice contained GMOs by adding a specific information to the label (Fig. B2). In the third stage (S3), the sample was randomly divided into two groups (A and B), and newscast information was provided. In particular, group A got pro-GMOs information; group B anti-GMOs information (Fig. B3 and B4). Finally, in the fourth stage (S4), subjects were allowed to select the sender of some *additional* information choosing among four alternatives (Fig. B5): a GP; a green lobby group (*Greenpeace*); a business-oriented newspaper (*Il Sole24Ore*, the Italian daily reflecting the views of the business association Confindustria); and the scientists.

In order to check whether choices were affected by socio-demographic characteristics, at the end of the fourth stage subjects were asked to fill up a questionnaire (Appendix C). When all the students handed in the questionnaire the survey ended. The survey lasted about 45 minutes.

[5] This restriction was introduced to avoid careless answers.

3.2. Data description

108 undergraduate students of the University of Turin, Faculty of Economics, participated in the survey. A summary of participants' socio-demographic characteristics is presented in Appendix D Table 1. [6] About 49% are male. The mean age of the participant is 22.8. 58% of the subjects interviewed declare to regularly consume orange juice. 39% control the label when buying products and all but one knew what GM foods are. Since only 20 participants declare whether they are in favour or against GMOs (with 17 out of 20 that were against biotech food), more than 80% of the sampled individuals do not seem to have any particular opinion about GMOs. This is a particularly favourable condition, as one of the aim of the survey was precisely that of understanding which kind of information individuals do choose when they are not sufficiently informed.

3.3. Results

Data accruing from the survey show that - although only 17 participants declared to be against biotech food - a considerable reduction in average valuation is observed as soon as the genetically modified content of the product is displayed. This happens *before* any additional information about GMOs is provided by the researchers. In particular, while subjects' average valuation in S2 is 0.78, average valuation in S1 is 1.46. The difference is statistically significant (paired t-test, $t = 10.64$, $p = 0.000$). Hence:

[6] Socio-demographic data are available only for 105 of them.

Result 1. *When subjects are informed about the genetically modified content of the product, their valuation decreases.*

This result is in line with findings by Rousu *et al.* (2007). A possible explanation relies on the risk averse behaviour adopted by consumers in an environment characterized by scarce information and uncertainty about the consequences upon health of consuming GM foods. Notice that controlling for socio-demographic characteristics (see Appendix D, Table 2) it turns out that individuals who usually scrutinize the label to inspect the characteristics of the product, display a significantly lower valuation in S2 with respect to S1 (0.65 vs 0.86; Mann-Whitney test, $z = 1.849$, $p = 0.064$), a result in line with the findings by Bucchi and Neresini (2002). This point is indeed relevant. As introducing mandatory labels to identify whether or not a food product contains GMOs significantly reduces consumers' valuation, introducing such labelling without first winning consumers' diffidence due to uncertainty and scarce information, may produce severe market failures. Potentially worthwhile exchanges could not be carried out due to lack of information about the consequences arising from consuming the product.

In S3 subjects are provided new additional information. Participants were randomly selected into two groups (A and B) and newscast information was offered in addition to the label where the genetically modified nature of the product is signalled. Group A got pro-GMOs information; group B got anti-GMOs information. 62

participants were informed about the positive contribution of genetically modified food to reduce world hunger (INFO1_POS), while 46 subjects were told that GM foods increase allergies (INFO1_NEG). Notice that both information have been proposed as arguments pro- or against-GMOs in public debates (e.g., Nestle, 2003). This additional information has a significant effect on individuals' valuation, even if the size of such an effect varies according to the type of information received (either positive or negative). In particular we find that:

Result 2. *Positive (negative) information about GMOs positively (negatively) affects subjects' valuation. The impact of the negative information on subjects' valuation is higher than the impact of positive information.*

Analysing subjects' valuation (see Appendix D Table 3), it turns out that in S3 the average valuation is higher than in S2 for those individuals who receive positive information (0.98 in S3 vs 0.73 in S2; Wilcoxon test, $z = 4.67$, $p = 0.000$; Kolmogorov-Smirnov test, $D = 1.5$, $p = 0.000$), whereas it is lower for those who receive negative information (0.40 in S3 vs 0.83 in S2; Wilcoxon test, $z = -5.588$, $p = 0.000$; Kolmogorov-Smirnov test, $D = 3.0217$, $p = 0.000$). On average, individuals who receive positive information increase their valuation by 34%, whereas individuals who receive negative information decrease their valuation by 51%. It is worth noticing that whereas the positive information was related to the contribution given by GMOs to

preserve the environment, the negative information was related to the risks they imply for consumers' health.

