Discussion Papers in Economics

Weak Aversion to GM Foods: Experimental Evidence from India

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March, 2010

Discussion Paper 10-02

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The authors would like to thank Charles Noussair for sharing the instructions from his experiment with us, and the participants at the EAERE Annual Conference 2008, Sweden, and at the Conference on Growth, Inequality and Institutions, Jawaharlal Nehru University, 2008 for their helpful comments. The authors gratefully acknowledge research funding from the South Asia Biosafety Program, an IFPRI managed program funded by the United States Agency for International Development.

Abstract

The paper makes two important contributions to the literature studying consumer attitudes towards genetically modified foods. First, it elicits willingness- to- pay for similar food products that differ only in their content of GMOs. Second and more importantly, it examines how probabilistic information matters in the formation of food preferences. The paper advances a definition of consumers who are weakly GM averse, i.e., those who do not react to probabilistic information unless it comes in the form of a label. An experiment involving auctions of food products is designed to estimate weak GM aversion on the part of such consumers. In our experiment, about one-fifth of GM averse subjects are weakly averse. Presence of such consumers may have implications for the potential market size for labeled GM foods.

Key words: Genetically modified foods, experimental methods, GM aversion, consumer attitudes, probabilistic information, GM-label

JEL Codes: C9, Q13, Q16, Q18, L15

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1. Introduction

Policies towards labeling of genetically modified or GM foods have varied between countries. The great divide has been between the policies in the European Union that has favored mandatory labeling and the United States, which has chosen not to impose such requirements. Developing countries have also been confronted with this issue. While Brazil and China have adopted mandatory labeling laws, Philippines and South Africa have pursued approaches based on voluntary labeling. In India, a proposal for mandatory labeling of all GM foods is being actively considered by the government.

The trans-Atlantic divide over labeling policy is matched by corresponding differences in other areas of policy as well as consumer acceptability of GM products. Since 1999, the EU has followed a moratorium on growing GM crops. The EU opposition to GM crops is strongly supported by lobbying efforts, including the Green Party, Greenpeace, Friends of the Earth, and organic farmers (Schmitz 2004). Consumer resistance to GM foods is also much greater in Europe and Japan than it is in the United States. This was confirmed by the study of Lusk *et. al* (2006) in an experimental setting where they showed that the level of compensation required to induce consumers to accept GM food was much higher for European compared to US consumers. Whether as a result of mandatory labeling or consumer resistance, most EU retailers have stopped selling GM food altogether (Gruere, 2006; Lusk et.al, 2006).

A conventional analysis of consumer preferences towards GM foods is, however, difficult because of unavailability of market data. As GM foods are not commonly sold in Europe, consumer demands cannot be estimated. In the US, where GM foods are available, market data cannot be used because the GM content is not labeled on the foods. An alternative is to elicit valuations via hypothetical surveys. However, it is questionable to what extent such hypothetical valuations match observed purchase behaviour.

To simulate real world purchase decisions, some researchers have designed experiments where subjects can bid for foods with money. In a typical experiment study, valuations are elicited for a GM and a non-GM food. As it is not possible by visual inspection to ascertain whether a product is GM, the foods used in the study are appropriately labelled. Huffman, *et. al* (2003, 2004), Lusk *et. al* (2006) and Noussair *et.al* (2002, 2004) are some of the studies that have utilized such experimental data to analyse consumer demand for GM food. European and US consumers are the subject of these studies. To our knowledge, there is no study that investigates consumer preferences towards GM foods in a developing country context using experimental methods.[1]

This paper is a contribution to this small and growing literature on consumer preferences and perceptions of GM foods. Like the literature cited above, we too use experimental methods to study attitudes towards GM foods. Our paper is, however, a departure from the literature in two important ways. First, we use subjects from New Delhi, India outside the usual developed country context. Consumers in developed countries are widely exposed to the debates on GM foods but media attention to GM foods has been limited in India.

Second, the paper advances the literature by examining how information formats (and in particular, probabilistic information) matter to the formation of food preferences. Towards this end, the study reports on an experiment that assigns information and

[1] Anand et al. (2007), Deodhar et al. (2007), Krishna and Qaim (2008) are some papers that study consumer awareness and willingness to pay for GM foods in India using consumer survey methods.

labeling treatments to subjects who participated in laboratory experiments of food items that might be genetically modified.

To establish the context for this paper, consider a scenario where labeling is not mandatory. A food company may then mull whether it ought to label its products. The supply of labeled GM-free food adds to costs because of the additional costs of not using GM ingredients and of putting in place segregation systems. As against this, by supplying GM-free food and pricing it at a premium, the company could hope for higher margins and greater revenues. Labeled GM-free food could attract additional consumers who in the absence of labeling stay away from the product suspecting it to contain GM ingredients.

It is not, however, automatic that revenues would increase as volumes could fall because of the behavior of existing consumers. Since these consumers buy the product even in the absence of labeling, it might be surmised that they are not GM-averse. Therefore, confronted with an equivalent but labeled GM-free food, these consumers could opt for the cheaper (GM) food.

This story, while seeming reasonable, ignores the impact of the label on existing consumers. In this paper, we consider a pathway by which the label affects the valuation of foods and propose a utility function that models these effects. We show that this allows for the possibility that once a food is labeled, some of the existing consumers (of unlabeled food) switch to labeled GM-free food. These are the consumers we call `weakly GM-averse' as against the `strongly GM-averse' who are the consumers who decline to consume unlabeled foods suspecting them to be GM. The goal of the experiment is to test for the existence of weakly GM averse consumers. If such consumers exist, the potential market for labeled GM-free foods would be larger than what might be evident from consumer behavior in a market with unlabeled food.

The next section surveys the literature in consumer research and in economics that is relevant to this paper. Section 3 defines weak aversion to GM foods with reference to a postulated utility function. This is followed by a section that describes the experiment and the test for weak GM aversion. Findings are reported in section 5.

2. Survey of Literature

The theoretical and experimental literature in economics assumes that consumer preferences towards GM foods are fully formed and that they are independent of external stimuli such as labels. This is quite contrary to the literature in consumer research and marketing. Referring to this literature, Creyer and Ross Jr. (1997) state that "…recent research suggests that many consumers do not have well-articulated preferences; consequently their choices and preferences are often influenced by the information available in the environment……… Different information formats seem to facilitate the use of different strategies and heuristics, which in turn may lead to differences in expressed preference and choice…. That preferences are often constructed during the choice process, rather than simply retrieved from memory, suggests that the information available at the time of choice has a significant impact on the decision outcome."

It is well known to survey researchers that consumer response is affected materially by how questions are posed and how information is presented. There is little reason to believe that labels are exempt from such framing effects. For instance, Grankvist, Dahlstrand and Biel (2004) compare "positive" and "negative" eco-labels.

Positive labels advertise the environmental benefit of the product while negative labels indicate the adverse outcomes to the environment. Their experiment shows that the label type did not matter either to consumers with no interest in environmental affairs or to those with strong interest in environmental protection. However, preferences of individuals with an intermediate interest in environment were more affected by a negative than a positive label. In another application of eco-labeling, Tiesl, Rubin and Noblet (2008) model the process by which preferences are formed. They show that the impact of labels depends on a number of other factors including prior perceptions, cognitive abilities, the credibility of information and personal characteristics.

The economics literature is now beginning to acknowledge the cognitive process by which consumers absorb information. For instance, it has been suggested that people have a limited capacity to process signals and only signals that are sufficiently intense are perceived. Consumers dedicate their attention capacity to the 'strongest' signals, i.e., the signal must be strong enough to have an impact (Falkinger 2008).

The cognitive process that is triggered by labels and other kinds of information has not received attention in experimental studies of consumer valuation of GM foods. The focus of this literature is to measure the extent of aversion to GM foods as revealed by the auctions of GM and non-GM foods. These studies, however, reveal some anomalies that point to the necessity of a deeper investigation of the cognitive processes.

Huffman et. al (2003, 2004) analyse the effects of labels when combined with different kinds of information (pro-biotech, pro-environment and so on). Subjects bid for the GM-labeled product in one round and a `plain' labeled product in another round. The plain label identified only the contents of the food package while the GM label also stated that the product was made using genetic modification. One set of participants were randomly assigned to first bid for the foods with plain labels and then for the foods with GM label in the subsequent round. For other participants, the sequence was reversed. The significant finding is that the discount on GM-labeled foods is less when consumers first bid on GM-labeled foods compared to the reverse sequence. Clearly, this result may have something to do with how consumers process information from labels.

Noussair et.al (2004) conduct an experiment where they auction four types of biscuits referred as S, L, C and N during the sessions. The first round consists of blind tasting followed by auctions. In the second round, the experimenters reveal the product type for S (`S contains GMOs') and N (`N is GMO free'). This is followed by an auction as well. No announcement is made for *L* and *C*. Yet, they report (Table 2 in the paper) a small decrease in average bids for these two products from round one to round two. In round three, labels for *L* (`No ingredient in *L* contains more than 1% GMOs') and *C* (`No ingredient in *C* contains more than 0.1% GMOs') are revealed. The auctions in this round lead to a sharp fall in the average bid for *L* and a modest rise in the average bid for *C*.

The decline in average bids in round two could have happened because it is probable that the labels for *S* and *N* change the subject's perceptions of *L* and *C* as well. In particular, subjects may perceive an increase in the probability that these products contain GM ingredients as well. However, the decrease in average bids were limited suggesting that for the great majority of subjects, the likelihood that products *L* and *C* contained GMOs did not change very much from rounds one and two or even if it did, it did not change their bids substantially. On the other hand, the label used in round three either sharply changed that likelihood and/or their bids for the products. Thus the data seem to suggest that there exist consumers who reveal only mild or no dislike for GM foods when information is probabilistic. However, when their foods are labeled, their disutility from consuming GM foods is pronounced. Their preferences could, in principle, be distinguished from consumers who intensely dislike GM foods. Such consumers, it might be expected, would react strongly to the background information in round two that implied non-negligible probabilities for the events that either *L* or *C* or both were GM. Therefore, this experiment is also suggestive that consumers may process probabilistic information in different ways.