This reduction in the stated valuation, consistent with the findings both by Fox et al. (2002) and Rousu et al. (2007), is robust to some key controls[7]. First, we check whether differences in average valuation between the two groups is due to a sample selection bias rather than to the nature of the information received. We therefore compare the two groups' valuation in S2: a Mann-Whitney test confirms that no sample bias has occurred (z = -0.577, p = 0.564). Second, we control for socio-demographic characteristics. The only significant difference is registered when considering students' gender. In particular, females' reaction to negative information is slightly smaller than males; furthermore, females show a stronger reaction to positive information (Mann-Whitney test, z = 2.475, p = 0.013). More details are given in Appendix D Table 4. The econometric analysis confirms the statistical significance of these results (see Appendix E, R1). Considering the difference in the average valuation of the *i*-th individual between S3 and S2 as the dependent variable of a multivariate model, both the coefficients associated with the variables INFO1_NEG and INFO1_POS, which record the type (whether negative or positive) of information given to each individual, display the expected sign (negative and positive respectively) and are statistically significant at the usual confidence levels. The effect persists across specifications and is robust to the addition of controls (only in the third specification

[7] Recent analyses based on field data (e.g., De Paola and Scoppa, 2010) similarly show a sensible effect on consumers' demand for a particular brand whenever negative information concerning that brand is provided.

the variable INFO1_POS keeps the expected sign but becomes insignificant). Notice that the difference in average valuation between S3 and S2 is less responsive to positive information if the subject is male (this effect is caught by the variable $INFO1\_POS_i$*male* in R1 Appendix E, whose coefficient is negative and statistically significant).

In S4 the scenario is more complex. Subjects are given the opportunity to ask for additional information. Each participant can choose among different sources – GPs (DOC), a green lobby group (GREEN), scientists (SC), and a business oriented newspaper (NEWS). This implies that it is possible to identify eight groups – INFO1_NEG_DOC (N = 28), INFO1_NEG_GREEN (N = 5), INFO1_NEG_SC (N = 10), INFO1_NEG_NEWS (N = 3), INFO1_POS_DOC (N = 25), INFO1_POS_GREEN (N = 11), INFO1_POS_SC (N = 20), INFO1_POS_NEWS (N = 6). Each of these groups consists of individuals who have received in S3 either positive or negative information on GMOs, and then choose in S4 one of the four information sources given the information received in S3. Before moving further, it is important to note that the sign of the new information was not revealed in advance to participants, but only publicized *after* their choice. This means that the choice was only conditional on information received in S3, and on the *trust* each participant hold in these different information sources. Two issues are then relevant here: a) what source is considered the most reliable; b) what is the impact of the new information given the messages previously received.

As for the first issue, Table 5 (Appendix D) reports the distribution of choices in S4. About 50% of the subjects choose to get further information from GPs, no matter the type of information received in S3; scientists (28%) follow. This result is more striking when gender is considered. Nearly 70% of females – the gender more concerned with health risk issues - choose GPs as the preferred information source, a result probably reflecting gender differences in risk taking behaviour, which has been observed both in lab settings and in the field (e.g., Croson and Gneezy, 2009). In particular, according to the literature, women are found to be more risk averse than men, either because of differences in emotional reactions to risky situations, or because they interpret risky situations as threats which should be avoided. This latter interpretation fits well in the case of GMOs.