3. Weak Aversion to GM foods

We model GM and non-GM products as being vertically differentiated, (based on the unit demand model of Mussa and Rosen, 1978) where consumers have a higher willingness to pay for the non-GM attribute.[2] An individual consumer buys at most one unit of the good, which could be GM with probability π, where $\pi \in [0,1]$. We posit that either quality (GM or non-GM) provides the same basic utility v, but consuming the GM variant also leads to a disutility that differs across consumers. The disutility is non-decreasing in the probability of the product being GM.[3] Specifically, utility is given by

$$U = v - p_i - g(\pi_i;\theta) \qquad (1)$$

where p_i is the price of the variant i. g is a reduced-form representation of the cognitive processes by which consumers map probabilistic information to utility outcomes. It is a

[2] The Mussa-Rosen model is widely employed in the theoretical literature on the economics of GM food labeling (Fulton and Giannakas (2004), Kirchhoff and Zago (2001), Lapan and Moschini (2004, 2007))

[3] A discrete version of the model where there are only two variants – GM and non-GM, is considered by Lapan and Moschini (2007).

function of π_i , i.e., the consumer's perception of the probability that a product is GM. θ is a parameter of the g function that varies across consumers and we assume that the disutility function is non-decreasing in θ. *As a result,* θ becomes an index of the aversion to GM foods.

The function g is non-decreasing in π_i for GM averse consumers. Further assume, that at the supports,

$$g(0,\theta) = 0, \qquad g(1,\theta) = \theta\overline{G}, \qquad \text{where} \quad \overline{G} > 0$$

As $g(\pi_i, \theta)$ is the disutility caused by the GM attribute, the maximum disutility (for a fixed θ) occurs at $\pi = 1$ and the least disutility occurs at $\pi = 0$.

Strongly GM averse consumers and weakly GM averse consumers are distinguished by the shape of the g function for values of π between zero and one. The strongly GM averse consumers are characterized by $\frac{\partial g}{\partial \pi} > 0$ for $0 < \pi < 1$ while the weakly GM averse consumers are characterized by

$$g(\pi;\theta) = \begin{cases} 0 & \mathit{for}\ 0 \le \pi < 1 \\ \theta\overline{G} & \mathit{for}\ \pi = 1 \end{cases}$$

Thus, for weakly GM averse consumers, the g(.) function is flat for all π < 1. On the other hand, the g(.) function is strictly increasing in this range for all strongly risk averse GM consumers.

Suppose U_0 is the reservation level of utility that a consumer gets when the good is not purchased. Then the maximum that a consumer is willing to pay for a product with GM probability π_i is W that satisfies

$$W = v - g(\pi_i;\theta) - U_0 \qquad (2)$$

Notice that as π_i increases, the willingness to pay *W* declines for strongly risk-averse GM consumers. On the other hand, for weakly risk averse consumers, *W* is invariant to π_i for all values less than one. At π_i = 1, the willingness to pay for both types of consumers (with the same θ and *g*(.) function) is identical and given by

$$W = v - \theta\overline{G} - U_0 \tag{3}$$

The difference in the slope of *W* with respect to π_i provides us with a basis to distinguish between strongly GM averse and weakly GM averse consumers.

In the above formulation, the cognitive function is postulated as mapping probabilities to utility outcomes. However, this ignores the underlying cognitive processes that lead to the formation of probabilities. The experiment that is described below attempts to identify the weakly GM averse on the basis of the invariance of price bids to probabilistic information. As the invariance could arise either because of static subjective probabilities or because of a flat *g* function, the empirical exercise is consistent with either reason.

4. Subject Pool and Experiment Design

The experiment is designed to study the extent that consumers value the absence of GMOs in food products by measuring changes in willingness to pay in response to new information about GMO content. The protocol we use is similar in spirit to several other experimental protocols in the literature that use Vickrey auction type techniques like Noussair et al (2002, 2004).

We ran three separate experimental sessions. Two of the sessions used Bachelors degree students in Engineering (from the Indian Institute of Technology (IIT) in New

Delhi). The other session consisted of university teachers from all parts of India (participants at a training course at the Jawaharlal Nehru University (JNU) also in New Delhi).

Of the total pool of 114 subjects, 64 were students and the 50 were older university teachers. As a result, about 58% of the subject pool is less than the age of 25. Most of the college teachers are in the early stages of their career – only about 9% of the subject pool is 36 or greater. About 39% of the subject pool is female. In terms of parental background, most of the subjects come from families with high levels of educational attainment. Nearly 76% of the subjects have fathers who have studied beyond high school. The corresponding figure for mother's education is 52%. About 69% of the subjects report family incomes in the range of Rs. 100,000 to Rs. 500,000 which spans the range of what is known as the middle class in India. These incomes are well above median incomes in India.

By no means is our sample representative. In particular, compared to a representative sample, our study sample is biased towards urban consumers with higher than average family incomes and educational attainment. However, it can be argued that even such a limited group is worthy of study because (a) their attitudes and lifestyles are aspired to by other socio-economic groups and more importantly (b) they are the primary consumers of packaged foods that would be subject to mandatory labeling laws.

The experiments were conducted in large classrooms with the subjects seated away from each other. They were trained in the bidding protocol using a quiz and were not allowed to communicate during the session. In our experiment, subjects bid for real consumer goods using the Becker-De-Groot -Marschak (BDM) mechanism (Becker et al, 1964). The subjects had an endowment of 200 units of lab currency (deemed Francs, which convert to Indian Rupees at the rate of 4 Francs to a Rupee). In each round of the four rounds of auctions, they gave in writing the price that they would be willing to pay for a unit of both the products (the GM and the non-GM). After all the four rounds were complete, one round was randomly picked and a valuation for each of the two products was picked from the uniform distribution [1, 100]. If a participant's valuation was above this, he or she would purchase a unit at the drawn price, otherwise he or she would keep her endowment to take home in Rupees.

In the BDM type of auction, bidders have a dominant strategy in bidding an amount equal to their true valuations for the good. There are several advantages to using demand-revealing mechanisms to elicit willingness to pay information. Firstly, the use of money as a metric allows for comparisons of intensity of preferences between subjects, as well as goods. Secondly in an auction, the subject is committing himself to an actual purchase, unlike in a poll where there is no commitment. Thirdly, in a demand-revealing mechanism, there is a dominant strategy to indicate one's true valuation. In principle this allows willingness to pay be directly measured, rather than inferred. Fourthly, notice that though we deem it an "auction" there is no strategic (in the standard game theoretic sense) incentive as in a usual sealed bid auction as every participant whose valuation lies above the drawn price wins a unit. Note that when bidding for the products, we do not make the bids public information at any time, so that privacy of the valuations is safeguarded and subjects cannot use others' bids to update their own valuations. The time line for the procedures is given in Table 1.

We auctioned two products, which we called *A* and *B* during the session. The products were chocolate chips cookies that are available in stores in Delhi. The products were close substitutes; very similar in taste and appearance. The experiment consisted of four rounds of bidding, as outlined in Table 1. At the beginning of the experiment, subjects received a sample of both products without its packaging or labeling. Before bidding in the first period, subjects were required to taste each product. Then they marked down how much they liked the product on a scale where "I like it very much" and "I don't like it at all" were at the extremes of the rating scale. Then the first period auction took place. The two products were auctioned simultaneously. Each of the following periods consisted of the revelation of some information about some or all of the products, followed by a simultaneous auction for both products. The sale price was not drawn for any period until the end of period four and no information was given to participants about other players' bids.

At the beginning of the second period, we distributed a handout containing answers to the following questions about GMOs.

a) What are genetically modified foods?

b) Why are they produced?

c) Why is there opposition to their consumption?

d) What is government policy regarding GM foods in India?

The information was an unbiased characterization so as not to affect consumer preferences towards GMO. The information handout is given in Appendix.

At the beginning of the third period, we revealed the information regarding the GM status of the product. The products were still enclosed in our packaging (and not the manufacturer's packaging) and they had labels designed by us. On both products, the label read "Chocolate Chip Cookies". But the label of product B had an additional statement which read "This product may have been subject to genetic modification". The label matched the proposed stipulation regarding GM labeling in India. Thus we revealed it to the participants that product A is GM-free and product B could be subject to genetic modification. Finally in the last period, we revealed the brands of two products in the original packaging.

5. Prior Information and weak GM aversion

By assumption, weak GM averse consumers do not react to probabilistic information unlike strongly GM averse consumers. The experiment is structured to capture this distinction. In period one, we ask consumers to bid based on blind tasting. The notion of GM foods is still very new in the Indian context and not many subjects would have imagined that possibility. To prompt the subjects' thinking in that direction, we provide in period two, a one page handout containing background information about GM foods. After the subjects have read it, we ask them to report their subjective probability that the products on offer are genetically modified. With nothing more than taste and appearance to guide them, their subjective probabilities are nothing but guesses. But we would expect that those who are strongly GM averse will react to their subjective probabilities. On the other hand, those who are weakly GM averse would not react to the possibilities implied by the information. In period three, the labels are revealed and so all the subjective uncertainty is resolved. In terms of the notation of section 3, the subjective probability π becomes zero for product A and one for product B for all consumers.

By comparing the price bids between the first and third period, we can identify the GM averse consumers. Out of this group, the class of weakly GM averse consumers would be those whose bids are unchanged from the first period (in the blind tasting environment) to the second period (in the probabilistic information environment). For these consumers, it takes a label to affect their responses. The remaining GM averse consumers are strongly averse because their bids in the second period (for one or both products) are different from the bids in period one. The direction of change depends on the subjective probabilities for both products and therefore cannot be generalized for all strongly GM averse consumers.

6. Taste Rankings and Subjective Probabilities

In the blind tasting, subjects are asked to rank each of the products on a taste scale of one to seven (higher is the number, greater is the liking) with increments of 0.5. Therefore, a choice is made from 14 possible values. Figure 1 plots the empirical cumulative density function of rankings for both these products. If one ignores, the crossing of the distributions at low taste levels, rankings for product A (which in later periods is revealed to be the non-GM product) dominate that of product B (revealed later to be the GM product) by first order stochastic dominance. The sample mean of the taste rankings of product A is 4.96 and that of product B is 4.44. The Spearman's rank correlation between the two taste rankings is –0.1664 and the null that the rankings are independent is not rejected at the 8% level of significance.