For what concerns the second issue, it is worth noticing that information given by GPs (negative in our survey) significantly affects valuation (see Appendix D Table 6). The Wilcoxon test shows that the reduction in valuation between S4 and S3 emerging as soon as individuals are exposed to the information coming from GPs, is statistically significant. Notice that neither positive (NEWS) nor neutral (SC) messages seem to affect individuals' valuation. This result is summarized as follows:

Result 3. *Individuals trust GPs most as a source of information on food safety. When – as in our case – GPs provide a negative information about GMOs, this message reduces valuation, no matter the sign of the information previously received.*

The above findings are confirmed also by the econometric analysis. In particular, considering a simple probit model (Table R2 in Appendix E), the probability of choosing in S4 one of the most popular information sources (i.e., DOC or SC) does not depend on the type of information previously received, as the coefficients on variables INFO1_NEG and INFO1_POS are both statistically insignificant. The only variable which has a statistically significant effect on the probability of choosing one of the above mentioned information sources is related to gender. As discussed above, this is probably reflecting gender differences in risk taking behaviour.

4. Discussion and Concluding Remarks

According to a view which can be traced back to Adam Smith's Lectures on Juresprudence (1763 [1978]), markets can enforce trustworthiness, as those sellers which offer low quality products are punished with ostracism. This view is based on the assumption that consumers are always able to find out the quality of the goods which are being provided, either by immediate inspection (*search goods*), or after consumption (*experience goods*). It is clear that if this were the case, the scope for public regulation would be very limited. It should be primarily aimed at ensuring that producers' behaviour would not limit the working of market forces. However, the need for public regulation has increased significantly over the last two centuries along with the dramatic development of new technologies, which have endowed producers with

the chance of marketing goods whose quality cannot be ascertained neither before nor after consumption (*trust goods*).

This asymmetric information problem is particularly striking also for food products, and even more so for those food products containing genetically modified organisms. Let us first assume that GM foods are substantially identical to other food products from the point of view of safety and health risks, and that the only problem from the societal point of view is to avoid adulteration that cannot be ascertained by consumers. The standard answer by policy makers to protect consumers has been the creation of independent agencies (e.g., Beraldo and Turati, 2011). But the actual concern is that the agencies which were created to protect consumers - such as for instance the *Food and Drug Administration* in the US (FDA, created in 1906), or the recent *European Food Safety Authority* (EFSA, created by European regulation 178/2002) - are less and less able to properly do their job for several reasons (e.g., Nestle, 2003). First, because the number of producers to be controlled has greatly increased, while the budget of government agencies has been reduced, not only relative to the need of additional controls[8]. Second, because agencies are called to regulate food producers which have become more and more powerful, and can exercise inexorable pressures on governments to obtain more favourable decisions. Third, because responsibility of controls has been allocated to a number of bureaucracies, that in order

[8] As it was recognized in a recent editorial published by *Nature*, the FDA has never before had so many demands placed on it, nor has its budget ever been so constrained relative to its duties: "Between 2001 and 2007, for example, the number of US food-manufacturing plants under the FDA's jurisdiction increased from about 51,000 to more than 65,000, yet the number of staff in its foods programme fell from 3,167 to 2,757. At current inspection rates, any given domestic food company faces a less than one-in-four chance of being inspected once in seven years" (Getting what you pay for, *Nature*, 462, 26 November 2009, p. 390).

to supply an effective action and really guarantee food safety need to coordinate their activities[9]. Given these difficulties, reputational mechanisms seem to have substituted in recent decades more traditional public controls. In other words, consumers solve the asymmetric information problem involved in buying *credence foods* by relying on the reputation of producers.

However, reputation cannot work for new technologies, and the idea that GM foods are identical to traditional foods from the point of view of health risks is not easily accepted by consumers, who question whether or not GM foods should be marketed at all given the uncertainty in terms of scientific evidence supporting the absence of any risks for human health. This view is based on at least three different unsolved issues. First, there is uncertainty on the long-term consequences to health following GM foods intake. For instance, as documented, e.g., in a recent paper by Tudisco et al. (2010), there is evidence of small genetically modified DNA fragments in milk (but also in kids organs) when mothers are fed with genetically modified soybean. An increase in cell metabolism is also observed; but there is no evidence to show what are the risks for consumers' health following this increase in metabolism. A second issue is related to the allergenic potential of GM foods. If the DNA for a new gene is introduced into a food, that food will also develop a new protein, which can cause allergic (unknown) reactions to some people. And the allergenic potential of most GM foods is both unpredictable and not easily testable (e.g., Nestle, 2003; Woolhiser and Metcalfe, 2003; EFSA, 2010). A third issue concerns the impact of GM