In period two, subjects were asked to evaluate the likelihood of either product being GM on a scale of 1 to 5. Figure 2 plots the empirical cumulative density of this evaluation. As can be seen, the proportion of consumers who regard product A (the non-GM product) as GM is higher than the similar proportion for product B at all likelihood levels from one to five. Thus, the sample mean of the likelihood that product B is GM is higher than that of product A (2.96 for B as against 2.63 for A). It therefore seems that product B was less liked and also regarded as more likely to be genetically modified.

Figure 3 plots the scatter between the consumer perceptions that either product is GM. The scatter suggests that there is not much of a relation between the perceptions of the two products. However, the Spearman rank correlation is 0.22 and is significant at the 2% level. Thus, there is a small, positive and significant correlation between the perceptions of both products.

For most of the subjects, the probabilities are strictly in the interior. Only a total of nine subjects report unit probabilities for either of the products.[4] In addition, only 11 subjects report prior probabilities of less than or equal to 0.3 on both products. Therefore, for the bulk of the subjects, the probabilistic perception about the products is in mid-range.

The sample means for both products indicate that the average probability that either product is GM is greater than 0.5. Out of the 113 subjects who report both these subjective probabilities, 94 of them have a probability of at least 0.5 on either or both products. Thus, the background information on GM foods provided in period 2 leads subjects to form high subjective probabilities for at least one of the products. With such high subjective probabilities, it is expected that that it will affect the price bids of those who are GM averse. In particular, if the sample is characterized by aversion to GM foods, then higher subjective probability should lead to lower price bids.

[4] No one reports unit subjective probabilities for both products.

This is confirmed in Table 2 where the second period bid price of product *i* (*i* =A, B) is regressed against its first period bid price, the first period bid price of the other product, the subjective probability that product *i* is GM, the subjective probability that the other product is GM, product *i*'s taste ranking revealed from the blind tasting round and the taste ranking of the other product. The first regression in Table 2 is in levels and the second regression is in logs.

As might be expected, the second period bids are highly (and positively) correlated with first period bids of the same product. Furthermore, the GM probability perception of a product drives its valuation down. As probability is defined on a likelihood scale from one to five, the first column results suggest that other things held constant, an individual with a probability perception of 0.5 has a valuation lower by Rs. 10 than an individual with a probability perception close to zero.

But do probability perceptions matter to everybody in the sample? Out of the 114 subjects, 102 report price bids in both periods. And out of these 102 subjects, 36 (i.e., more than a third) did not alter their price bids (for both products) from period one to period two. We call these as "information inert" subjects because their price bids are invariant to the elicitation of subjective probabilities and to the background information on GM foods that was distributed in the second period. Therefore the negative relation between second period bids and the subjective probability in the regression of Table 2 must come from rest of the sample.

At the end of section 3, it was noted that individuals could be information inert because of two reasons. The first possibility is that the information does not change bids because it does not sufficiently change subjective probabilities upwards. The second possibility is that the cognitive mapping *g* is flat in the relevant range. In Table 3, we tabulate the averages of the subjective probabilities of information inert and non-information inert subjects. These figures show that the subjective probabilities of the inert subjects are indeed lower than that of non-inert subjects. However, in no case is the difference statistically significant at the 5% level. Also the average subjective probability for the inert subject for both products is 0.5 or higher. So it seems that in our sample, while both reasons may operate, it is the difference in the cognitive component of the utility function (the *g* function) that seems more important for inertness.

Thus we have seen that while in the aggregate, probabilistic perceptions of foods being GM do negatively affect their valuation, this is not true for a substantial fraction of the sample that are information inert. Despite subjective probabilities greater than 0.5, these information inert subjects do not alter their price bids from period one to period two.

7. Weak Aversion to GM Foods

Let w_{ij} denote the willingness to pay for product j (j = A,B) in period i. Consider the difference in valuations between product A and product B in period three, i.e., $(w_{3A} - w_{3B})$ when the GM labels are revealed to the subjects. This difference can be decomposed into a difference in valuation because of GM content and a difference in valuation because of perceptions of taste, color, appearance and other quality attributes. The latter can be computed from the difference in valuation in period one, i.e., $(w_{1A} - w_{1B})$ when the subjects state their price bids on the basis of blind tasting. Therefore, the difference in valuation because of GM label is $(w_{3A} - w_{3B})$ - $(w_{1A} - w_{1B})$.

This is the quantitative measure of GM aversion. More generally define, $V_i = (w_{iA} - w_{iB})$ - ($w_{1A} - w_{1B}$), i = 2,3,4, as the change in the quality spread between the two products as a result of the information revealed up to period *i*.

A subject is defined to be GM averse if $V_3 > 0$. The subject is said to exhibit weak GM aversion if the subject is both GM averse and information inert. GM averse subjects who are not information inert are strongly GM averse. A subject is GM indifferent if $V_3 = 0$ and is GM loving if $V_3 < 0$.