[9] As for US, if we take food security in a broader sense, Nestle (2003) estimates that about four-dozen federal bureaucracies are involved in protecting food against terrorists attacks.

foods on antibiotic resistance. In particular, considering plant biotechnology, many fear that the use of antibiotic resistance marker genes in GM plants can contribute to increase bacterial resistance, aggravating the problem for public health. Also in this case, conclusions from expert panels go in the direction of uncertain and unpredictable effects (e.g., EFSA, 2009).

The ambiguities on the risks for human health do not shadow the ambiguities on the risks for the environment (and, indirectly, on human health). From this point of view, a first unsettled dispute is about the possibility that characteristics of GMOs can be transmitted to non-GMOs. For instance, transgenic oilseed canola plants have been found to pass on herbicide resistance to related weeds. As these reproduce at a highest pace than crops, there is fear that cross-pollination will create varieties of super-resistant weeds that could displace traditional crops and result in an ecological catastrophe (e.g., Nestle, 2003). A second issue is related to the risks for biodiversity, and – in particular – for beneficial insects, when exposed to GM plants. The most striking example on this matter is the debate developed around the case of monarch butterflies and the *Bt* corn starting from the contribution by Losey et al. (1999). As the authors argue, the genetically modified corn takes advantage from a toxin, which has been however proved to be harmful not only for a pest causing severe damages to crops, but also for insects like the monarch butterflies. These findings were highly criticised by Sears et al. (2001), who concluded that the impact on monarch butterfly population of *Bt* corn is negligible. As before, these wide differences in opinions by highly reputed scholars can only result in an increased uncertainty surrounding GMOs.

Traditionally, when the consequences of consuming a particular good are uncertain, there are two competing visions of public regulation. The "paternalistic" vision dictates that - given the lack of reliable information and a likely myopic assessment of the health risk by consumers - governments should be called to make a final decision about the opportunity of marketing the product. A competing vision - rooted in the liberal principle that anyone is the best judge of his or her own interest - claims that governments should only favour both the dissemination of valuable information and an acceptable level of competition among producers, leaving consumers free of making the choices which suit them best. It is commonly argued that the first vision has basically characterized the European policy towards GMOs, whereas the second would fit better the direction undertaken by U.S. In any case, both visions would reflect citizens' (voters') attitudes towards GM foods, rooted in cultural sensitivities, trust in regulation and quality of the available information (Gaskell et al., 1999).

The above mentioned distinction is however less precise than what is commonly understood. For example, one can interpret the U.S. policy of *not* requiring labelling food with genetically modified content as paternalistic as well, for it presupposes that there is no need to inform consumers to allow them to make the right choice given their beliefs. The government has already made it for all consumers *in order to avoid confusion*[10]. Indeed, the favour accorded by consumers to biotechnology may in many

[10] On this point see,e.g., results by Mathios and Ippolito (1999). The authors test whether regulatory changes in the mid '80s in the US – which allowed producers to link diet to disease risk in advertising and labelling – resulted in improved consumers' food choices (i.e., more

cases reflect governments' support; as in China, where Public Authorities work to fulfil a self-sufficiency food policy (McCluskey and Loureiro, 2003). This compels us to consider the arguments put forward to increase public acceptance of GMOs. Pro-biotech parties usually try to gain support for GMOs by emphasizing that their use contributes both to enhance environmental quality and to increase food availability, so reducing the world hunger[11]. But these arguments tend to overcome consumers' diffidence by proposing that comprehensible cautiousness be traded-off with the potential gains accruing from full exploitation of modern technology. Apart from not being entirely clear why pro bio-tech parties should be interested either in reducing the world hunger or in contributing to preserve the environment, there might be reasons to argue that the alleged beneficial effects deriving from the diffusion of biotech food are regarded by consumers as second-order with respect to their primary concern, that is their health.