Table 4 classifies the sample according to these definitions.[5] About half of the sample is GM averse and out of this about a fifth is weakly GM averse. Note that it could be argued that our definition of information inert subjects is on the stringent side. Of the subjects who altered their price bids between periods one and the two, the revision is by small amounts in many cases. It is possible that faced with a second round of bidding, these subjects may have thought that the "correct" response was to alter the price bid. A broader definition of inertness could consider subjects who did not either alter the price bids or they did so by small amounts. For instance, suppose we define subjects as information inert if the revision of price bids is Rs. 5 or less on both the products. Then the number of information inert subjects rises to 55 (from 36) and the number of weakly GM averse rises to 19 (from 11).

Table 5 displays the measures of quality difference $(w_{iA} - w_{iB})$, i = 1,2,3,4 from each round of bidding and the change in quality spread V_i, i = 2,3,4 in the successive periods. The measures are computed for the entire sample, the pool of GM averse and the subsets of strong and weak GM averse. For the entire sample, the quality spread

[5] The table classifies 101 subjects who report bids for both products in periods one and three. The remainder thirteen subjects do not report bids for both products and in both periods.

doubles from period one to period three and the average GM aversion is Rs, 6.25 which is about 13% of the average bid for the GM product in period three. However, the modest aversion on average conceals the wide variation among consumers as GM aversion is confined to only about half of the sample. As a result, the aversion among the GM averse is much higher at Rs. 24. As our sample was biased towards urban, well-educated middle-class subjects, it is likely that aversion would be lower in a more representative sample.

The striking feature of Table 5 is that the levels of aversion of the weakly GM averse are almost at the same levels as the strongly GM averse. In the case of the strongly GM averse, the discounting of the GM product begins in period two itself. For this group, the quality spreads between products A and B is highly sensitive to the probabilistic information that the products might be genetically modified. On the other hand, for the weakly GM averse, the quality spread is insensitive to probabilistic information. It is the label in period three that affects the quality spread thereby manifesting in GM food aversion.

8. Conclusions

Studies of consumer preferences towards GM foods have focused on the impact of labels on consumer behavior. On that basis, they have concluded about the extent of aversion to GM foods. In this paper, we examined what happens prior to the expression of aversion to GM-labeled foods. In particular, the paper investigated the effect of probabilistic information on GM food aversion using experimental methods.

On the basis of existing research in consumer psychology and marketing, the paper postulated that different consumers may process probabilistic information differently. The paper distinguished between weakly and strongly GM averse consumers – a distinction not previously made in the literature. While both categories express aversion to GM-labeled food, the former do not react to probabilistic information. The experiment was designed to capture this distinction.

The experiment confirmed the existence of weakly GM averse consumers. While these consumers show no or little aversion to GM foods on the basis of probabilistic information (in the second period of the experiment), their aversion to GM-labeled foods is almost as large as that of the strongly GM averse consumers. This suggests that labeling would have a significant impact on the market for GM-labeled foods. Indeed, the existence of weakly GM averse consumers may be one reason why suppliers of GM foods oppose mandatory labeling of GM foods.

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Appendix I

Background information about GMOs

1. What are genetically modified foods?

Foods derived from plants that are genetically modified are called genetically modified (GM) foods. A plant is genetically modified if it contains genes that have been inserted using genetic engineering techniques.

2. How is genetic engineering different from traditional plant breeding?

Genetic engineering makes it possible to insert a gene from another organism (such as another plant species, bacteria or animal) into the plant variety of interest. This is not possible with the traditional techniques of producing improved plant varieties.

3. Why are GM foods produced?

GM foods are developed – and marketed – because there is some perceived advantage either to the producer or consumer of these foods. The first generation of GM plants have given more direct benefits to growers than to consumers although the latter have possibly gained from lower prices.

4. What are examples of genetically modified plants?

The principal examples of genetically modified crops occur in soyabeans, maize (i.e., corn) and cotton. For instance, genes from a commonly found soil bacteria have been used to produce soybeans, maize and cotton that are naturally resistant to certain pests.

5. Why are GM foods regulated?

There are two broad concerns with GM plants. First, because the foods are novel, the must be tested for toxicity and possible allergenicity. The second issue is whether the engineered gene can escape into wild populations and other unintended plants. For these reasons, GM crops must be assessed for food and environmental safety before they can be planted.

6. What is the status of GM foods in India?

In India, no GM food crop has been approved for planting yet. Therefore, foods produced from domestically produced crops are not genetically modified. Foods that are imported could contain ingredients that are genetically modified. As of now, India does not have separate regulations for imports of GM food other than what applies to imported foods generally.

7. Why do some people oppose GM foods?

Several NGOs and individuals claim that GM plants pose unacceptable risks to food safety as well as environment safety. They argue that transferring genes between organisms creates new risks for human health that cannot be fully comprehended by our existing scientific knowledge. They would therefore recommend that GM foods should be banned or severely curtailed until risk assessments are more comprehensive in testing the adverse effects on human health.

This is disputed by biotechnology advocates who point out that GM crops are extensively tested before they are approved. According to the World Health Organization (WHO), "GM foods currently available on the international market have passed risk assessments and are not likely to present risks for human health. In addition, no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved."