How should then the decision between two *paternalistic* policies, one aimed at informing consumers and the other aimed at helping consumers to avoid confusion, be made? Our results put forward that information on GMOs matters, and negative information matters more than positive information (which suggests that consumers' are risk-averse); hence – having decided to market these products – governments

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information is better) or, on the contrary, confused consumers slowing improvements in diet that would otherwise occur (i.e., more information is worst). Results suggest there is no evidence in support of the "confusion hypothesis". On the contrary, more healthful product innovations emerged from the competition of producers on health.

[11] See, for example, the website of the *Council for Biotechnology information*, a non-profit organization that communicates science-based information about the benefits and safety of agricultural biotechnology and its contribution to sustainable development, http://www.whybiotech.com/.

should impose mandatory labels[12]. GM foods are practically *indistinguishable* from their non genetically modified counterparts. Therefore, in the absence of labelling information, no chance is given to consumers to identify them. Labels involve substantial costs for the biotech and the food industries, basically connected to the need of maintaining a segregation system (e.g., Buckwell et al., 1999; Wilson and Dahl, 2005). From this point of view, even if there were no doubts that GMOs are safe for public health, labelling would be beneficial to consumers, because it would allow them to properly identify different products[13]. Clearly, this benefits should be weighted against costs. But labelling (and benefits for consumers) is even more important here, given, as discussed before, uncertainty on several important aspects concerning GMOs.

Second, our findings indicate that not all information has an equal value to consumers; these trust particularly what they believe are unbiased information sources, like their GPs. This result indicate that the crucial issue is not the presence of the label *per se*, but the availability of the necessary information to make good use of the label to assess potential health risks. In the light of this result, the problem for producers should not be to lobby in order to obtain a non mandatory label, but to remove uncertainties and ambiguities surrounding GM foods. Our results suggest that this can be achieved by properly informing (and convincing) GPs and other health

[12] In Europe, actual legislation dictates that food and feed must carry a label if they contain (or are produced from) GMOs in a proportion higher than 0.9 %.
[13] Not surprisingly, labels are used to inform consumers about different production techinques, involving organic farming or exclusion of GMOs.

professionals that risks for human health are minimal[14]. The fact that producers of GM foods are not going in this direction is an indirect signal of the remaining uncertainties.

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[14] This seems not to be the case. See for instance the *Better Health Channel* sponsored by the State Government of Victoria in Australia, approved by independent health and medical experts, and award winning health and medical information website (http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/genetically_modified_foods?open). As for the health effects of GMOs, consumers come to know that *"minimal research has been conducted into the potential acute or chronic health risks of using GM foods and of their performance in relation to a range of health effects. Research also needs to involve independent (not company-based) assessment of the long-term effects of GM crops in the field and on human health"* (last access, March 2011). See also the conclusion of the position paper by the *American Academy of Environmental Medicine* (AAEM), a group of clinicians funded in 1965 in the US: "with the precautionary principle in mind, because GM foods have not been properly tested for human consumption, and because there is ample evidence of probable harm, the AAEM asks: a) physicians to educate their patients, the medical community, and the public to avoid GM foods when possible and provide educational materials concerning GM foods and health risks; b) physicians to consider the possible role of GM foods in the disease processes of the patients they treat and to document any changes in patient health when changing from GM food to non-GM food; c) our members, the medical community, and the independent scientific community to gather case studies potentially related to GM food consumption and health effects, begin epidemiological research to investigate the role of GM foods on human health, and conduct safe methods of determining the effect of GM foods on human health; d) for a moratorium on GM food, implementation of immediate long term independent safety testing, and labelling of GM foods, which is necessary for the health and safety of consumers" (http://www.aaemonline.org/gmopost.html; last access, March 2011).

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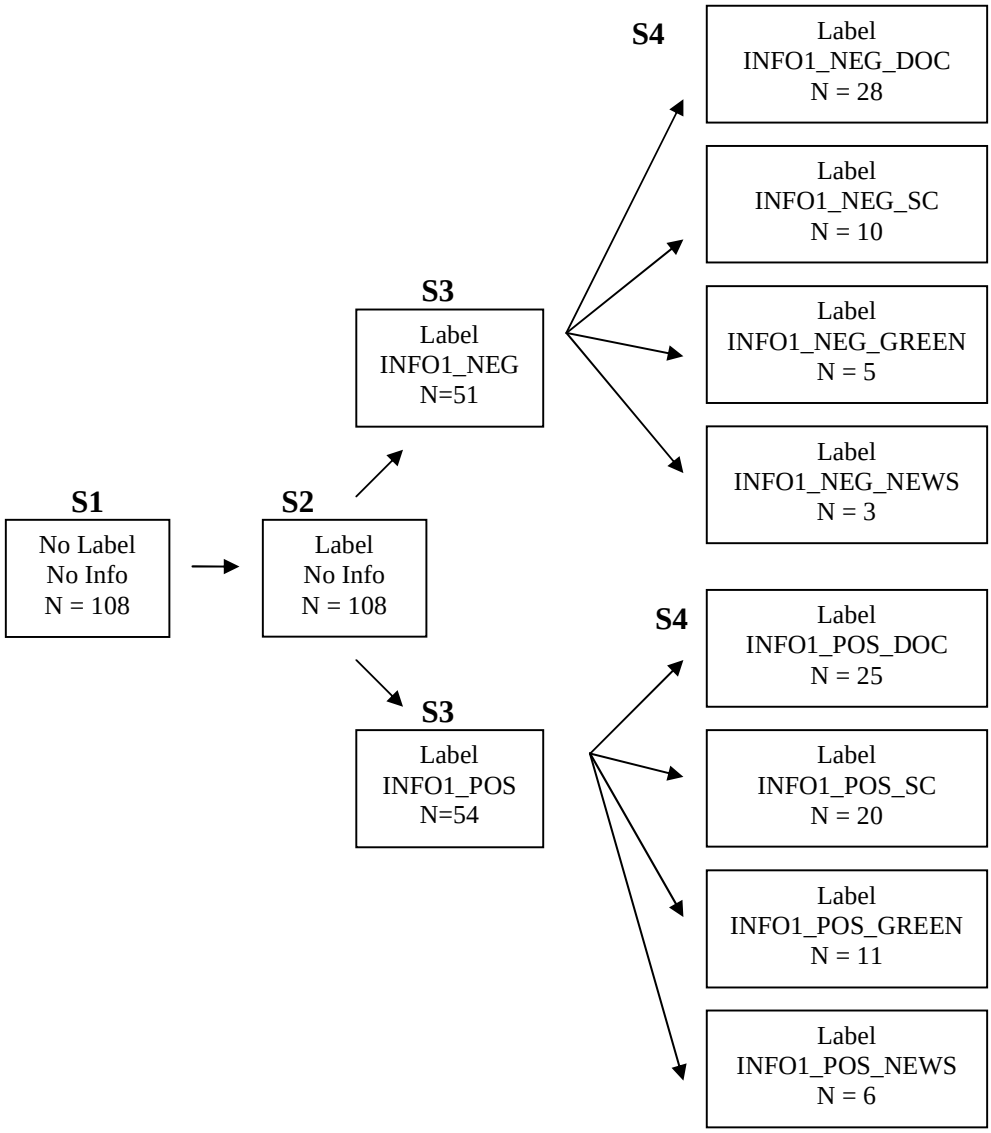
Appendix A – The Experimental Design



Appendix B – Decision Sheets

FIGURE B1. Decision sheet in S1.

CODE_____

Net WT: 1 liter
Ingredients: orange juice
No GMOs

Suppose you are endowed with 5 €. How much are you willing to pay to get the product displayed above?

FIGURE B2. Decision sheet in S2.

CODE_____

Net WT: 1 liter
Ingredients: orange juice
Contains GMOs

Suppose you are endowed with 5 €. How much are you willing to pay to get the product displayed above?

FIGURE B3. Decision sheet in S3
(Group A – Positive information).