Table 1

Sequence of Events in the Experiment Session

Period 1	- Information: blind tasting of two products
	- Recording of hedonic rating of the two products
	- Auction
Period 2	- Additional information: General information about GM products
	- Recording of consumer perception about likelihood of each product being GM
	- Auction
Period 3	- Additional information: Product *A* is non-GM and product *B* may be subject to genetic modification (Product Labeling)
	- Auction
Period 4	- Additional information: Brand names of the two products
	- Auction
Transactions	- Random draw of the auction that counts towards final allocations
	- Random draw of sale price of two products
	- Implementation of the transaction for the period that counts

Figure 1: Cumulative density function of taste rankings

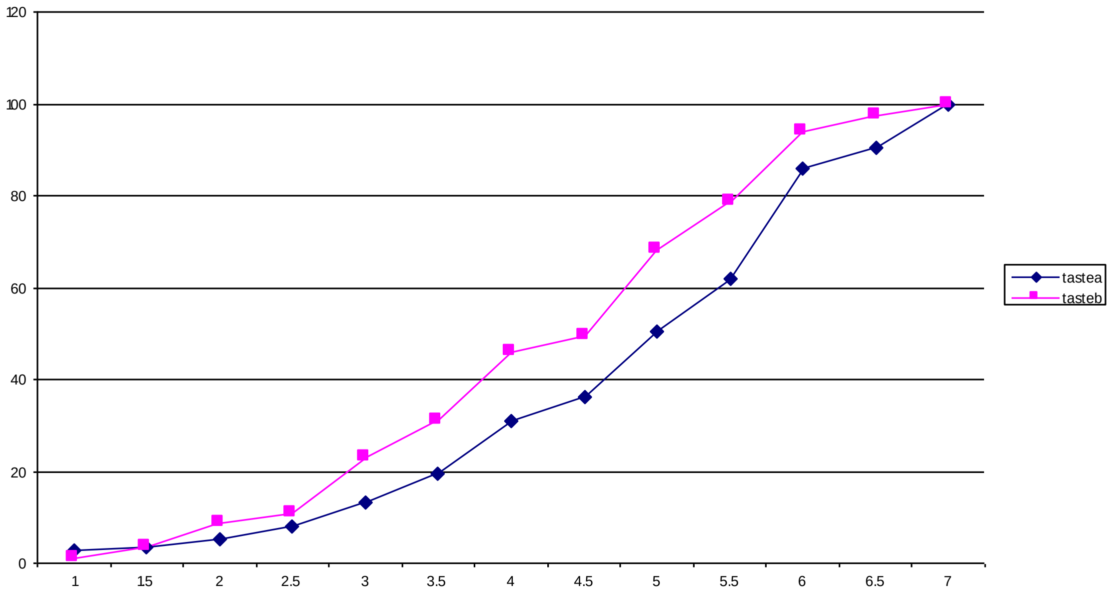

Figure 2: Cumulative density function of GM likelihood rankings

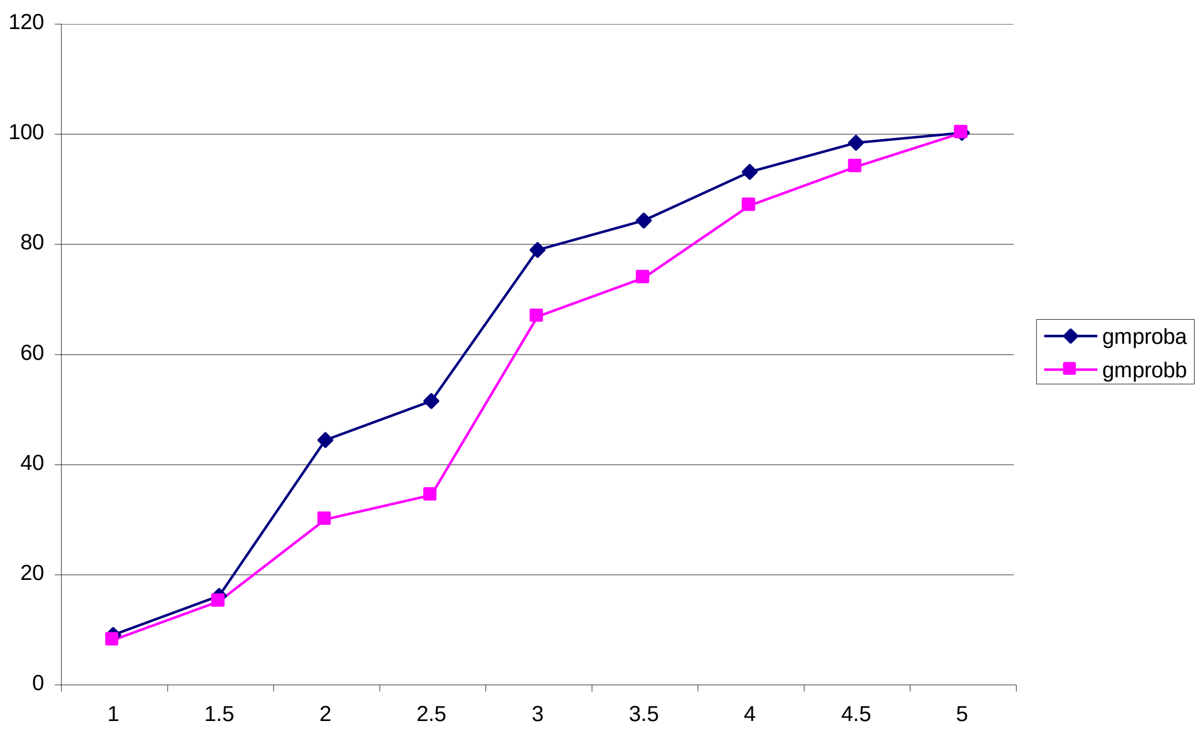

Figure 3: Scatter of subject perceptions of likelihood of product A is GM vs likelihood of product B is GM