CODE_____

Net WT: 1 liter
Ingredients: orange juice
Contains GMOs

The newscast gave the following news: the use of GMOs increases crops and helps in reducing global hunger

Suppose you are endowed with 5 €. How much are you willing to pay to get the product displayed above?

FIGURE B4. Decision sheet in S3
(Group B – Negative information).

CODE_____

Net WT: 1 liter
Ingredients: orange juice
Contains GMOs

The newscast gave the following news: the use of GMOs causes immune reactions and increases the percentage of allergic people

Suppose you are endowed with 5 €. How much are you willing to pay to get the product displayed above?

FIGURE B5. Decision sheet in S4.
Subjects choose the information source among: GPs, Greenpeace, Il Sole24Ore, Scientists

CODE_____

Net WT: 1 liter
Ingredients: orange juice
Contains GMOs

INFORMATION

Suppose you are endowed with 5 €. How much are you willing to pay to get the product displayed above?

Information – GPs

Genetically modified proteins are very injurious. After having consumed genetically modified food, we can keep on living with genetically modified proteins for long time because they continuously replicate in our body. Doctors report increasing digestive problems among their patients during the last ten years.

Information – Greenpeace

Plants and animals become a sort of "living" genetic pollution that shifts, reproduces itself and interacts with the surrounding environment. If something goes wrong, there is no way to come back: the process is irreversible.

Information – IlSole24ore (October 2007, the 28th)

Vegetables are more and more attacked by new viruses and parasites. The recombined techniques of the DNA allow us to save them: actually, GMO food is more ecologic.

Information – Scientists

Is biotech food safe for human being? Yes, until the opposite is proved. Concerning toxicity, it is clear specific effects from GMOs are not likely to be expected.

Appendix C – Socio-Demographic Questionnaire

CODE: _____

1. Age:
2. Gender: Male Female
3. How often do you do shopping? Never Once a month Twice a month More than twice a month
4. If you did not answer "never" to the previous question: do you check whether the product you buy contains GMOs? Yes No
5. Do you usually buy orange juice? Yes No
6. Is this the first time you have heard of genetically modified food? Yes No
7. If you answered "yes" to the previous question, could you tell us if you are either: in favour of GMOs against GMOs
8. Do you live out of Turin? Yes No
9)If you have answered "yes" to the previous question: how do you usually come to the University? by car by tram/bus by train.

Appendix D - Tables and Figures

TABLE 1. Variable Definition.

Variable	Definition	Mean	St.dev.	Min	Max
Male	1 = male	0.49	0.5		
Age	participant's age	22.8	4.83	20	54
Supermarket	1 = participants who regularly go to the supermarket	0.12	0.33		
Control	1 = participant controls the label before buying a product	0.39	0.49		
Juice	1 = participant regularly consumes orange juice	0.58	0.49		
Pro-GMOs	1 = participant is pro GMOs (only 20 subjects answered)	0.15	0.37		
First	1 = participant know what GMOs are	All but one knew what GMOs means			

Table 2. Determinants of average valuation in S1 and S2.

		Average valuation in S1	**Average valuation in S2**
M (N = 51)		1.57	0.88
F (N = 54)		1.36	0.71
Mann-Whitney test		*p = 0.28*	*p = 0.35*
Juice (N = 13)		1.49	0.79
┐Juice (N = 91)		1.43	0.77
Mann-Whitney test		*p = 0.10*	*p = 0.35*
Control (N = 41)		1.40	0.65
┐Control (N = 63)		1.50	0.86
Mann-Whitney test		*p = 0.45*	***p = 0.064***
Supermarket (N = 13)		1.45	0.93
┐ Supermarket (N = 91)		1.46	0.76
Mann-Whitney test		*p = 0.8*	*p = 0.13*

TABLE 3. Average valuation (S2 and S3) by quality of information received, either negative (INFO1_NEG) or positive (INFO1_POS).

	Average valuation in S2	**Average valuation in S3**	*Wilcoxon test*	*Kolmogorov-Smirnov test*
INFO1_NEG (N = 51)	0.83	0.40	***p = 0.000***	***p = 0.000***
INFO1_POS (N = 54)	0.73	0.98	***p = 0.000***	***p = 0.000***
Mann-Whitney test	*p = 0.564*			

TABLE 4. Average valuation (S2 and S3) by sex and quality of the information received (either negative or positive).

		Average valuation in S2 (1)	**Average valuation in S3 (2)**	**Difference in average valuation between S3 and S2 (2) – (1)**	***Wilcoxon test***
	INFO1_ NEG				
Male (N = 14)		1.15	0.63	-0.52	***p = 0.0024***
Female (N = 30)		0.72	0.31	-0.41	***p = 0.000***
Mann – Whitney test				*p = 0.334*	
	INFO1_ POS				
Male (N = 37)		0.75	0.87	0.12	***p = 0.0055***
Female (N = 24)		0.71	1.14	0.43	***p = 0.0003***
Mann – Whitney test				***p = 0.013***	

TABLE 5. Distribution of the choices concerning the information source in S4 by sex.

	M	**F**	**TOT**
Physicians	18	35	53
Scientists	19	11	30
Other	14	8	22
TOT	54	51	105
Chi2		***p = 0.01***	

TABLE 6. Average valuation (S1-S4) by quality of information received in S3 (either positive or negative) and choice of the information source in S4.

	Average valuation in S1	**Average valuation in S2**	**Average valuation in S3 (1)**	**Average valuation in S4 (2)**	*Wilcoxon test (1) = (2)*
INFO1_NEG_DOC (N = 28)	1.42	0.87	0.4	0.13	**p = 0.0007**
INFO1_NEG_SC (N = 10)	1.29	0.84	0.58	0.66	p = 0.5653
INFO1_NEG_GREEN (N = 5)	1.32	0.61	0.04	0.14	-
INFO1_NEG_NEWS (N = 3)	2	0.83	0.4	0.37	-
INFO1_POS_DOC (N = 25)	1.43	0.82	1.17	0.48	**p = 0.000**
INFO1_POS_SC (N = 20)	1.45	0.74	0.88	0.94	p = 0.12
INFO1_POS_GREEN (N = 11)	1.67	0.41	0.45	0.34	p = 0.12
INFO1_POS_NEWS (N = 6)	1.6	0.93	1.47	1.62	-

Appendix E – The econometric analysis

R1. OLS Regression. Dependent variable: Average evaluation S3$_i$ – Average evaluation S2$_i$

	I	II	III
INFO1_NEG$_i$	- .436*** (.07)	- .316** (.13)	-.55** (.254)
INFO1_POS$_i$	.243*** (.06)	.482*** (.131)	.25 (.274)
age	-	-	.009 (.01)
*INFO1_NEG$_i$*male*	-	- .036 (.166)	-.071 (.165)
*INFO1_POS$_i$*male*	-	- .299** (.132)	-.349*** (.13)
*INFO1_NEG$_i$*control*	-	.042 (.156)	.05 (.155)
*INFO1_POS$_i$*control*	-	- .043 (.136)	-.039 (.134)
*INFO1_NEG$_i$*juice*	-	- .21 (.16)	-.18 (.156)
*INFO1_POS$_i$*juice*	-	- .038 (.129)	-.009 (.134)
INFO1_NEG$_i$ supermarket*	-	- .366 (.361)	-
INFO1_POS$_i$ supermarket*	-	- .119 (.172)	-
N	108	104	104
F	27.76***	6.3***	6.9***
R^2	.3437	.4014	.3971

Standard errors in parentheses
** significance at 5%
*** significance at 1%

R2. Bivariate probit regression – Dependent variables: DOC, SC

	DOC	**SC**
INFO1_NEG$_i$	-.155 (.702)	-1.02 (.739)
INFO1_POS$_i$	-.573 (.745)	-.808 (.809)
age	.037 (.029)	.002 (.03)
male	-.879*** (.291)	.573* (.309)
control	-.219 (.283)	.257 (.29)
juice	-.007 (.277)	-.158 (.298)
supermarket	.621 (.436)	-.378 (.47)
N	104	104
rho	-1***	
Wald chi2	50.7***	

Standard errors in parentheses
*** significance at 10%**
***** significance at 1%**