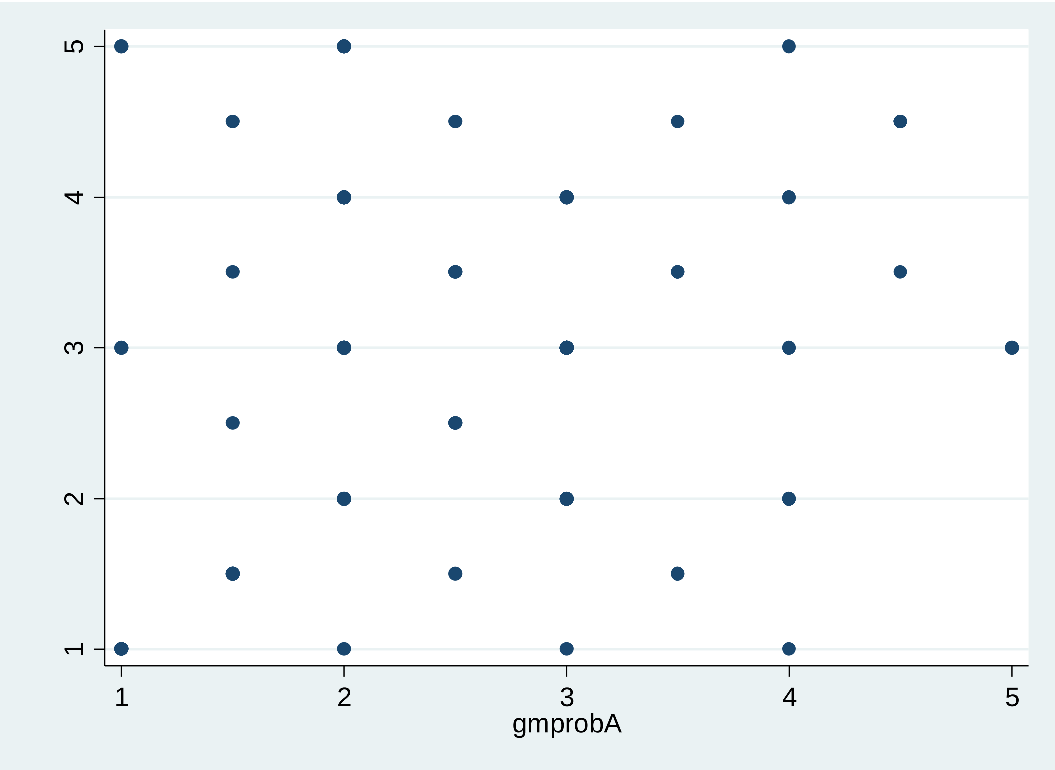

Table 2: The determinants of second round bids

VARIABLES	(1) In levels	(2) In logs
First round price bid	0.842***	0.948***
	(0.0554)	(0.0743)
First round price bid for other product	0.0361	0.0427
	(0.0509)	(0.0780)
Probability that product is GM	-3.997***	-0.462**
	(1.374)	(0.179)
Probability that other product is GM	0.792	0.117
	(1.352)	(0.197)
Taste Ranking of product	-0.876	-0.115
	(1.019)	(0.238)
Taste Ranking of other product	-2.384**	-0.395*
	(1.066)	(0.204)
Constant	32.39***	1.013
	(10.25)	(0.812)
Observations	202	202
R-squared	0.647	0.349

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Difference in Average Subjective Probabilities between Inert and Non-Inert Subjects

	Inert	Non-Inert	Difference	p-value of test that difference = 0
Likelihood that A is GM	2.5	2.66	0.16	0.44
Likeliihood that B is GM	2.66	2.99	0.33	0.17
# of subjects	36	66	--	---

Table 4: Classification of Sample

	# Subjects	% of sample
GM Averse	51	50%
Weakly GM averse (subset of GM averse)	11	11%
GM indifferent	25	25%
GM loving	25	25%
Total	101	

Table 5: Measure of Quality Difference and GM Aversion

Periods	All Sample		GM Averse		Strongly GM Averse		Weakly GM Averse	
	$(w_{iA} - w_{iB})$	V_i	$(w_{iA} - w_{iB})$	V_i	$(w_{iA} - w_{iB})$	V_i	$(w_{iA} - w_{iB})$	V_i
1	5.91	----	5.10	-----	6.65	-------	-0.55	-------
2	9.56	3.65	18.16	13.06	23.30	16.65	-0.55	0.00
3	12.16	6.25	28.86	23.76	30.72	24.07	22.09	22.63
4	12.25	6.34	26.27	21.18	26.72	20.07	24.63	25.18